Metric 3.4.1-

The Institution ensures implementation of its stated Code of Ethics for research.

The institution has a stated Code of Ethics for research and the implementation of which is ensured through the following:

- **Inclusion of research ethics in the research methodology course work**
- **Presence of institutional Ethics committee (Animal, Chemical, Bio-ethics etc.)**
- **Plagiarism check through software**
- **Research Advisory Committee**

Findings of DVV-

Copy of the syllabus of the research methodology course work. □ Constitution of the ethics committee and its proceedings approved by the appropriate body. □ Constitution of research advisory committee and its proceedings approved by the appropriate body. □ Bills of purchase of plagiarism check software in the name of the HEI. In case if documents are in regional language please provide translated copy in English. Google drive links are not accepted.

Response of HEI-

1) Copy of the syllabus of the research methodology course work is attached. (**Appendix-I**)

2) Constitution of the ethics committee and its proceedings are attached. (**Appendix-II**)

3) Constitution of research advisory committee and its proceedings are attached. (**Appendix-III**)

4) Bills of purchase of plagiarism check software in the name of the HEI is attached. (**Appendix-IV**)

Appendix-I

Research Methodology Subject in PG

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University)

Andheri (W), Mumbai – 400058

COURSE CONTENTS

(M. Tech. in Power Electronics & Power System)

Semester I

Academic Year: 2023-24

List of Courses

Advanced Power Electronics

Course Code	Course Name
PC-MTPX101	**Advanced Power Electronics**

Course pre-requisites	**Power Electronics**

Course Objectives
The objectives of this course are 1. To understand the switching behaviour of power electronics devices 2. To study the different power electronics circuits such as AC-DC, DC-AC converters 3. To demonstrate the design of power electronics circuit for different applications
Course Outcomes
Upon successful completion of the course, students should be able to 1. to classify and demonstrate the switching behavior of the power electronic devices 2. Analyze, design and select proper converters for various applications in electrical engineering

Course Content

Module No.	***Details***	***Hrs.***
1	**Advanced solid state devices:** • MOSFETs, IGBT, GTO, IGCT etc. • Power modules, intelligent power modules, gating circuits. • Thermal design, protection. • Digital signal processors used in their control	4
2	**Non-isolated dc-dc converters:** Buck, boost, Buck-boost, Cuk, SEPIC, Zeta in DCM and CCM **Isolated dc-dc converters:** Flyback, forward, Cuk, SEPIC, Zeta, half bridge, push-pull. Bridge in DCM and CCM Non-Isolated and Isolated dc-dc converters application in SMPS, UPS, welding and lighting systems. Analysis and design methodology (Case study based on IEEE papers)	8
3	**Modeling and control of DC to DC converters:** Review of classical methods of modeling. State space model of various ideal and non-ideal dc to dc converters, state space averaging techniques, small signal analysis, transfer function, feedback control, compensator design, voltage feed forward PWM control, current mode control, slope compensation, comparison of current mode and voltage mode control.	6
4	**Three-phase improved power quality dc-ac converters:** VSC, multilevel VSCs, multi pulse VSCs, PWM CSC (current voltage source converters).Analysis and design methodology **Multi pulse ac-dc converters:** Diode and thyristor based converters. Refer IEEE papers for case study.	6
5	Implementation aspects, modification of power circuit for four quadrant operation of inverter	6

6	**Applications of power electronic converters:** Residential applications, Industrial applications, Electric utility applications, Renewable energy technology applications. Case study based on IEEE papers	6
7	**Soft switching techniques:** Loss reduction in power electronic switches. Soft switching in DC-DC converters, Resonant soft switching converters. Case study based on IEEE papers	

Text Books	
1	N. Mohan, T. M. Undeland & W. P. Robbins, "Power Electronics: Converter, Applications & Design", John Wiley & Sons, 3rd edition sept. 2002, © 2003.
2	M.H. Rashid, "Power Electronics: Circuits Devices and Applications", Prentice Hall of India, 3rd edition 1994.
Reference Books	
1.	K. Bose, "Power Electronics & A.C. Drives", Prentice Hall, 2002.
2.	B. Xinbo Ruan "Soft-switching PWM Full-Bridge converters Topologies, Control & Design", John Wiley & Sons, Inc. 1st edition April 2014, © 2018

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Computer Aided Power System Analysis

Course Code	Course Name
PC-MTPX102	Computer Aided Power System Analysis

Course pre-requisites	PSA, PSOC, Numerical techniques, programming skills

Course Objectives

The objectives of this course are

1. To understand analysis of power systems using Computer methods.
2. To understand the advance techniques in the solution of power flow problem.
3. To understand the solution methods and techniques involved in power system analysis.
4. To understand the behavior of power system under healthy and faulty condition.

Course Outcomes

At the end of the course, students will demonstrate the ability to

1. Analyze the power system under symmetrical and unsymmetrical fault condition using Zbus
2. Appraise the use of matrix computation and optimization in the field of power system
3. Evaluate state of the complex power system by various state estimation tools.
4. Investigate the behavior of power system under different operating conditions

Course Content

Module No.	*Details*	*Hrs.*
1	**Mathematical concepts:** Sparse Matrices: Sparsity directed Optimal Ordering Schemes, Solution Algorithms – LU Factorization Numerical methods to solve non-linear equation: Gauss-Seidel, Newton Raphson method, Optimization Methods: Nonlinear constraint optimization, Lagrangian Multiplier approach, Linear programming, Least square Estimation	5
2	**AC Power Flow Analysis:** Preparing/using data files required for power flow studies such as line data, generation data, and bus data. Ybus formation by Power flow solution algorithms such as Gauss Siedel, Newton Raphson, Fast Decoupled and DC power flow for multi- machine or IEEE systems. Power flow studies for distribution systems.	6
3	**Analysis of Faulted Power System:** Symmetrical and Asymmetrical Faults, Zbus Formulation, Short Circuit Analysis of Large Power Systems using Zbus.	5
4	**Power System stability:** Numerical solution of Swing equation using Forward Euler method, Runge-kutta 4^{th} order method, and stability study of multi-machine system.	6
5	**Load Forecasting Techniques:** classification of forecasting, Introduction to time series, Linear regression, forecasting methodologies, estimation of average, trend & periodic components, time series approach, kalman filter approach, long term load forecasting for system planning. Introduction to Machine learning approach for load forecasting. Error analysis in load forecasting.	8

6	**Power System State Estimation**: Introduction, Network Topology Processing, observability analysis, Linear and non-linear state estimation	6
7	**Security Analysis:** Basic Concepts, Static Security Analysis at Control Centre, Contingency Analysis, Contingency Selection.	6

Term Work

Term work shall comprise of

1. Tutorials based on each module in the syllabus content
2. MCQ examination

Text Books

1. Kothari. D.P, Nagrath I.J., "Modern Power System Analysis" ,TMH publication.
2. Prabha Kundur, "Power System stability and Control", TMH Publication.

Reference Books

1. Grainger John J., Stevenson William D., "Power system Analysis", MC Graw Hill.
2. Chakrabarti .A, Halder.S, "Power System Analysis-Operation and Control", PHI
3. Hadi Sadat, "Power System Analysis", MC Graw Hill
4. S. A. Soman, S. A. Khaparde, Shubha Pandit, "Computational Methods for Large Sparse Power System Analysis: An Object Oriented Approach", Springer
5. M. A. Pai, D. Chatterjee, "Computer Techniques in Power System Analysis", McGraw Hill Education
6. David S. Watkins, Fundamentals of Matrix Computations, 3rd Edition, Willey-Inter science, 2010

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-2024

Research Methodology and IPR

Course Code	Course Name
PC-MTPX103	Research Methodology and IPR

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To develop an ability to identify, formulate research problem.
2. To develop an ability to apply knowledge of research methodology to engineering
3. Problems.
4. To carry out research on engineering problems.
5. To develop an ability to investigate the phenomenon in a critical manner.
6. Develop critical thinking to find business opportunities and to solve questions related to industries.
7. To get knowledge on various kinds of research questions and research designs

Course Outcomes

Upon successful completion of the course, students should be able

1. To carry out literature survey by using various research considerations
2. To formulate the problem statement using research considerations.
3. Understanding that when IPR would take such important place in growth of individuals and nation, it is needless to emphasize the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
4. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Definition of Research: Research Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Definition and Dimension of a Theory, Functions and Characteristics; Types of Theory: General Theory and Particular/Empirical Theory. Cases and their Limitations; Causal Relations. Philosophy and validity of research. Objectives of research.	8
2	**Characteristics of research** Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.	4
3	**Types of research** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.	6
4	**Research Procedure** Formulating the Research Problem, Literature Review, Developing the objectives, preparing the research design including sample Design, Sample size.	6
5	**Considerations in selecting research problem**	6

	Relevance, interest, available data, choice of data, Analysis of data, generalization and interpretation of analysis	
6	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of Technology. Patent information and databases. Geographical Indications.	6
7	**New Developments in IPR:** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	6

Text Books

Reference Books

1. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers" Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques,* New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2nd ed), Singapore, Pearson Education.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Distributed Generation and Micro Grid

Course Code	Course Name
PE-MTPX101	**Distributed Generation and Micro Grid**
Course pre-requisites	Power System

Course Objectives
The objectives of this course are 1. To illustrate the concept of distributed generation. 2. To analyse the impact of grid integration. 3. To study concept of Micro grid and its configuration
Course Outcomes
Upon successful completion of the course, students should be able to 1. Review the conventional power generation 2. Analyse the concept of distributed generation and installation 3. Design the grid integration system with conventional and non-conventional energy sources 4 D sign AC and DC icro grid 5. grid planning and operational issues related to Distributed Generation & micro grid.

Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction:** Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Distributed vs Central Station Generation Sources of Energy **Distributed generations:** Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547, DG installation classes, security issues in DG Implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants	6
2	**Impact of grid integration:** Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.	6
3	**Basics of a micro grid:** Concept and definition of micro grid, micro grid drivers and benefits, review of sources of micro grids, typical structure and configuration of a micro grid, AC and DC micro grids, Power Electronics interfaces in DC & AC micro grids.	6
4	**Control and operation of micro grid:** Modes of operation and control of micro grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active & communication based techniques, micro grid communication infrastructure	6

5	Impact of Distributed Generation on the Power System. Power Quality Disturbances. Power quality issues in micro grids, regulatory standards, Micro grid economics	4
6	Control of DG inverters, phase locked loops, current control and DC voltage control for standalone and grid parallel operations. Protection of the converter Relaying and protection: distributed generation interconnection relaying, sensing using CTs and PTs.	6
7	DG planning cost implications of power quality, cost of energy and net present value calculations and implications on power converter design. Economics of Distributed Generation-Case Studies	8

Term Work

Term work shall comprise of

1. Tutorials based on each module in the syllabus content
   Case study based on IEEE papers
2. MCQ examination

Reference Books

1. Technical literature-papers published in power electronics related journals and IEEE standards.
2. Ned Mohan, Tore M. Undeland, William P Robbins, “Power Electronics: Converters, Application, and Design”. Wiley, 2002.
3. Ranjan Rakesh, Kothari D.P, Singal K.C, “Renewable Energy Sources and Emerging Technologies”,2nd Ed. Prentice Hall of India ,2011
4. Math H. Bollen, Fainan Hassan,“ Integration of Distributed Generation in the Power System”, July 2011, Wiley –IEEE Press
5. Loi Lei Lai, Tze Fun Chan, “Distributed Generation: Induction and Permanent Magnet Generators”, October 2007, Wiley-IEEE Press.
6. Roger A. Messenger, Jerry Ventre, “Photovoltaic System Engineering”, 3rd Ed, 2010

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Power Electronics Applications to Renewable Energy

Course Code	Course Name
PE-MTPX102	**Power Electronics Applications to Renewable Energy**

Course pre-requisites	Power Electronics

Course Objectives

The objectives of this course are
1. To get exposure to wind and solar systems
2. To understand the factors involved in installation and commissioning of a Solar or Wind plant.
3. Learning the dynamics involved when interconnected with power system grid

Course Outcomes

Upon successful completion of the course, students should be able
1. Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems
2. Demonstrate the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems.
3. Demonstrate the knowledge of physics of solar power generation and the associated issues
4. Identify, formulate and solve the problems of energy crises using wind and solar energy

Course Content

Module No.	*Details*	*Hrs.*
1	**Solar Photovoltaic (PV) Systems**: PV cell concepts, Mathematical representation and basic performance characteristic, performance with series parallel combination of cells with identical and non-identical cell combination. **Energy Storage devices**.	6
2	**Power Electronics for PV applications:** Maximum Power point Tracking (MPPT) analysis. Algorithm for MPPT.	6
3	**Solar Energy System:** Analysis and Design of solar system for small and large installations- case study. Refer IEEE papers for case studies	6
4	**Wind Energy Systems:** Basic concept and Mathematical representation and basic performance characteristics and control strategy.	6
5	Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm with power systems. Isolated wind systems, reactive power and voltage control, economic aspects Case study based on IEEE papers	6
6	Analysis and Design of wind energy system for small & large installations Case study. Refer IEEE papers for case studies	6
7	**Grid connected wind and Solar Energy conversion systems:** Grid connectors, connection issues, its impacts on power	6

	system quality & dynamics –analysis	

Term Work

Term work shall comprise of

1.Tutorials based on . Using hardware such as latest microcontroller/processor such as Arduino, TI DSP, Atmel uC, Lattice CPLD evaluation board with peripherals.
2.MCQ examination

Text Books

1. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata McGraw Hill, Second Edition, 1999
2. Mukund R Patel " Wind and Solar Power Systems: Design, Analysis, and Operation" 2nd edition CRC Taylor Francis, 2006.

Reference Books

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Wiley and sons ltd.2005
2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Wiley and sons ltd., 2006

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Modeling and Analysis of Electrical Machines

Course Code	Course Name
PE-MTPX103	**Modeling and Analysis of Electrical Machines**

Course pre-requisites	Electrical Machines

Course Objectives		
The objectives of this course are 1. To understand the representation electrical machines by the set of mathematical equations. 2. To realize the real behaviour of electrical machines. 3. To study the concepts of space phasors and frame transformation		
Course Outcomes		
Upon successful completion of the course, students should be able to 1. Implement the mathematical representation of electrical machines. 2. Demonstrate the reference frame theory and its application for representation of induction machine model. 3. Analyse the behaviour of induction machine from its mathematical model		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Magnetically Coupled Circuits:** Coupled Circuit with and without Leakage Linear Magnetic System, Nonlinear Magnetic System, Computer Simulation of Coupled Circuits with and without leakage	5
2	**Electromechanical Energy Conversion:** Energy Relationship, Energy in Coupling Fields, Graphical Interpretation of Energy Conversion, Electromagnetic and Electrostatic Forces and Torques, Steady State and Dynamic Performance of and Electromechanical System	6
3	Machine Windings and Air Gap EMF, Winding Inductances and Voltage Equations: Synchronous Machine, Induction Machine	5
4	**Reference Frame Theory:** Introduction, Equations of Transformation Change of Variables, Stationary Circuit Variables, Transformed to the Arbitrary Frame, Resistive Elements, Inductive Elements, Capacitive Elements, Commonly used Reference Frame, Transformation between Reference Frames, Transformation of a Balanced Set, Balanced Steady State Phasor Relationships, Balanced Steady State Voltage Equations, Variables Observed from Several Frame of Reference Case study based on IEEE papers	8
5	**Theory of Symmetrical Induction Machines:** Voltage Equations in Machine Variables, Torque Equations in Machine Variables, Equations of Transformation for Rotor Circuits, Voltage Equations in Arbitrary Reference Frame Variables Case study based on IEEE papers	5
6	**Symmetrical Induction Machines Steady State and Dynamic Characteristics:**	8

	Analysis of Steady State Operation, Free Acceleration Characteristics, Free Acceleration Characteristics Viewed from Various Reference Frames, Dynamic Performance during Sudden Changes in Load Torque, Dynamic Performance during a Three Phase fault at Machine Terminals	
7	**Introduction to Synchronous Machine Theory:** Voltage Equations in Machine Variables, Torque Equations in Machine Variables, Stator Voltage Equations in Arbitrary Reference Frame Variables, Voltage Equations in Rotor Reference Frame Variables- Parks Equations, Torque Equation in Substitute Variables, Rotor Angle and Angle between Rotors.	5

Term Work

Term work shall comprise of

1. Tutorials based FEM simulation software such as COMSOL, Maxwell, Quickfield etc should be used to analyse machine design and behaviour
2. Case study based on IEEE papers
3. MCQ examination

Text Books

1. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India 2015.
2. P. C. Krause, "Analysis of Electrical Machinery and Drive System," Wiley IEEE Press, Third edition, 2013

Reference Books

1. Charles Kingsley, Jr., A.E. Fitzgerald, Stephen D. Umans, "Electric Machinery", Tata McGraw Hill, Seventh edition, 2013.
2. Ned Mohan, "Advanced electrical drives Analysis, Control and Modeling using Simulink", Wiley, 2014.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Reliability Assessment of Power System

Course Code	Course Name
PE-MTPX104	**Reliability Assessment of Power System**

Course pre-requisites	Power System

Course Objectives		
The objectives of this course are 1. The course will give a comprehensive overview of power system reliability. 2. Evaluation of conventional and non-conventional power generation system reliability. 3. To learn Modern Trends in Power system Reliability analysis		
Course Outcomes		
Upon successful completion of the course, students should be able to 1. Able to have a thorough understanding of the main principles in power system reliability analysis, knowledge of different methods and tools for reliability analysis 2. Able to interpret some advanced concepts of power system reliability that will be useful for engineering professional practice in the power sector operation and planning. 3. Able to model and analyse power system with respect to reliability of supply		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Power system Reliability:** Introduction, Basic reliability Concepts, Terms and Definitions, outage, failure rate, and outage rate availability, unavailability, Reliability function, Mean time to failure, Hazard Rate Function, Bathtub Curve. Hierarchical levels of Power system Functional Zones	6
2	**Reliability of Systems:** Serial Configuration, Parallel Configuration, Combined Series – Parallel Systems, System Structure Faction, Minimal Cuts and Minimal Paths. Reliability models, Markov process, Monte Carlo Simulation.	6
3	**Generation system reliability analysis:** Introduction, Probabilistic generating unit models, Probabilistic load models, Effective load, Reliability analysis for an Isolated system	6
4	**Generating Capacity reliability Evaluation**: Static Generating capacity: Introduction, Basic probability methods and Frequency & Duration method, capacity outage probability table, recursive algorithm, Evaluation of: loss of load indices, Loss of load expectation & Loss of energy Spinning Generating capacity: Introduction, load forecast uncertainty de rated capacity levels	6
5	Reliability evaluation of: Grid connected PV and Concentrated	6

	Solar Power (CSP) system, Wind energy system - Case study. Cost estimation, Economic and Technical Analysis of Distributed Generation Connection: Wind Farm & PV system Case Study	
6	Distributed Generation and its impacts on distribution system and reliability & Evaluation technique – Case study.	6
7	Modern Trends in Power system Reliability analysis, XML Annotations for power system reliability data representation, Web service based power system reliability data generation model. XMLised Power System Reliability Data Generation Service Interface & Implementation	6

Term Work

Term work shall comprise of

1. Tutorials based on each module in the syllabus content
2. MCQ examination

Text Books

1. Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Power System," Plenum, Press, 2nd edition, 1996.

Reference Books

1 R.L. Sullivan, "Power System Planning," Tata McGraw Hill Publishing Company, 1st edition,1997.
2 Roy Belington and Ronald N Allan, "Reliability Assessment of Large Electric Power Systems", Kluwer academic publishers, 2nd edition 1995.
3 X. Wang and J.R. McDonald, "Modern Power System Planning", McGraw Hill, 1994.
4 Ali Chowdhury, Don Koval, "Power distribution system reliability- Practical methods and applications", Wiley- IEEE press, April 2011.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Restructuring and Deregulation of Power System

Course Code	Course Name
PE-MTPX105	**Restructuring and Deregulation of Power System**

Course pre-requisites	Power system-I and power system –II

Course Objectives

The objectives of this course are

1. To differentiate between vertically integrated and deregulated power system.
2. Challenges faced in operating restructured power system with reliability, security and economic efficiency.
3. Reforms adopted by developing country like India

Course Outcomes

Upon successful completion of the course, students should be able to

1. Identify different electrical market designs.
2. Understand fundamentals of micro economics.
3. Determine the suitable pricing method for centralised and decentralised trading.
4. Understand ancillary service and congestion management requirement of restructured power system

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction of restructured power system.** • Reasons for restructuring and deregulation of power system • Entities involved • Different model of competition • Electrical market, market of commodities	**6**
2	**Fundamentals of micro economics** • Consumer behaviour • Supplier behaviour • Market equilibrium • Various cost of production • Long term and short-term cost • Types of markets • Markets with imperfection competition	**8**
3	**Introduction to optimization** • Linear optimization • Convexity • Duality • KKT condition • Lagrange multiplier • Optimal dispatch of generation	**6**

4	**Optimal Power Flow and Congestion Management.** • Optimal power flow – AC and DC formulation • Spot Pricing • Decentralized trading over the transmission network. • Centralized trading over the transmission network.	**8**
5	**Participating in markets for electrical energy** • Consumer's perspective • Producer's perspective	**4**
6	**System security and ancillary service** • Ancillary service needs • Obtaining ancillary service • Buying ancillary service • Selling ancillary service	**5**
7	**Reforms in Indian Power Sector** • Frame work of Indian power sector • Electricity act 2003 and amendments • Transmission system cost allocation • Power exchanges – Day ahead market, real-time market • Deviation settlement mechanism • Ongoing and future developments	**5**

Term Work

Term work shall comprise of

1. Tutorials based on Case study based on IEEE papers
2. MCQ examination

Text Books

1. Daniel Krischen and Goran Strbac, "Fundamental of Power System Economics", John Wiley and Sons Ltd ,2004.
2. Sally Hunt, "Making Competition Work in Electricity", John Wiley and Sons, Inc.,2002
3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolean, "Operation of restructured Power systems", Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems operation, trading and volatility", Marcel Dekker

Reference Books

1. Lorrin Philipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub.1998.
2. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Optimization Techniques

Course Code	Course Name
PE-MTPX106	Optimization Techniques

Course pre-requisites	

Course Objectives

The objectives of this course are
1. Understand various classical optimization techniques
2. Understand intelligent optimization techniques

Course Outcomes

Upon successful completion of the course, students should be able to
1. Understand importance of optimization
2. Apply basic concepts of mathematics to formulate an optimization problem
3. Analyse and appreciate variety of performance measures for various optimization problems

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to Classical Methods & Linear Programming Problems Terminology, Design Variables, Constraints, Objective Function, Problem Formulation. Calculus method, Kuhn Tucker conditions, Method of Multipliers	7
2	Linear Programming Problem, Simplex method, Two-phase method, Big-M method, duality, Integer linear Programming, Dynamic Programming, Sensitivity analysis	7
3	Single Variable Optimization Problems: Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic search method	7
4	Multi Variable and Constrained Optimization Technique, Optimality criteria, Direct search Method, Simplex search methods, Hooke-Jeve s pattern search method, Powells conjugate direction method, Gradient based method, Cauchy„s Steepest descent method, Newton„s method , Conjugate gradient method. Kuhn - Tucker conditions, Penalty Function, Concept of Lagrangian multiplier, Complex search method, Random search method	7
5	Intelligent Optimization Techniques: Introduction to Intelligent Optimization, Soft Computing, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO) - Graph 7Grammer Approach – Example Problems	7

6	Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP	7

Term Work
Term work shall comprise of 1. Tutorials 2. MCQ examination

Text Books
1. S. S. Rao, "Engineering Optimization: Theory and Practice", Wiley, 2008. 2. K. Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall, 2005.
Reference Books
1. C.J. Ray, "Optimum Design of Mechanical Elements", Wiley, 2007. 2. R. Saravanan, "Manufacturing Optimization through Intelligent Techniques, Taylor & Francis Publications, 2006. 3. D. E. Goldberg, "Genetic algorithms in Search, Optimization, and Machine learning", Addison Wesley Longman Publishing, 1989.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 6

Electric Vehicle System Design

Course Code	Course Name
PE-MTPX107	Electric Vehicle System Design

Course pre-requisites	Machines I and Machines II

Course Objectives
1. To illustrate the design philosophies used in the EV domain. 2. To explore the selection of power and control architecture of EV drives 3. To study the design aspects of EV battery packs and other auxiliary systems

Course Outcomes
Upon successful completion of the course, students should be able to 1. Select and size the electric motor for a particular EV application and performance criteria 2. Select and size the battery pack to meet desired EV performance and 3. Design the EV drive system with functional safety considerations. 4. Illustrate the use of hybrid energy source for EV performance improvement 5. Illustrate the design aspects of Automotive Subsystem

Course Content

Module No.	***Details***	***Hrs.***
1	**Selection/ Sizing of EV Electric Motors** Electric Vehicle modelling, Tractive force calculations, Design considerations for 2W, 3W and 4W EVs; Torque, power and Speed requirement, Traction Limit, Maximum Acceleration Limit, Maximum Grade Limit, Vehicle Power Demand Vehicle Performance Envelope, and Vehicle Power Envelope; Vehicle Power Demand during Driving Cycles. Design considerations for EV motors and their cooling system. Application Examples of EV /HEV motors with vehicles and motor specifications.	08
2	**Selection/ Sizing of Battery pack and other Energy Resource:** Selection of type of Battery pack for 2W, 3W and 4W EVs, Battery pack sizing, Design considerations, Range per charge, range anxiety, EV motor power requirement, Impact of road conditions, environmental conditions and traffic conditions. High-Voltage Cabling and Disconnects, Safety in Battery Design, Testing for safety. Accelerated Reliability Testing of Electric Vehicles, Battery Cycle Life versus Peak Power and Rest Period. Selection and sizing of Fuel cell for FCEV, design considerations; Battery-ultra-capacitor hybrid combination sizing, performance analysis. Design considerations for Ultra-capacitor based EV, requirement of charging infra. Flywheel selection and sizing for EV/HEV applications.	06
3	**Automotive Subsystem Design:** Electronic Control Unit (ECU) and its Control Features, Communications between ECUs, Control Software Development:	04

	Software-in-the-Loop (SIL) Simulation and Hardware-in-the-Loop (HIL) Simulation. Acceleration and braking control, regenerative braking; Automotive Steering Systems. Design considerations of HVAC controller	
4	**EV System integration:** EMC design on ECU level, EMC design on system level and in special subsystems, Radiated emissions and Conducted emissions, EMI EMC measurements.	04
5	**Design of Charging Infrastructure-1:** Design considerations for AC charger: vehicle interface and charging protocol design. applicable charging standards. Installation guidelines and grid requirement for charger installations.	08
6	**Design of Charging Infrastructure-2:** Design of On-Board Charger (OBC)-Schematic, power topology and control, Power capacities, regenerative braking control. Design considerations of DC fast charger: vehicle interface and charging protocol design. Connectivity and applicable charging standards	06
7	**Design with Functional Safety of Automotive Electronics:** Functional Safety requirements of Automotive Electronics; ASIL identification and safety goal finalization, ISO 26262. Energy Storage integrity / protection: rupture and toxic gas management; low energy stranding, Unintended vehicle movement, shock protection, and Elimination of potential thermal/ explosive event. Hazard and Risk Analysis (HARA) for different situations, Testing of vehicles for compliance of safety norms	06

Term Work
Term work shall comprise of 1. Tutorials based on each module in the syllabus content 2. MCQ examination

Text Books / Reference Books
1. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015 2. Electric Vehicle Machines and Drives Design, Analysis and Application by K. T. Chau, IEEE Press and Wiley, 2015 3. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003. 4. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press. 2005 5. Sheldon Williamsom, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013 6. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003 7. EMC and Functional Safety of Automotive Electronics by Kai Borgeest, IET, 2018

Sr. No.	Examination	Module

1	T-I	1 and 2
2	T-II	3 and 4
3	End Sem	1 to 7

Advanced Power Electronics Laboratory

Course Code	Course Name
PL-MTPX101	**Advanced Power Electronics Laboratory**

Course pre-requisites	Power Electronics

Course Objectives

The objectives of this course are
1. To realize of the real world problem of power electronics systems.
2. To study model of the power electronics systems.
3. To understand the techniques of voltage control using PWM techniques

Course Outcomes

Upon successful completion of the course, students should be able to
1. judge the results of the simulation study
2. Able to simulate the given electrical system for various operating conditions.

Course Content

Laboratory work to include at least Eight MATLAB Simulations/mini project
(refer IEEE papers as case study and implement)

Using hardware such as latest microcontroller/processor such as Arduino, TI DSP, Atmel uC, Lattice CPLD evaluation board with peripherals atleast for some experiments.

1. Study and simulate the switching characteristics MOSFETs, IGBT, GTO.
2. Simulation of Isolated and non-isolated DC-DC converters and verifying their applications in UPS, SMPS etc.
3. Simulating state space model of buck, boost converters.
4. VSC and CSC converters simulation 1 and 3 phase
5. Multi pulse DC-AC converters simulations based on papers or case study
6. Implementation of four quadrant operation of converter using inverters
7. Simulation study of soft switching techniques. ZCS and ZVS refer papers.
8. Applications of power electronics in residential, industrial etc case study

Term Work

Term work shall comprise of
1. Laboratory internal examination
2. MCQ or viva voce examination

Text Books

Reference Books

1. N. Mohan, T. M. Undeland & W. P. Robbins, “Power Electronics: Converter, Applications and Design”, John Wiley & Sons, 3rd edition sept. 2002, © 2003.
2. M.H. Rashid, “Power Electronics: Circuits Devices and Applications”, Prentice Hall of India,3rd edition 1994.
3. B. K. Bose, “Power Electronics & A.C. Drives”, Prentice Hall, 2002.
4. Xinbo Ruan “Soft-switching PWM Full-Bridge converters Topologies, Control & Design”, John Wiley & Sons, Inc. 1st edition April 2014, © 2018

Computer Aided Power System Analysis Laboratory

Course Code	Course Name
PL-MTPX102	**Computer Aided Power System Analysis Laboratory**

Course pre-requisites	Power System

Course Objectives
The objectives of this course are 1. To understand analysis of power systems using Computer methods. 2. To understand the advance techniques in the solution of power flow problem. 3. To understand the solution methods and techniques involved in power system analysis. 4. To understand the behviour of power system under healthy and faulty condition.
Course Outcomes
Upon successful completion of the course, students should be able to 1. Appraise the use of computational methods in the solution of power flow problem 2. Investigate the behaviour of power system under different operating conditions.

Course Content
Laboratory work to include at least Eight Simulations or mini projects based on reference papers. (refer IEEE papers) 1. Write MATLAB code for 4x4 Y bus matrix formation. 2. Write MATLAB code for 5X5 Y bus matrix formation 3. Compute Y bus in matlab for the following 14 bus system 4. Case study Newton Raphson method refer paper. 5. Case study Guass Siedel method refer paper. 6. LU decomposition code and case study. 7. Compute Y bus in MATLAB for the following 30 bus system 8. Seminar based on case study.
Term Work
Term work shall comprise of 1. Experiments 2. MCQ examination
Text Books
1. Kothari. D.P, Nagrath I.J., "Modern Power System Analysis" ,TMH publication. 2. Prabha Kundur, "Power System stability and Control", TMH Publication.
Reference Books

1. Grainger John J., Stevenson William D., "Power system Analysis", MC Graw Hill.
2. Chakrabarti .A, Halder.S, "Power System Analysis-Operation and Control", PHI
3. Hadi Sadat, "Power System Analysis", MC Graw Hill
4. S. A. Soman, S. A. Khaparde, Shubha Pandit, "Computational Methods for Large Sparse Power System Analysis: An Object Oriented Approach", Springer
5. M. A. Pai, D. Chatterjee, "Computer Techniques in Power System Analysis", McGraw Hill Education
6. David S. Watkins, Fundamentals of Matrix Computations, 3rd Edition, Willey-Inter science, 2010

Constitution of India

Course Code	Course Name
IK-MTPX101	Constitution of India

Course pre-requisites	

Course Objectives
Students will be able to: 1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals" constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution

Course Outcomes
Students will be able to: 1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. 3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. 4. Discuss the passage of the Hindu Code Bill of 1956

Course Content

Module No.	*Details*	*Hrs.*
1	History of Making of the Indian Constitution: History Drafting, Committee, (Composition & Working)	3
2	Philosophy of the Indian Constitution: Preamble Salient Features	3
3	Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.	3
4	Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume -II][194], Parliament, Composition ,Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions	3
5	Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat.	3
6	Elected officials and their roles, CEO Zila Pachayat: Position and	3

	role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	
7	Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women	3

Reference Books

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University)
Andheri (W), Mumbai – 400058

COURSE CONTENTS

(M.Tech. in Power Electronics & Power System)

Semester II

Academic Year: 2023-24

List of Courses

Power System Dynamics and Control

Course Code	Course Name
PC-MTPX201	**Power System Dynamics and Control**

Course pre-requisites	Power System

Course Objectives
The objectives of this course are 1. To study the stability considerations in power system. 2. To understand the different stability of power system and multi-machine stability concept 3. To study of voltage stability, PV, QV and PQ curves 4. To study of improving the stability of power system
Course Outcomes
Upon successful completion of the course, students should be able to 1. Understand and appreciate the stability concept in the power network. 2. Apply the effects of various electrical parameter on stability

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction to Power System Stability • Power system operation and control • Stability problems faced by power systems • Impact on power system operation control • Concept of equilibrium, small and large Disturbance in stability • Analysis using Numerical Integration Techniques	6
2	Modeling of a Synchronous Machine • Physical characteristics • Rotor position dependent Model • D-Q transformation, Parks transformation • Model with Standard parameters • Steady state Analysis of synchronous machine • Short circuit transient analysis of a synchronous machine • Synchronous machine connected to infinite Bus	6
3	Modeling of Exciters and prime mover system, transmission lines and load	6
4	Transient stability, swing equation, equal area criterion, solution of swing equation, Numerical methods, Euler method, Runge-Kutta method, critical clearing time and angle, effect of excitation system and governors, Application of power system stability	6
5	Multi machine stability, extended equal area criterion, transient	6

	energy function approach	
6	Methods of improving stability, transient stability enhancement High speed fault clearing ,steam turbine fast valving, high speed excitation systems, small signal stability enhancement power 6system stabilizers voltage stability enhancement, reactive power control.	6
7	Voltage stability, generation aspects, transmission system aspects, load aspects, PV curve, QV curve, PQ curve, analysis with static loads, load ability limit, sensitivity analysis, continuation power flow analysis, Instability mechanisms-examples	6

Text Books

1. Kundur, P., "Power System Stability and Control", McGraw-Hill International Editions, 1994.
2. K. R. Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.

Reference Books

1. Anderson, P.M. and Fouad, A.A., "Power System Control and Stability", John Wiley, second edition 2003.
2. Van Cutsem, T. and Vournas, C., "Voltage Stability of Electric Power Systems", Springer
3. P. Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Advanced Control of Electrical Drives

Course Code	Course Name
PC-MTPX202	**Advanced Control of Electrical Drives**

Course pre-requisites	Electrical Drives

Course Objectives
The objectives of this course are 1. To study the torque-speed characteristics of AC and DC drives and different types of load 2. To discuss modification of torque speed characteristics of AC and DC motors as per load requirements. 3. To understand the power modulators and control strategies 4. To study steady state stability of the motor load system and higher level control of ac drives.
Course Outcomes
Upon successful completion of the course, students should be able to 1. Apply the knowledge of electrical drives system for various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology. 2. Understand the basic requirements placed by mechanical systems on electric drives. 3. Apply the basic principles of power electronics in drives using switch-mode converters and pulse width modulation to synthesize the voltages in dc and ac motor drives. 4. Understand the need of modification of the torque speed characteristics of machines. Describe the operation of induction machines in steady state and dynamic condition. 5. Appreciate the speed control of induction motor drives in an energy efficient manner using power electronics with higher level control technique such as vector control.

Course Content

Module No.	***Details***	***Hrs.***
1	Review: Basics of AC and DC Drives	4
2	Principle of phase control, Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters, Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter. Constant torque and constant horsepower operations.	6
3	Modeling of DC drive elements: Equivalent circuit, transfer	6

	function of self, separately excited DC motors, Linear Transfer function model of power converters, Sensing and feedback elements, Closed loop speed control, Current and speed loops, P, PI and PID controllers response comparison, Simulation of converter and chopper fed DC drive.	
4	AC voltage controller fed induction machine operation, Energy conservation issues ,V/f operation theory, requirement for slip and stator voltage compensation, CSI fed induction machine , Operation and characteristics	8
5	Field oriented control of induction machines , DC drive analogy, Direct and Indirect methods, Flux vector estimation.	6
6	Direct torque control of Induction Machines, Torque expression with stator and rotor fluxes, DTC control strategy	6
7	Synchronous motor control, Brush and Brushless excitation, Load Commutated inverter fed drive.	6

Text Books

1. G. K. Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersey, 1989.
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

Reference Books

1. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2001.
2. B. K. Bose "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
3. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill Publishing company Ltd., New Delhi, 2002.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-2024

Seminar/Mini Project

Course Code	Course Name
PC-MTPX203	**Seminar/Mini Project**

Course pre-requisites	

Course Outcomes
1. Student will be able to apply the skill of presentation and communication techniques. 2. Student will be able to use the knowledge of the fundamentals of subjects to search the related literature. 3. Student will be able to analyze the available resources and to select most appropriate one.

Sr. No.	**Course content (Seminar):**	***Hrs.***
1	The student gathers and presents information/data about seminar topic allotted to him/her. The report and presentation shall include review of literature, case studies if applicable and findings about recent trends in the area of seminar topic. On completion of the work the student shall prepare a report and will give a Seminar on the report.	**48**
	Course Content (Mini Project):	
1	The mini project work extends for a single semester and exposes the student to develop and present his/her work related to specific topic. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	**48**
	Guidelines for Seminar-II/Mini Project	
1.	Seminar/ mini project should be based on thrust areas in Electrical Engineering (Power Electronics and Power System aspect is appreciated)	
2.	Students should do literature survey and identify the topic of seminar/ mini project and finalize in Consultation with mentor/Guide/Supervisor.	
3.	Students should use multiple literatures and understand the topic and compile the report in standard format as in front of Examiners.	
	Assessment Guidelines:	
1.	Quality of Literature survey and Novelty in the topic	
2.	Relevance to the specialization	
3.	Understanding of the topic	
4.	Quality of Written and Oral Presentation	

Advanced Techniques in Power System Protection

Course Code	Course Name
PE-MTPX201	**Advanced Techniques in Power System Protection**

Course pre-requisites	Switchgear and Protection

Course Objectives		
The objectives of this course are to 1. Understand the art and science of numerical relay technology. 2. Demonstrate the hardware description of relaying system		
Course Outcomes		
Upon successful completion of the course, students should be able to **1.** Exposure to the modern protection practices. **2.** Appreciate new trends in relay technologies		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Review of Relaying Practices:** Evolution of digital relays from electromechanical relays, Review of protection philosophies for transmission lines, generators and transformers. Modeling of Current and voltage transformers	5
2	**Mathematical background to protection algorithms:** Finite difference Techniques, Interpolation formulae-Forward, backward and central difference, interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier series and Fourier transform	8
3	**Numerical Relay :** architecture, sampling theorem, anti-aliasing filter, Fourier Algorithm, Full cycle window algorithm for phasor estimation	5
4	**Transmission Line Protection:** Distance relay scheme for three phase line, Different relay algorithms for distance protection, Out of step blocking and tripping schemes.	8
5	**Digital differential Protection**: protection of generator, transformer, bus bar protection, Travelling wave based protection schemes.	8
6	**Adaptive Relaying:** Need for adaptive relaying, Adaptive relaying for transmission lines, transformer, Auto-reclosing.	4
7	**Wide Area Measurement Applications:** WAMS architecture, WAMS based out of step relaying, supervision of back up zones, Intelligent load shedding, Intelligent islanding. Travelling Wave based techniques	4

Term Work
Term work shall comprise of . 1. Tutorials include case study of IEEE papers and some real time data study 2. MCQ examination

Text Books
1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009
Reference Books
1. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999 **2.** Gerhard Ziegler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006 **3.** S.R. Bhide “Digital Power System Protection” PHI

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Smart Grid Technologies

Course Code	Course Name
PE-MTPX202	**Smart Grid Technologies**

Course pre-requisites	Power System

Course Objectives
The objectives of this course are 1. To understand the concept of smart grid and its advantages over conventional grid 2. To understand smart metering techniques 3. To learn wide area measurement techniques 4. Understand the problems associated with integration of distributed generation & its solution through smart grid.
Course Outcomes
Upon successful completion of the course, students should be able to 1. Appreciate the difference between smart grid & conventional grid 2. Apply smart metering concepts to industrial and commercial installations 3. Formulate solutions in the areas of smart substations ,distributed generation and wide area measurements 4. Come up with smart grid solutions using modern communication technologies

Course Content

Module No.	***Details***	***Hrs.***
1	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust Self Healing Grid, Present development & International policies in Smart Grid, Threats and security in smart grid	
2	**Introduction to Smart Meters:** Real Time Pricing. Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid. Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Auto	
3	Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection. Smart storage like Battery. SMES, Pumped Hydro. Compressed Air Energy Storage, Wide Area Measurement System (WAMS). Phase Measurement Unit (PMU)	
4	**Concept of micro-grid:** Need & applications of micro-grid Formation of micro-grid, Issues of Interconnection. Protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators. Fuel-cells. Micro-turbines, Captive power plants. Integration of renewable energy sources.	

5	**Power Quality & EMC in Smart Grid**: Power Quality issues of grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid. Web based Power Quality monitoring. Power Quality Audit	
6	Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN), Bluetooth. ZigBee	
7	GPS, Wi-Fi, Wimax based communication, Wireless Mesh Network, Basics of cloud computing and cyber security for smart grid, Broadband Over Power Line(BPL), IP protocols	

Term Work

Term work shall comprise of
1.Tutorials include case study of IEEE papers and some real time data study
2. MCQ examination

Text Books

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press ,2009

Reference Books

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley 2012
2. Stuart Borlase,"Smart Grid :Infrastructure , Technology and solutions " CRC Press
3. A.G. Phadke, "Synchronized Phasor Measurement and their Applications", Springer

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

DSP Control in Power Electronics

Course Code	Course Name
PE-MTPX203	**DSP Control in Power Electronics**

Course pre-requisites	Digital Electronics

Course Objectives

The objectives of this course are

1. To understand comparison of microcontrollers and digital signal processors
2. To learn and implement DSP programming
3. To understand internal details of DSP architecture, peripheral, addressing modes, interrupt structure, hardware multiplier

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand and use new /advanced DSP
2. Implement the basic power electronics control algorithm such as PWM techniques using DSPs

Course Content

Module No.	*Details*	*Hrs.*
1	Review of microcontrollers and digital signal processors, architecture, peripheral modules.	6
2	Typical processors for control implementation, memory organization, CPU details	6
3	Addressing modes interrupt structure, hardware multiplier, pipelining, Fixed and floating-point data representations, Assemblers, linkers and loaders.	6
4	Binary file formats for processor executable files, Typical structure of timer interrupt driven programs, Implementing digital processor based control systems for power electronics.	6
5	Reference frame transformations, PLL implementations, machine models, harmonic and reactive power compensation, space vector PWM.	6
6	Numerical integration methods. Comparison in terms of time step, stability	6
7	Multitasking concepts for power electronics implementations, The need for multitasking, various multitasking method	6

Term Work

Term work shall comprise of

1. Tutorials using hardware such as latest microcontroller/processor such as Arduino, TI DSP, Atmel uC, Lattice CPLD evaluation board with peripherals.
2. MCQ examination

Text Books

1. N. Mohan, “Power Electronics”, third edition, John Wiley and Sons.

Reference Books
1. K. Ogata, “Discrete-Time Control Systems”, second edition, Pearson Education Asia.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Power Quality and FACTS

Course Code	Course Name
PE-MTPX204	**Power Quality and FACTS**

Course pre-requisites	Power System

Course Objectives		
The objectives of this course are 1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation. 2. Understand the working principles of FACTS devices and their operating characteristics. 3. Understand the basic concepts of power quality. 4. Understand the working principles of devices to improve power quality.		
Course Outcomes		
Upon successful completion of the course, students should be able to 1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation. 2. Understand the working principles of FACTS devices and their operating characteristics. 3. Understand the basic concepts of power quality. 4. Understand the working principles of devices to improve power quality.		
Course Content		
Module No.	***Details***	***Hrs.***
1	Transmission Lines and Series/Shunt Reactive Power Compensation Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	**04**
2	Thyristor-based Flexible AC Transmission Controllers (FACTS) Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	**06**
3	Voltage Source Converter based (FACTS) controllers Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM andSpace Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and	**08**

	Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.	
4	Application of FACTS Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single- machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM	**06**
5	Power Quality Problems in Distribution Systems Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc- offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	**04**
6	DSTATCOM Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM	**08**
7	Dynamic Voltage Restorer and Unified Power Quality Conditioner Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.	**06**

Term Work

Term work shall comprise of

1. Tutorials include case study of IEEE papers and some real time data study
2. MCQ examination

Text Books

1. J. Arrillaga, M. R. Watson, S. Chan, Power System Quality Assessment, John Wiley and Sons.

Reference Books

1. M. H. J. Bollen, Understanding Power Quality Problems, Voltage Sag and Interruptions, New York IEEE press, 2000 Series on Power Engineering.
2. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, Electrical Power System Quality, McGraw Hill Publication:
3. EnriquesAcha, Manuel Madrigal, Power System Harmonics – Computer Modeling and Analysis, John Wiley and Sons Ltd.
4. Ewald F. Fuchs, Mohammad A. S. Masoum, Power Quality in Power Systems and Electrical Machines.
5. G. J. Heydt, Electric Power Quality, Stars in Circule publications.
6. IEEE Std. 519-1992, IEEE recommended practices and requirements for harmonics control in electrical power system

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Nonlinear Control Theory

Course Code	Course Name
PE-MTPX 205	**Nonlinear Control Theory**

Course pre-requisites	Control System

Course Objectives		
The objectives of this course are 1. To introduce the nature of nonlinearities found in systems and control 2. To learn standard methods of analysis and design in nonlinear system.		
Course Outcomes		
Upon successful completion of the course, students should be able to 1. Understand and apply concepts of linear algebra for system analysis. 2. Understand mathematical models of various nonlinear systems. 3. Analyze performance of linear and nonlinear system and design controller		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Non-linear systems:** Introduction, behavior of non-linear system, common physical non linearity- saturation, friction, backlash, dead zone, relay, multi variable non-linearity.	4
2	**Phase Plane Analysis:** Concept of phase plane, constructing phase portrait, Phase plane analysis of linear systems, Phase plane analysis of nonlinear systems, Existence of limit cycles.	7
3	**Fundamentals of Lyapunov theory:** equilibrium points, concept of stability, linearization of nonlinear systems, Local stability, Lyapunov Equation, Lyapunov"s direct method, Stability and instability theorems.	8
4	System analysis based on Lyapunov"s direct method and Control Design based on Lyapunov"s direct method.	6
5	**Describing Functions:** Stability analysis and limit cycles, Linear compensation methods, General describing functions of common nonlinearities, Relative stability.	5
6	**Feedback linearization:** feedback linearization and canonical form, Input-state linearization, Input- output linearization.	5
7	**Control design for nonlinear system:** Control design using linearized model, Lyapunov method of control design, control design using feedback linearization and back stepping.	7
Term Work		
Term work shall comprise of 1. Tutorials 2. MCQ examination		

Text Books
1. Slotine, J. E. & Weiping Li, Applied Nonlinear Control, Prentice-Hall, [1991] 2. Khalil, Hasan K., Nonlinear Systems, Macmillan Publishing, [1992]
Reference Books
1. Chi-Tsong Chen, "Linear Systems Theory and Design", Oxford University Press New York, 1999. 2. T. Kailath, "Linear Systems", Prentice-Hall, New Jersey, 1980, Science and Business Media 2008. 3. Gilbert Strang, " Linear Algebra and its Application", Fourth Edition CENGAGE Learning 4. Ogata, K., Modern Control Engineering, Prentice-Hall, [2002] 5. Gopal, M., Modern Control System Theory, John Wiley Eastern Ltd. New Delhi, [1984] 6. Friedland, B., Control System Design, McGraw-Hill, [1986] 7. Ogata, K., State Space Analysis of Control Systems, Prentice-Hall, [1967] 8. Kuo, B. C., Automatic Control Systems, Prentice-Hall, [1987]

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Renewable Energy Sources and Grid Integration

Course Code	Course Name
PE-MTPX206	Renewable Energy Sources and Grid Integration

Course pre-requisites	Power System –I , Power Electronics

Course Objectives
The objectives of this course are 1. To study the energy scenario and the consequent growth of the power generation from renewable energy sources. 2. To study the basic physics of wind, solar, tidal, and geothermal generation power generation. 3. To study the power electronic interfaces for wind and solar generation. 4. To study social and environmental of various RES 5. To study Life cycle cost of wind and solar.
Course Outcomes
Upon successful completion of the course, students should be able to 1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources. 2. Estimate the wind, solar and small hydro power generation. 3. Understand the power electronic interfaces for wind and solar generation. 4. Evaluate the socio-environmental impact of various RES 5. Analyse the life cycle cost of wind and solar energy.

Course Content

Module No.	*Details*	*Hrs.*
1	**History of RES and basic concepts**: Graphs - global and Indian statistics, heat transfer, essential of fluid dynamics	4
2	**Wind Energy**: Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics- probability distributions, Wind speed and power-cumulative distribution functions. Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Social and environmental aspects. Life cycle cost	8
3	**Solar Energy**: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. **Solar photovoltaic:** Technologies-Amorphous, mono crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Maximum Power Point Tracking (MPPT) algorithms. **Solar thermal Electric System**: Concentrating solar power system, low temperature solar thermal, non-grid solar thermal applications. Life cycle cost	10
4	**Bulk solar and Wind farms**: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behaviour during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.	6

5	**Small Hydro**: stream flow, measuring flow, dam, diversion, measuring head calculating power.	4
6	**Tidal power**: Power from a tidal barrage, tidal resonance, kinetic energy of tidal currents, generation of tidal energy, advantages and disadvantages of tidal energy. **Geothermal power generation:** Introduction to Geophysics, dry rock and hot aquifer analysis, harnessing geothermal resources, social and environmental aspects	6
7	**Cogeneration Introduction:** Need for cogeneration, Principle of cogeneration, technical options for cogeneration, classification of cogeneration systems, Factors influencing cogeneration choice, important technical parameters for cogeneration	4

Term Work

Term work shall comprise of

1. Tutorials
2. MCQ examination.

Text Books

1. John Twidell,Tony Weir, "Renewable energy resources", Routledge; 4th edition (November 30, 2021).
2. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
3. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill,1984.

. 4. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons 2004.

5. William Shepherd, "Electricity Generation using wind power", World Scietific

Reference Books

1. S. C. Bhatia, "Advanced Renewable Energy Systems", CRC Press, 2014
2. J.F. Manwel,J G Mcgowan., "Wind Energy Explained: Theory, design and application", Wiley Publications.
3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004
4. 1547 IEEE standard

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3, Part of 4
3	End Sem	1 to 7

Business Analytics

Course Code	Course Name
OE-MTPX201	**Business Analytics**

Course pre-requisites	

Course Objectives		
The objectives of this course are 1. Understand business analysis 2. Understand transforming and financial requirements 3. Recent trends in business		
Course Outcomes		
Upon successful completion of the course, students WILL have a comprehensive understanding of business analytics methods		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Business Analysis**: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst, Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.	7
2	**Life Cycles:** Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.	7
3	**Forming Requirements**: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.	7
4	**Transforming Requirements**: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modelling, Business Process Modelling	7
5	**Finalizing Requirements**: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools	7

6	**Recent Trends in**: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.	7

Reference Books
1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press. 2. Business Analytics by James Evans, persons Education.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 6

Industrial Safety

Course Code	Course Name
OE-MTPX202	Industrial Safety

Course pre-requisites	

Course Outcomes
At the end of the course students will be able to 1. Understand basic safety norms, rules and regulations and hazards 2. Understand maintenance of utility systems and its service life expectancy 3. Understand fault and diagnostics and preventive measures 4. Understand repair cycles of machines and trouble shootings

Course Content

Module No.	*Details*	*Hrs.*
1	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	4
2	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	4
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity Lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods	4
4	Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their	4

	general causes.	
5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor	4
6	Troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive Maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets	4
7	Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	4

Reference Books

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Operations Research

Course Code	Course Name
OE-MTPX203	**Operations Research**

Course pre-requisites	

Course Outcomes
At the end of the course, the student should be able to 1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables. 2. Students should able to apply the concept of non-linear programming 3. Students should able to carry out sensitivity analysis 4. Student should able to model the real world problem and simulate it.

Course Content

Module No.	***Details***	***Hrs.***
1	Optimization Techniques, Model Formulation, models, General L. R Formulation, Simplex Techniques, Sensitivity Analysis,	5
2	Formulation of a LPP - Graphical solution revised simplex method- duality theory - dual simplex method - sensitivity analysis parametric programming	6
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem – CPM/PERT	5
4	Scheduling and sequencing – single server and multiple server models – deterministic inventory models –	5
5	Inventory Control Models, Probabilistic inventory control models – Geometric Programming.	5
6	Competitive Models, Single and Multi-channel Problems, Sequencing Models	5
7	Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	5

Reference Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Cost Management of Engineering Projects

Course Code	Course Name
OE-MTPX204	Cost Management of Engineering Projects

Course pre-requisites	

Course Outcomes
At the end of the course students will be able to 1. Estimate project cost and project commisioning 2. Analyse cost behaviour in project 3. Know different project strategies 4. Apply quantitative techniques for cost management of engineering projects

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction and Overview of the Strategic Cost Management Process	4
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational Control; Provision of data for Decision-Making.	4
3	Project: meaning, Different types, why to manage, cost overrun centres, various stages of project execution: conception commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and Documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar chart sand Network diagram. Project commissioning: mechanical and process	8
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.	8
5	Pricing strategies: Pareto Analysis. Target Costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.	6
6	Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement	6

	of Divisional profitability pricing decisions including transfer pricing.	
7	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	6

Reference Books

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Waste to Energy

Course Code	Course Name
OE-MTPX205	Waste to Energy

Course pre-requisites	

Course Outcomes
At the end of the course students will be able to 1. Classify waste from ebergy recovery point of view 2. Know biomass pyrolysis and gasification 3. Understand biomass combustion 4. Understand working of biogas plant and importance of biomass energy programme in India

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	6
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	6
4	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	6
5	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion	6
6	Direct combustion - biomass gasification - pyrolysis And	

	liquefaction - biochemical conversion - anaerobic digestion	
7	Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	6
Reference Books		
1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990. 2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983. 3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991. 4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &Sons, 1996.		

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Linear Algebra & Matrix Computation

Course Code	Course Name
OE-MTPX206	Linear Algebra & Matrix Computation

Course pre-requisites	Engineering Mathematics

Course Objectives
Objectives of this course are 1. To make student conversant with fundamentals of Linear Algebra. 2. To impart knowledge about various concepts of matrix computation. 3. To learn the complexity in solving least square problems. 4. To understand concepts of Eigen Value and Eigen vectors.
Course Outcomes
Upon successful completion of the course, students should be able 1. To apply theoretical concepts of vector spaces to solve linear equations. 2. To analyse various properties such as rank, subspaces, norm, condition number, eigen value etc. of a given matrix. 3. To compare complexity of various matrix decomposition methods. 4. To solve least square problem with different matrix computation techniques 5. To suitably select various matrix computation tools to solve real life complex problems.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction:** Over-view of the course, applications in various engineering fields, **Vector-spaces:** Fields, definition of a vector-space, examples, subspaces, sums and intersections of subspaces, span, linear independence, bases, dimension, basis extension, coordinates, calculations of bases concerning solutions of linear equations.	4
2	**Linear maps:** Definition, examples, null/kernel space, range/image space, matrix representations of linear maps, row-rank, column-rank, rank-nullity theorem, algebra of linear maps, linear functions	4
3	**Gaussian elimination:** Basic Gaussian elimination without pivoting, LU decomposition, Gaussian elimination with pivoting. Positive definite matrices, A brief discussion on sparsity.	6
4	**Sensitivity and round-off errors:** Vector norms, matrix norms. Condition number. Perturbation, residual, round-off errors. Error propagation in Gaussian elimination.	6
5	**Least Squares Problem:** Orthogonal matrices, rotators and reflectors. Solution of the least squares problem, the full-rank case.	8

	Gram-Schmidt process. Singular value Decomposition (SVD): Introduction, Some basic applications, least squares problem	
6	**Eigenvalues and Eigenvectors:** The power method. Unitary similarity transform, Schur's theorem, normal matrices, spectral theorem of normal matrices. Hessenberg and tri-diagonal matrices, reduction to these forms. The QR algorithm. A brief discussion on sparsity.	8
7	**Applications:** a) Graphs, KCL and KVL b) Solving linear ODEs c) The geometry of gradient descent d) Best approximation e) Multi-agent systems.	6

Text / Reference Books

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson, 2015.
2. G. Strang, Linear algebra and its applications (4th Edition).
3. David S. Watkins, Fundamentals of Matrix Computations, 3rd Edition, Willey-Inter science, 2010.
4. Gene H. Golub and Charles F. Van Loan, Matrix Computations, 4th Edition, The Johns Hopkins University Press, 2013.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Project Management

Course Code	Course Name
OE-MTPX207	**Project Management**

Course pre-requisites	Basics of Electrical Engineering, Basics of statistics and mathematics, general knowledge about working of organizations

Course Objectives		
The objectives of this course are 1. Get familiarized with basics of project management, its organization and project management framework. 2. Learn five important project management process groups, namely: initiating, planning, executing, monitoring & control, closing and ten important project management knowledge areas. 3. Understand the relationship between project management process groups and knowledge areas.		
Course Outcomes		
Upon successful completion of the course, students should be able TO 1. Explain basics of Project Management, its organization and project management framework. 2. Perform project management process group and knowledge area mapping. 3. Solve a case study using step-by-step process of managing projects and explain why each step is necessary.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction** • Basics of project management, operations management and organizational strategy, • Project management framework, organizational structures, • Project Management Processes – Initiating, Planning, Executing, Monitoring & Control, Closing.	03
2	**Project Integration Management** • Integrated change control, Developing project management plan and project charter, • Project selection, corrective action, preventive action, defect repair, change control board, • Cost benefit analysis, Net present value, internal rate of return, payback period, present value, economic value added, • Opportunity costs, sunk costs, law of diminishing returns, working capital, depreciation. **Project Scope Management**	04

	• Scope baseline, WBS, Project scope statement, WBS dictionary, benefits and uses of WBS • Requirement documentation, requirements traceability matrix, requirements management plan	
3	**Project Time Management** • Schedule baseline, schedule compression, Network diagram, • Precedence Diagramming Method (PDM), Three point estimating, analogous estimating, parametric estimating, • Schedule management plan, resource optimization, Critical path method, Program Evaluation Review Technique (PERT). **Project Cost Management** • Earned value measurement, Earned value monitoring, cost baseline, cost budget, Cost management plan, • Reserve analysis, contingency reserve, management reserves, cost risk, • Variable / fixed costs, direct / indirect costs, life cycle costing, value analysis, control thresholds, cost of quality, Return of Interest (RoI), and discounted cash flow. **Project Quality Management** • Seven basic quality improvement tools – control chart, Pareto diagram, Cause and effect diagram, flow chart, scatter diagram, histogram. Use of s-curve in project monitoring. • Quality assurance tools and techniques – Affinity diagram, tree diagrams, process decision program charts, matrix diagrams, prioritization matrices, network diagrams.	09
4	**Project Human Resource Management** • Role of PM, sponsor, stakeholders, functional manager, portfolio manager, program manager, • HR management plan, recognition and reward systems, team building, stages of team formation and development, team types. • Conflict Management, • Responsibility Assignment Matrix (RAM), RACI Chart, • Motivation theory, Management and Leadership styles, **Project Communication Management** • Communication models, channels, method, communication blockers.	04
5	**Project Risk Management** • Risk management plan, risk response strategies, threats, opportunities, risk register, contingency plans, fallback plans, residual risks, secondary risks, • Risk types and categories, SWOT analysis, **Project Procurement Management** • Procurement management plan, types of agreements and contract types, advantages and disadvantages of each contract type, • PM’s role in procurement, procurement documents : RFP, IFB, RFQ, RFI, • Types of procurement, procurement negotiations, centralized / decentralized contracting, contract interpretation, price, profit, cost, target price, sharing ratio, ceiling price	06
6	**Project Stakeholder Management** • Stakeholder analysis, stakeholder register, stakeholder expectations,	03

	stakeholder engagement, • Power and interest grid, stakeholders engagement assessment matrix	
7	**Professional and Social Responsibility** • Project management traits in professional and social responsibility, • Code of Ethics and Professional conduct w. r. t. responsibility, respect, fairness, honesty. **Project Management Case Study / Activity**	05

Text Books

1. Rita Mulcahy, "PMP Exam Prep", Eight Edition, RMC Publications, Inc., 2013.
2. Kalpesh Ashar, "Project Management – Essentials You Always Wanted to Know", Vibrant Publishers, 2012.
3. Prasanna Chandra, "Projects: Planning, Analysis, Selection, Financing, Implementation and Review", McGraw Hill India, 2014.

Reference Books

1. Dennis Lock and Lindsay Scott, "Gower Handbook of People in Project Management", Routledge Publishers, NY, USA, 2016.
2. "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, Project Management Institute, USA.
3. David Cleland, "Project Management Handbook", 2nd Edition, Wiley, 1988.

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-2024

Artificial Intelligence

Course Code	Course Name
OE-MTPX208	**Artificial Intelligence**

Course pre-requisites	

Course Objectives
The objectives of this course are 1. Introduce to Artificial Intelligence 2. Understand problem solving methods 3. Discuss applications of AI
Course Outcomes
Upon successful completion of the course, students should be able TO 1. Develop a basic understanding of AI building blocks presented in intelligent agents 2. Choose an appropriate problem solving method and knowledge representation technique, analyze the strength and weaknesses of AI approaches to knowledge – intensive problem solving 3. Design models for reasoning with uncertainty as well as the use of unreliable information

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction to Artificial Intelligence (AI) History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub- areas of AI, Applications of AI, Current trends in AI	04
2	Intelligent Agents Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Age	04
3	Problem solving 1 Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search A* Search , Memory bound edheuristic Search.	07
4	Problem solving 2 Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search, Genetic algorithms. Adversarial Search: Games, Optimal strategies, The minimax algorithm, Alpha-Beta Pruning.	07
5	Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL,	10

	Forward chaining, backward Chaining, Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG), Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	
6	Planning and Learning The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning, Learning: Forms of Learning, Inductive Learning, Learning Decision Tree, Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	06
7	Applications Natural Language Processing (NLP), Expert Systems.	04

Text Books

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach "Second Edition" Pearson Education.
2. Saroj Kaushik "Artificial Intelligence" ,Cengage Learning.

Reference Books

1. George F Luger "Artificial Intelligence" Low Price Edition , Pearson Education., Fourth edition.
2. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
3. Elaine Rich and Kevin Knight "Artificial Intelligence" Third Edition
4. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
5. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition

Sr. No.	Examination	Module
1	T-I	1,2, Part of 3
2	T-II	Part of 3,4, Part of 5
3	End Sem	1 to 7

Power system dynamics and control Laboratory

Course Code	Course Name
SE-MTPX201	**Power system dynamics and control Laboratory**

Course pre-requisites	Power System

Course Objectives

The objectives of this course are

1. To study the stability considerations in power system.
2. To understand the different stability of power system and multi-machine stability concept
3. To study of voltage stability, PV, QV and PQ curves
4. To study of improving the stability of power system

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand and appreciate the stability concept in the power network.
2. Apply the effects of various electrical parameter on stability

Course Content

Laboratory work to include at least Eight Simulations/Programmes based on every module.

1. Construct the SIMULINK block diagram to obtain frequency deviation and power deviation step response for 2 area system.
2. Modelling of Automatic Generation control in multi area system.
3. Visualization of droop characteristics of Synchronous Generator
4. Small signal stability and transient stability analysis of single machine- Infinite bus.
5. To simulate study and analyse the effect of loading on long transmission line.
6. Find state space equation and output equation using MATLAB
7. Design of linear state feedback controller.
8. Use the MATLAB step function to obtain frequency deviation step response for a sudden load change.

Term Work

Term work shall comprise of

1.Experiments

.2. MCQ Examination

Text Books	
1.	Kundur, P., "Power System Stability and Control", McGraw-Hill International Editions, 1994.
2.	K. R. Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.
Reference Books	
1.	Anderson, P.M. and Fouad, A.A., "Power System Control and Stability", John Wiley, second edition 2003.
2.	Van Cutsem, T. and Vournas, C., "Voltage Stability of Electric Power Systems", Springer
3.	P. Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-2024

Advanced Control of Electrical Drives Laboratory

Course Code	Course Name
SE-MTPX202	**Advanced Control of Electrical Drives Laboratory**

Course pre-requisites	Electrical Drives

Course Objectives

The objectives of this course are

1. To study the torque-speed characteristics of AC and DC drives and different types of load
2. To discuss modification of torque speed characteristics of AC and DC motors as per load requirements.
3. To understand the power modulators and control strategies
4. To study steady state stability of the motor load system and higher level control of ac drives

Course Outcomes

Upon successful completion of the course, students should be able to

1. Able to apply the knowledge of electrical drives system for various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology.
2. Able to understand the basic requirements placed by mechanical systems on electric drives.
3. Able to apply the basic principles of power electronics in drives using switch-mode converters and pulse width modulation to synthesize the voltages in dc and ac motor drives.
4. Able to understand the need of modification of the torque speed characteristics of machines. Describe the operation of induction machines in steady state and dynamic condition.
5. Able to appreciate the speed control of induction motor drives in an energy efficient manner using power electronics with higher level control technique such as vector control.

Course Content

Laboratory work to include at least Eight MATLAB Simulations/hardware experiments based on every module. (refer IEEE papers).

Using hardware such as latest microcontroller/processor such as Arduino, TI DSP, Atmel uC, Lattice CPLD evaluation board with peripherals atleast for some experiments .

1. Review and study of AC and DC drives
2. Analysis of series and separately excited DC motor with single-phase and three-phase converters, Continuous and discontinuous armature current.
3. Simulating drive in closed loop system

4. Simulation of 3 phase IM V/f operation theory
5. Field oriented control of induction machines using vector control scheme case study
6. Direct torque control of Induction Machines case study and papers
7. Simulation of Synchronous motor control.
8. Simulation of case study of any industry or IEEE Paper on application of drives .

Term Work

Term work shall comprise of

. 1. Experiments
2. MCQ examination

Text Books

1. G. K. Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersey, 1989.
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

Reference Books

1. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi,2001
2. B. K. Bose "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte.Ltd., New Delhi, 2003.
3. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill Publishing company Ltd., New Delhi, 2002.

English for Research Paper Writing

Course Code	Course Name
AE-MTPX201	**English for Research Paper Writing**

Course pre-requisites	Communication Skills

Course Objectives		
The objectives of this course are 1. Understand that how to improve your writing skills and level of readability. 2. Learn about what to write in each section. 3. Understand the skills needed when writing a Title.		
Course Outcomes		
Students will be able to Write research paper, article, thesis		
Course Content		
Module No.	***Details***	***Hrs.***
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	3
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.	3
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	3
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.	3
5	Skills are needed when writing the Methods, skills needed when writing the Results	3
6	Skills are needed when writing the Discussion, skills are needed when writing the Conclusions	3
7	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	3

Reference Books
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) 2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press 3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman"s book. 4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Personality Development through Life Enlightenment Skills

Course Code	Course Name
AE-MTPX202	Personality Development through Life Enlightenment Skills

Course pre-requisites	

Course Objectives

1. To learn to achieve the highest goal happily
2. 2. To become a person with stable mind, pleasing personality and determination
3. 3. To awaken wisdom in students

Course Outcomes

Students will be able to understand:

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
3. Study of Neetishatakam will help in developing versatile personality of students.

Course Content

Module No.	Details	Hrs.
1	Neetisatakam-Holistic development of personality: ▪ Verses- 19,20,21,22 (wisdom) ▪ Verses- 29,31,32 (pride & heroism) ▪	3
2	▪ Verses- 26,28,63,65 (virtue) ▪ Verses- 52,53,59 (dont's) ▪ Verses- 71,73,75,78 (do's)	3
3	Approach to day-to-day work and duties: ▪ Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48, ▪ Chapter 3-Verses 13, 21, 27, 35.	3
4	▪ Chapter 6-Verses 5,13,17, 23, 35, ▪ Chapter 18-Verses 45, 46, 48.	3
5	Statements of basic knowledge: ▪ Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 ▪ Chapter 12 -Verses 13, 14, 15, 16,17, 18	3
6	▪ Personality of Role model. Shrimad Bhagwad Geeta: Chapter2 Verses 17, Chapter 3-Verses 36,37,42,	3
7	▪ Chapter 4-Verses 18, 38,39 ▪ Chapter18 – Verses 37,38,63	3

Reference Books

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Sr. No.	Examination	Module
1	T-I	1
2	T-II	2
3	End Sem	1 to 3

Pedagogy Studies

Course Code	Course Name
AE-MTPX203	Pedagogy Studies

Course pre-requisites	

Course Objectives
1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers. 2. Identify critical evidence gaps to guide the development.
Course Outcomes
Students will be able to understand: 1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries? 2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? 3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Course Content

Module No.	Details	Hrs.
1	Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.	3
2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.	3
3	Evidence on the effectiveness of pedagogical practices: Methodology for the in-depth stage: quality assessment of included studies, how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	3
4	Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches,	3
5	Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community,	3

6	Research gaps and future directions, Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.	3
7	Teachers' attitudes and beliefs and Pedagogic strategies, Curriculum and assessment, Barriers to learning: limited resources and large class sizes	3

Reference Books

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University)
Andheri (W), Mumbai – 400058

COURSE CONTENTS

(M.Tech. in Power Electronics & Power System)

Semester III and IV

Academic Year: 2023-24

LIST OF COURSES

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-2024

Value Education Course VE-MTPX301

Disaster Management

Course Code	Course Name
VE-MTPX301	Disaster Management

Course pre-requisites	

Course Outcomes
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and Humanitarian response. 2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. 4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	5
2	**Repercussions Of Disasters And Hazards:** Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	5
3	**Disaster Prone Areas In India** Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	5
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	5
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment	5

6	**Global Co-Operation** In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	5
7	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	6

Reference Books
1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company. 2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi. 3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Value Education Course VE-MTPX302

Value Education

Course Code	Course Name
VE-MTPX302	Value Education

Course pre-requisites	

Course Objectives		
1. Understand value of education and self- development 2. Imbibe good values in students 3. Let the should know about the importance of character		
Course Outcomes		
Students will be able to: 1. Knowledge of self-development 2.Learn the importance of Human values 3.Developing the overall personality		
Course Content		
Module No.	**Details**	**Hrs.**
1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non-moral valuation. Standards and principles, Value judgements	3
2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness.	3
3	Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature ,Discipline.	3
4	Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour.	3
5	Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence ,Humility.	3
6	Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature	3
7	Role of Women, Women empowerment, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively	3
Reference Books		

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Dissertation

Course Code	Course Name
DS-MTPX 301	**Dissertation**

Course pre-requisites	

Course Objective		
1. To inculcate self-learning and research aptitude among students to handle and Investigate a real life problem.		
Course Outcomes		
Student will be able to 1. Apply principles of ethics and standards, skill of presentation and communication techniques. 2. Integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution. 3. Use knowledge for formulation / fabrication of the desired project. 4. Analyze the available resources and to select most appropriate one.		
Course Content		
Sr. No.	***Description***	***Hrs***
1	Student shall finalize a theme, related to his/her area of specialization for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.	28 Per Week
Guidelines for Dissertation		
Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.		
Guidelines for Assessment of Dissertation		
Dissertation I should be assessed based on following points 1. Quality of Literature survey and Novelty in the problem 2. Clarity of Problem definition and Feasibility of problem solution 3. Relevance to the specialization 4. Clarity of objective and scope		

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-2024

Co-curricular Course CC-MTPX401

Stress Management by Yoga

Course Code	**Course Name**
CC-MTPX401	Stress Management by Yoga

Course pre-requisites	**BT107**

Course Objectives		
1. To achieve overall health of body and mind 2. To overcome stress		
Course Outcomes		
Students will be able to: 1. Develop healthy mind in a healthy body thus improving social health also 2. Improve efficiency		
Course Content		
Module No.	***Details***	***Hrs.***
1	➢ Definitions of Eight parts of yog. (Ashtanga)	5
2	➢ Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	5
3	Yoga & The Brain ➢ Brain Based Learning ➢ The Brain ➢ Teaching to the Developing Brain ➢ Supporting the Learning Brain with Yoga	5
4	Social Emotional Learning	5
5	POSITIVE CLASSROOM MANAGEMENT ➢ Transitions and Engagement ➢ Dynamic Teaching ➢ Understanding Behavior ➢ Classroom Boundaries	5
6	THE YOGA ENVIRONMENT ➢ Clothing ➢ Assistants • ➢ Adjustments	5
7	➢ Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- ➢ Types of pranayam	6

Reference Books
1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur 2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Dissertation

Course Code	Course Name
DS-MTPX401	**Dissertation**

Course pre-requisites	DS-MTPX301

Course Outcomes		
1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques 2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution 3. Student will be able to use knowledge for execution of the desired project and validation of the results obtained 4. Student will be able to analyze the experimental data/ findings		
Course Content		
Sr. No.	***Details***	***Hrs.***
1	Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inferencing, the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis.	28 Per Wee k
Guidelines for Assessment of Dissertation Dissertation should be assessed based on following points 1. Quality of Literature survey and Novelty in the problem 2. Clarity of Problem definition and Feasibility of problem solution 3. Relevance to the specialization or current Research / Industrial trends 4. Clarity of objective and scope 5. Quality of work attempted 6. Validation of results 7. Quality of Written and Oral Presentation		

M. Tech. in Mechanical Engineering with

Machine Design Courses

Course Contents

Academic Year 2023-24

Table of Contents

PC-MTMD101 Advance Stress Analysis

Course Code	Course Name
PC-MTMD101	Advance Stress Analysis

Course pre-requisites	BTM302, BTM701

Course Objectives

The objectives of this course are

1. To develop the student's understanding of the foundations of stress and strain
2. To develop the student understands of the displacement field, Hooke's constitutive law.
3. To develop student's skills in analyzing stress problems through the application of the basic laws and equations.

Course Outcomes

Upon successful completion of the course, students should be able

1. Apply knowledge of failure theories appropriately to solve problems of practical interest with a variety of loading situations.
2. Analyze and calculate stress/strain distributions for 2D problems of elasticity using stress function approach and evaluate using IT tools like ANSYS, etc.
3. Describe stress strain measurement through experimental technique, and stress-strain relation of composite materials.
4. Describe various equipment required to preform the experimental stress-strain analysis.

Course Content

Module No.	*Details*	*Hrs.*
1	Analysis of Stress: Introduction to tensor analysis, stress tensors, Cauchy's stress principle, Principal stresses in three dimensions, Equilibrium equations, Octahedral stresses, and Mohr's stress circle.	**5**
2	Analysis of strain: Strain tensors, Strain transformation, Principal strains, Octahedral strains, Mohr Circle for strain, Equations of compatibility.	**6**
3	Stress -Strain Relations: Generalized Hooke's Law, Transformation of compatibility	**6**

	condition from strain components to stress components, Strain energy in an elastic body, St. Venant's principle, Uniqueness theorem.	
4	Two dimensional Problems in Cartesian Coordinate system: Plane stress and plane strain problems, Stress function, Stress function for plane stress and plain strain cases, Solution of two-dimensional problems with different, loading conditions by the use of polynomials.	**7**
5	Introduction to fracture mechanics,Ductile & brittle fracture, LEFM(Elementary),Modes of failure, Griffith's Analysis & Energy Release rate, SIF & its determination, Westergaard's approach(Mode I&II-only elementary treatment),Fracture toughness, J integral(Elementary),Crack growth studies, Paris law Torsion of Prismatic Bars: General solution of the torsion problem, Torsion of circular and elliptic cross sections.	10
6	Experimental stress Analysis: Introduction to Photo elasticity, Moir, Holography, Speckle Methods etc.	**5**
7	Strain Guage Technique: Strain measurement by resistance gauges, types of strain gauges, Equipment for indicating and recording strains transducer and its application.	**5**

Reference Books

1. T. G. Sitharam and L. Govindraju, "Applied Elasticity", Interline Publishers, Bangalore
2. Timoshenko, Stephen P.; James Norman Goodier (1970). Theory of Elasticity (Third Ed.). Tata McGraw-Hill India Edition.
3. Y. C. Fung, "Foundations of Solid Mechanics." Prentice- Hall Publishers.
4. Arthur P. Boresi, Richard J. Schmidt- Advanced Mechanics of Materials-Wiley (2003).
5. Advances in Engineering Vol -4- Fatigue Design Handbook (SAE)

6. Collins, Jack A. *Failure of materials in mechanical design: analysis, prediction, prevention*. John Wiley & Sons, 1993.
7. Singh, Sadhu. *Experimental Stress Analysis: A Text Book for Engineering Students*. Khanna publishers, 1982.
8. Dally, James W., and William F. Riley. "Experimental stress analysis." (1965).

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

PC-MTMD102 Computer Aided Design

Course Code	Course Name
PC-MTMD102	Computer Aided Design

Course pre-requisites	BTM802, BT207

Course Objectives

The objectives of this course are

1. Understand the basic analytical fundamentals that are used to create and manipulate geometric models in computer programs.
2. To visualize how the components looks like before its manufacturing or fabrication
3. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
4. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc.
5. To understand the different types of curves like Bezier curve, B-Spline curve & Graphics Standards, Surfaces and G-V lines.
6. To understand different Algorithms for optimization of drawing of basic entities

Course Outcomes

Upon successful completion of the course, students should be able

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
2. Describe key neutral specifications and standards for product data
3. Design parts in modern parametric CAD systems for manufacturing on a Rapid Prototyping machine.
4. Footprints of emerging breakthrough technologies created in the areas of CAD and be able to apply C++ skills in the domain of CAD

Course Content

Module No.	***Details***	***Hrs.***
1	**INTRODUCTION & ELEMENTS OF INTERACTIVE COMPUTER GRAPHICS** The design process, the role of modeling & communication, modeling using CAD, Product life cycle, Concurrent engineering in Product design & development, Collaborative Engineering, computers for design Process, CAD System Architecture.	**05**

2	**TECHNIQUES FOR GEOMETRIC MODELING** Data translators like IGES methodology, DXF (Data Exchange Format), STEP, Jupiter Technology, curves, parametric representation of line, circle, ellipse & parabola constructive solid geometry (CSG), Boundary Representation (B-Rep), Geometric Construction methods and its requirements, Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Constraint driven modeling, Feature recognition, Design by feature, generative family of parts.	**05**
3	**ALGORITHMS** Evaluation criteria of CAD/CAM software, Line, circle, ellipse algorithm and C or C++ programming for the same. Two dimensional computer graphics, vector generation, the windowing transformation, three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Visual realism, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing, automation, scripting, animation, write function calling, use a library, continuity C^1, C^2, G^1,G^2	**08**
4	**TRANSFORMATION, MAINPULATION** 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. The parametric representation of geometry, Problems on Bezier, Cubic, B-Spline, rendering.	**07**
5	**DATA STORAGE** Object transformation, mirror transformation, graphics modeling data structures, Bill of materials from attribute data, The use of Object Orientation & associatively, Engineering data management system, relational data base for design, object Oriental database, Structured Query language, Design information Systems. Artificial Intelligence in Design, Knowledge Enabled Engineering, Representation of Knowledge, and Knowledge base Engineering.	**06**
6	**EMERGING AREAS in CAD** Virtual Prototyping, Design for Assembly and Dis- Assembly, VR and PLM introduction, Reverse Engineering and Data Capture techniques like Contact Inspection methods and Scanning methods	**05**
7	**CAD for Machine Elements and Sub-Assemblies** • Introduction to Object Oriented Programming • Develop Concepts of Mechanical Engineering CAD	

	• Develop Algorithm, Flow Charts and Software for at least 5 Mechanical Engineering Design problems like Design of Gears, Design of Knuckle and cotter Joints etc.	**06**

Reference Books
1. Groover, Mikell P. *Computer aided design and manufacturing*. 1987. 2. Zeid, Ibrahim. *CAD/CAM theory and practice*. McGraw-Hill Higher Education, 1991. 3. Hearn, Donald, M. Pauline Baker, and Bjarne Stroustrup. *Computer Graphics with OpenGL, 3/E*. Prentice-Hall, 2003. 4. McMahon, C. A., and J. Browne. "CADCAM: principles, practice and manufacturing management, 1998." 5. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raju. *Cad/cam/cim*. New Age International, 2008. 6. Rao, PosinasettiNageswara. *CAD/CAM: principles and applications*. Tata McGraw-Hill Education, 2004. **7.** Neumann W.M., Sproul R.F., *Principle of Computer Graphics*, McGraw Hill Book Co. Singapore, 1989. 8. Rogers, David F., and J. Alan Adams. *Mathematical elements for computer graphics*. McGraw-Hill Higher Education, 1989. 9. ASIC/ Parasolid library.

Sr. No.	**Examination**	**Module**
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

PC-MTMD151 Design Laboratory-I

Course Code	**Course Name**
PC-MTMD151	**Design Laboratory-I**

Course pre-requisites	BTM 352, BTM701

Course Objectives
The objectives of this course are 1. To study different types of stresses and strains induced in the mechanical components due to external loads in three dimensions. 2. To study the elastic behaviour of different materials in three dimensions and different factors affecting failures of materials. 3. To study Geometric modeling and assembling of any mechanical system. 4. To make appropriate selection of CAD functionality to use as tools in the design process.
Course Outcomes
Upon successful completion of the course, students should be able 1. Demonstrate knowledge about various types of loading and stresses induced in three Dimensions. 2. Apply the knowledge of strain gauges for measuring strain in practical applications. 3. Apply knowledge of CAD to generate and interpret engineering technical drawings of parts and assemblies according to engineering design standards. 4. Demonstrate skill of modeling and assembling of any mechanical system.

List of Experiments (any 8)

Sr. No.	***Details***	***Hrs.***
1	Experiments using strain gauges	**2**
2	Measurement of strain, temperature effects	**2**
3	Fixing of gauges on surfaces	**2**
4	Study of photoelastic bench for stress measurement	**2**
5	Study of polariscope and calibration of disc, beam and tension model	**2**
6	Application of strain gauge techniques: Lecture on strain gauge based methods, Cantilever beam and Portal frame	**2**
7	Study of semiconductor based strain gauges	**2**

8	Case study on thermal stress analysis using different simulation platforms	**2**
9	Case study on stress analysis due to structural loading using different simulation platforms	**2**
10	Case study on stress analysis due to dynamic loading using different simulation platforms	**2**
11	Executing basic algorithms for generation of line, circle, ellipse in any programming language	**2**
12	Executing transformations and projection both in 2D and 3D in any programming language	**2**
13	Generating curves using any programming language	**2**
14	Creation of 3D assembly model.	**2**

PC-MTMD152 Design Laboratory-II

Course Code	Course Name
PC-MTMD152	**Design Laboratory-II**

Course pre-requisites	BTM802

Course Objectives

The objectives of this course are
1. To study the mathematical simulation software for analysis of single and multi degree freedom problem.
2. Perform experimentation and processing the data and demonstration of condition based maintenance tool.
3. To learn the various Techniques used in design of experiments and reliability engineering
4. To learn about wear, wear mechanisms, wear theories applied in machine elements.

Course Outcomes

Upon successful completion of the course, students should be able
1. Apply and analyze different systems using mathematical simulation software.
2. Demonstrate acquiring and processing of data.
3. Compile data and write technical reports.
4. Use different software's and interprets results of analysis.

List of Experiments

Sr. No.	*Details*	*Hrs.*
1	Simulation study using mathematical simulation software (or any programming language) on a. Single DOF system b. Multi DOF system	**2**
2	Simulation study of the followings on any simulation platform a. Modal analysis b. Transient analysis c. Harmonic analysis d. Active vibration control	**2** **5**
3	Experimentation a. Acquiring time domain vibration data by using sensors (displacement / velocity / acceleration) b. Demonstration of condition based maintenance tool using vibration techniques	**2**

4	Case study each on DOE and reliability engineering.	**2**
5	Case study on any one rapid prototyping machine.	**2**
6	At least two (02) problems each on design of hydrostatic bearings, design of brakes and clutches.	**2**
7	At least one case studies on application of tribology in machine elements based on the above syllabus.	**2**

PC-MTMD103 Research Methodology & IPR

Course Code	Course Name
PC-MTMD103	**Research Methodology & IPR**

Course pre-requisites	BTM898

Course Objectives

The objectives of this course are

1. To develop an ability to identify, formulate research problem.
2. To develop an ability to apply knowledge of research methodology to engineering Problems.
3. To develop an ability to investigate the phenomenon in a critical manner.
4. Develop critical thinking to find business opportunities and to solve questions related to industries.
5. To get knowledge on various kinds of research questions and research designs

Course Outcomes

Upon successful completion of the course, students should be able

1. To carry out literature survey methodically
2. To formulate the problem statement using research considerations.
3. To carry out data collection systematically and to carry out data analysis using various data analysis tools
4. To be able to investigate what can be patented

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction to Research Definition of Research, How to define the research problem Various considerations for defining research problem	**8**
2	Literature Survey Search Engines, Source of Literature, Identifying the appropriate period for Literature, Key words Primary key words, secondary key words, research Gaps	**4**
3	Data collection Techniques • Interviews techniques, Structured semi-structured, unstructured interviews • Sampling Techniques, simple random sampling, Sample Size Calculation, Sample Design Case study method	**6**

4	Data Analysis Hypothesis , Null and alternate hypothesis statements, Z test, F test, T Test, Chi square Test, Annova	**6**
5	Simulation techniques • Monte Carlo Simulation, Simulation exercises for Product Design , Service Design , System Design	**6**
6	Intellectual property right Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	**6**
7	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems.	**6**

Reference Books

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers, Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi,¬ Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners,¬ (2nd ed), Singapore, Pearson Education.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
5. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

PC-MTMD201 System Modeling & Synthesis of Mechanisms

Course Code	Course Name
PC-MTMD201	System Modeling & Synthesis of Mechanisms

Course pre-requisites	BTM402, BTM502

Course Objectives

The objectives of this course are

1. To Understand what is a model, types of models, purpose of models
2. To Learn the graphical and analytical techniques commonly used in the synthesis of mechanisms.
3. To Orient applications of analytical techniques by means of computer programs.
4. To simplify the mechanism for analysis purposes.

Course Outcomes

Upon successful completion of the course, students should be able

1. Apply mathematically model for a given system and Mechanical Elements.
2. Apply the graphical and analytical techniques commonly used in the synthesis of mechanisms.
3. Formulate and solve problems of synthesis of mechanisms using modern IT tools and Synthesize mechanisms with 3 and 4 accuracy points.
4. Explain and discuss the theory and methodologies employed for design of mechanisms.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction to System and Mathematical Modeling System:** Environment and variables, the state of a system, Physical Laws for Modeling of System, Representation of System in terms of Block Diagram, Reduction of Multiple Subsystems, Signal Flow Graph, Mason’s Gain Formula.	**6**
2	**Mathematical Modeling of Mechanical Elements** – inertia, stiffness and damper	**6**
3	**Basics of Mechanism:** Rigid body, Kinematic pairs, Lower and Higher pair connections, Kinematic Chain, Mechanism, Four Bar Mechanism, Slider Crank Mechanism, Equivalent mechanisms. **Type Synthesis, Number Synthesis, Dimensional Synthesis** Type, Number & Dimensional synthesis, Accuracy points, Spacing of accuracy points, Chebyshev polynomials.	**6**

4	**Four Bar Coupler Point Curve:** Four bar linkage, coupler curve equation, double points and symmetry, Roberts-Chebyshev theorem	**6**
5	**The Euler Savary Equation and Cubic of Stationary Curvature:** The Euler Savary equation and the Inflection circle, The cubic of stationary curvature.	**6**
6	**Linkage Synthesis with Three Accuracy Points (Geometric Methods):** Concept of poles, relative poles, pole triangle of four bar and slider crank mechanism. Application in position generation, function generation problems.	**6**
7	**Linkage Synthesis with Three Accuracy Points (Algebraic Method):** Fredeinstain displacement equation of four bar linkage for three accuracy points, Crank-follower linkage synthesis angular velocities and acceleration Complex Number Method	**6**

Reference Books

1. 1.Nicola Bellomoand Luigi Preziosi, “Modeling Mathematical Methods & Scientific Computations”, 1995, CRC Press.
2. Mallik, Asok Kumar, Amitabha Ghosh, and Gunter Dittrich. *Kinematic analysis and synthesis of mechanisms*. CRC Press, 1994.
3. Vu, Hung V., and Ramin S. Esfandiari. Dynamic systems: modeling and analysis. McGraw Hill Science, Engineering & Mathematics, 1997.
4. Beyer, Rudolf. "The kinematic synthesis of mechanisms." (1963).
5. Tao, Deh Chang. *Applied linkage synthesis*. Addison-Wesley Pub. Co., 1964.
6. Hartenberg, Richard Scheunemann, and Jacques Denavit. *Kinematic synthesis of linkages*. McGraw-Hill, 1964.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

PC-MTMD202 Advanced Finite Element Methods

Course Code	Course Name
PC-MTMD202	Advanced Finite Element Methods

Course pre-requisites	BTM703

Course Objectives
The objectives of this course are 1. To provide the student with knowledge and analysis skills in applying basic laws in mechanics 2. Steps used in solving the problem by finite element method. 3. To expose students to some of the recent trends and research areas in finite elements.
Course Outcomes
Upon successful completion of the course, students should be able 1. Formulate simple types of finite elements and apply appropriate boundary conditions. 2. Apply finite element method for obtaining solutions to problems in solid mechanics, steady and transient analysis to be conducted. 3. Assess stresses and strains in complex mechanical systems and interpret structural behavior of components by analyzing post processor result. 4. Practical applications related to solver theory.

Course Content

Module No.	***Details***	***Hrs.***
1	**Introduction:** Element Matrices: Direct stiffness Method, Properties of global stiffness Matrix, Analysis of simply supported beam, One dimensional linear element: Division of region into elements The Linear Element, weight Residual integral Evaluation of the Integral. Variational approach, Glerkin's Methods. Classification of problems – Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear, etc,	**6**
2	**FE procedures for 1D formulations:** FE formulation of 1D bar, 2D plane strain, plane stress, and axisymmetric elements; 3D linear elastic continuum, Iso-parametric mapping; numerical integration.	**6**
3	**FE procedures for 2D formulations:**	**6**

	Two Dimensional Elements: Linear Triangular Elements, Rectangular Elements, The displacement functions, Element Shape Functions: Evaluating shape functions Two Dimensional Field equations: Coordinate Systems, Integral equations for the element Matrices, Heat transfer by conduction: two dimensional fins, Long and convection Two Dimensional bodies. Eigen-value problems, Natural vibration of bars and beams.	
4	**FE Applications in Solid Mechanics:** The axial force members, potential energy formulations. The Truss Element, Beam element, plane frame element, Review of tensor algebra; Yield surface, flow rule and hardening rules.	**6**
5	**FE procedures for 3D formulations:** FE formulation for 3D problems, Total Lagrangian and updated Lagrangian descriptions; Quadrilater elements, Tetrahedran element – Jacobian matrix – Stiffness matrix.	**6**
6	**FEA Solver Theory** Overview of using the flow solver, Pressure based solver, Density based solver, Matrix discretization, Multigrid method, Full Multigrid (FMG) Initialization.	**6**
7	**Advances in FEA:** FEM Computations Solution Methods FEM Modeling and Preprocessing FEM Hardware and Post processing Survey of some FE Software Systems, Dynamic system analysis.	**6**

Reference Books

1. Reddy, Junuthula Narasimha. *An introduction to the finite element method*. Vol. 2, no. 2.2. New York: McGraw-Hill, 1993.
2. K. J. Bathe, Finite Element Procedures, Prentice-Hall of India Private Limited, New Delhi, 1996
3. Chandrupatla, Tirupathi R., Ashok D. Belegundu, T. Ramesh, and Chaitali Ray. *Introduction to finite elements in engineering*. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2002.
4. Zienkiewicz, Olek C., and Robert L. Taylor. *The finite element method for solid and structural mechanics*. Butterworth-heinemann, 2005.
5. Segerlind, Larry J., and H. Saunders. "Applied finite element analysis." (1987): 329-330.
6. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition

Sr. No.	Examination	Module

1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

SE-MTMD201 Skill Based Design Laboratory-I

Course Code	Course Name
SE-MTMD201	**Skill Based Design Laboratory-I**

Course pre-requisites	MTMD101, MTMD104

Course Objectives
The objectives of this course are 1. To expand student's knowledge in the area of linear-elastic fracture mechanics and the stress analysis of cracked bodies with a focus on metallic structures using simulations. 2. To develop student understands of the relationship between the energetic approach and the stress analysis of cracked bodies using simulation tools. 3. To study the finite element analysis software. 4. To apply Finite Element Analysis for real life mechanical component.
Course Outcomes
Upon successful completion of the course, students should be able 1. Analyze nature of stresses around a cracked body by applying principles of linear elastic fracture mechanics and compute stress intensity factors using simulation tools. 2. Interpret the result of a fracture mechanics analysis for metallic structures using simulation tools. 3. Analyze different mechanical components using mathematical simulation software. 4. Apply and analyze different mechanical components using FEA software.

List of Experiments

Sr. No.	*Details*	*Hrs.*
1	To Compute space intensity factor using FEM (Displacement Method).	**2**
2	To Compute space intensity factor using FEM (Stress Method).	**2**
3	Computation of J integral using numerical method.	**2**
4	Computation of CTOD for CT specimen using FEM.	**2**
5	Develop numerical code for crack growth rate under fatigue load.	
6	Finite element analysis (FEA) of minimum 03 mechanical components using mathematical simulation software (or any programming language) which must include structural, thermal and coupled structural-thermal analysis.	**2**
7	Finite Element Analysis of a real life mechanical component subjected to both structural and thermal loading, using	**2**

SE-MTMD202 Skill Based Design Laboratory-II

Course Code	Course Name
SE-MTMD202	**Design Laboratory-IV**

Course pre-requisites	BTM703

Course Objectives

The objectives of this course are

1. To introduce the concepts of analysis and synthesis of mechanisms.
2. To develop a broad and basic comprehension of different methods of analysis for the determination of motion characteristics of linkage mechanisms.
3. To learn some Case studies of Design of Power Transmission System [mechanical and hydraulic systems] to reinforce their concepts.
4. Learn efficient computational procedures to solve optimization problems.

Course Outcomes

Upon successful completion of the course, students should be able

1. Develop graphical and analytical synthesis techniques and careful problem formulation and solution skills.
2. Develop an ability to solve mechanism problems that may involve selection, specification, design and sizing of mechanisms to accomplish a given task.
3. Analyze vibration characteristics, wear and life of critical components of power transmission systems.
4. Use MATLAB and implement optimization algorithms.

List of Experiments

Sr. No.	***Details***	***Hrs.***
1	Linkage design and experimental verification.	**2**
2	Assembly of mechanisms from links and joints, study of mobility.	**2**
3	Design and selection of linkage mechanisms for specific applications.	**2**
4	Analysis of an existing mechanism/machine or synthesis of a new mechanism to perform a prescribed task.	**2**
5	Calculate sizing of elements of transmission systems like couplings, belts, chains, gears, brakes, clutches, shafts, bearing,	**2**
6	Case studies on Power Transmission System Design.	**2**
7	Implementation of KKT theorem in MATLAB	**2**

PC-MTMD203 Seminar/Mini Project

Course Code	Course Name
PC-MTMD203	Seminar/Mini Project

Course pre-requisites	MTMD105

Course Outcomes

1. Student will be able to apply the skill of presentation and communication techniques.
2. Student will be able to use the knowledge of the fundamentals of subjects to search the related literature.
3. Student will be able to analyze the available resources and to select most appropriate one.

Sr. No.	**Course content (Seminar):**	*Hrs.*
1	The student gathers and presents information/data about seminar topic allotted to him/her. The report and presentation shall include review of literature, case studies if applicable and findings about recent trends in the area of seminar topic. On completion of the work the student shall prepare a report and will give a Seminar on the report.	**48**
	Course Content (Mini Project):	
1	The mini project work extends for a single semester and exposes the student to develop and present his/her work related to specific topic. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	**48**
	Guidelines for Seminar-II/Mini Project	
1.	Seminar/ mini project should be based on thrust areas in Mechanical Engineering (Machine Design aspect is appreciated)	
2.	Students should do literature survey and identify the topic of seminar/ mini project and finalize in Consultation with mentor/Guide/Supervisor.	

3.	Students should use multiple literatures and understand the topic and compile the report in standard format as in front of Examiners.	
	Assessment Guidelines:	
1.	Quality of Literature survey and Novelty in the topic	
2.	Relevance to the specialization	
3.	Understanding of the topic	
4.	Quality of Written and Oral Presentation	

Program Elective PE-MTMD01: Machine Dynamics and Advance Vibration

Course Code	Course Name
PE-MTMD01	**Program Elective: Machine Dynamics and Advance Vibration**

Course pre-requisites	BTM502

Course Objectives
The objectives of this course are 1. Understand Un-damped, damped, forced SDOF and MDOF systems and its relation to a vibrating system. 2. Understand how to derive eqs. of motion for two degree of freedom systems or higher. 3. Understand how to find frequencies using Rayleigh and Dunkerley Methods.
Course Outcomes
Upon successful completion of the course, students should be able 1. Analyze motion of rigid bodies in space and calculate dynamic forces/moments. 2. Solve for response of un-damped, damped, forced SDOF and MDOF mechanical vibrating systems. 3. Design vibration control system. 4. Estimate response of non-linear vibration system using iterative or graphical methods.

Course Content

Module No.	***Details***	***Hrs.***
1	Dynamics of Particle: Kinematics of particles: Rectilinear Motion, Plane Curvilinear Motion, Rectangular Coordinates Normal and Tangential Coordinates, Polar Coordinates. Kinetics of particles: Newton's Second law Equation of motion, Work and kinetic Energy, Potential Energy, Impulse and Momentum.	**6**
2	Dynamics of rigid body: Plane Kinematics of rigid body: Absolute Motion, Relative Velocity, Instantaneous center of Zero velocity, Relative Acceleration. Plane Kinetics of rigid body: Work and energy principle. Three dimensional dynamics of rigid body, Euler's equations of motions, Impulse momentum formulation, Work energy formulation.	**6**
3	Discrete Vibration Damped and undamped free vibration, Special cases: Oscillatory, non-oscillatory and critically damped motions, Forced harmonic vibration, Magnification factor, Logarithmic decrement, Generalized and principal coordinates, Derivation of equations of motion, Newton's	**8**

	Method, Energy Method, Lagrange's equation, Influence coefficient method, Properties of vibrating systems: flexibility and stiffness matrices, reciprocity theorem, Modal analysis: undamped, Modal analysis: damped.	
4	Continuous vibration-Equations of motion and boundary conditions, natural frequencies and mode shapes. Vibration of strings, Longitudinal and torsional vibration of rods, Transverse vibration of beams, Rayleigh's energy method, Rayleigh-Ritz method, Matrix iteration method.	**6**
5	Practical application of vibration-Vibration isolation, Vibration absorber, Tuned and damped absorber, Introductory concept of rotor dynamics, Jeffcott rotor model.	**6**
6	Basics of non-linear vibration – causes of non – linearity – formulation. Solution methods iterative, Graphical, Method of isoclines. Stability of equilibrium state and type of singularity. Limits cycles.	**5**
7	Brief introduction to experimental modal analysis-Signal generation, measuring and conditioning instruments, signal analysis instruments, Vibration signatures and standards, Virtual Lab experiments.	**5**

Reference Books

1. Rao, Singiresu S., and Fook Fah Yap. *Mechanical vibrations*. Vol. 4. New York: Addison-Wesley, 1995.
2. Leonard Meirovitch- Fundamentals of Vibrations- McGraw-Hill Companies (2000)
3. Engineering Mechanics Dynamics (7th Edition)- J.L. Meriam, L.G. Kraige
4. Shames, I. H. "Engineering mechanics: statics and dynamics, 1996."*PrenticeHall of India, New Delhi*: 911-960.Non – linear mechanical vibration – Srinivasan
5. Kelly, S. Graham. "Fundamentals of mechanical vibrations." (1992).
6. Theory & Practice of Rotor Dynamics
7. Mechanical Vibrations NPTEL Lectures (http://nptel.ac.in/courses/112103112/)
8. Reference websites on Virtual Lab experiments
   http://vlab.co.in/
   http://iitg.vlab.co.in/?sub=62&brch=175
   http://mdmv-nitk.vlabs.ac.in/

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD02: Additive Manufacturing

Course Code	Course Name
PE-MTMD02	**Program Elective: Additive Manufacturing**

Course pre-requisites	BTM405

Course Objectives		
The objectives of this course are 1. To study the fundamentals of rapid prototyping and tooling technologies. 2. To study basic concepts of rapid prototyping and their application in product development. 3. To study different working materials and systems used in rapid prototyping techniques 4. To study layering techniques in rapid prototyping systems		
Course Outcomes		
Upon successful completion of the course, students should be able 1. Describe working principles of rapid prototyping techniques 2. Select proper rapid prototyping techniques for specific technical applications. 3. Select an appropriate material and tools to develop a given product using rapid prototyping Machine. 4. Design layering technique for rapid prototyping		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Rapid Prototyping** • Historical Development • Applications: Design, Planning, Manufacturing and Tooling • Applications: Automotive, Jewelry, Coin and Bio-Medical • Fundamentals of Rapid Prototyping, Design Process • Rapid Prototyping Process Chain	6
2	**Subsystems of RP Machine** • Subsystems of RP achine o Optical System o Mechanical Scanning System o Computer Interfacing hardware, DAQs o Signal Flow, 3D Model to RP Prototype • Introduction to 3D Modeling Softwares (Auto-CAD, PROE,	6

	CATIA, IDEAs etc.) • Slicing and Scan Path Generation Algorithms • Data Conversion and Transmission • File Formats, IGES, STL • Preprocessing and Post-processing	
3	**Liquid Based Rapid Prototyping Systems** • Materials • Stereolithography • Solid Ground Curing • Solid Object UV (Ultra-Violet) Printer • Two Laser System • Micro-stereolithography.	6
4	**Solid Based Rapid Prototyping Systems** • Materials • LOM (Laminated Object Manufacturing) System • FDM (Fuse Deposition Modeling) System • Multi-Jet Modeling (MJM) System • Model Maker and Pattern Master • Shape Deposition Manufacturing Process	6
5	**Powder Based Rapid Prototyping Systems** • Materials • SLS (Selective Laser Sintering) • (3DP) Three-Dimensional Printing • (LENS) Laser Engineered Net Shaping • (MJS) Multiphase Jet Solidification • (EBM) Electron Beam Melting	6
6	**Advances in RP Systems and Case Studies** • Advances in RP: Resolution & Accuracy issues, Integrated Hardening Process, Two Photon Process for Micro/Nano Fabrication, Reverse Engineering Process and Applications.	6

7	Case Study: Wind-Tunnel Testing with RP Models Case Study: Investment Casting with RP Case Study: Fabrication of microlens arrays Case Study: Fabrication of Scaffolds for medical applications	6

Reference Books

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping Principles and Applications",World Publishing Co. Pte.Ltd.
2. James O. Hamblen, and Michael D. Furman, "Rapid Prototyping of Digital Systems", Kluwer Academic Publishers.
3. Kenneth G. Cooper, "Rapid Prototyping Technology Selection and Application", 2001,Marcel Dekker Inc, New York.
4. Ali Kamrani, EmadAbouel Nasr, "Rapid Prototyping Theory and Practice", 2006, Springer Inc.
5. BopayaBidanda, Paulo J. Bartolo, "Virtual Prototyping and Bio Manufacturing in Medical Applications", 2008, Springer Inc.
6. I. Gibson, D.W. Rosen, and B. Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", 2010, Springer Inc.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD03: Design for Manufacturing and Assembly

Course Code	Course Name
PE-MTMD03	**Program Elective: Design for Manufacturing and Assembly**

Course pre-requisites	BTM801, BTM802, BTM898

Course Objectives

The objectives of this course are

1. To study the fundamentals of product development cycle.
2. To study manufacturing issues that must be considered in the mechanical engineering design process.
3. To study principles of assembly to minimize the assembly time
4. To study manufacturing process and assembly operations on the cost of product.

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand the product development cycle
2. Know the manufacturing issues that must be considered in the mechanical engineering design process
3. Know the principles of assembly to minimize the assembly time
4. Know the effect of manufacturing process and assembly operations on the cost of product.

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes.	**6**
2	Properties of Engineering Materials, Selection of Materials – I, Selection of Materials – II, Case Studies – I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies – II,	**6**
3	Selection ofManufacturing Processes, Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer	**8**

	Processing, Co-selection of Materials and Processes, Case-Studies – III	
4	Design for Assembly, Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering,	**6**
5	Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies - IV	**6**
6	Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality,	**5**
7	Design for Reliability, Approach to Robust Design, Design for Optimization	**5**

Reference Books

1. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 03.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 00.
3. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 1999.
4. T H Courtney, Mechanical Behaviour of Materials, McGraw Hill, NY, 00.
5. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold,1997.
6. S S Rao, Engineering Optimization: theory and practice, John Wiley, NY, 1996.
7. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.
8. J G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.
9. Houldcroft, Which Process – an introduction to welding and related processes and guide to their selection, Cambridge, Abington Pub., 1990.
10. ASTM Design handbook.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD04: Tribology in Design

Course Code	Course Name
PE-MTMD04	**Program Elective: Tribology in Design**

Course pre-requisites	BTM701, BTM 801

Course Objectives

The objectives of this course are

1. To provide overview of tribology and practical implications in machine elements.
2. To understand the material properties, nature of surfaces, their topography and surface characterization techniques.
3. To understand the genesis of friction, the theories/laws.
4. To learn about wear, wear mechanisms, wear theories applied in machine elements.

Course Outcomes

Upon successful completion of the course, students should be able

1. Apply the principles of lubrication, lubrication regimes, and theories of hydrodynamic, elasto-hydrodynamic and mixed / boundary lubrication.
2. Explain essentials of tribo-testing and experimental techniques in Tribology.
3. Discuss and formulate tribological modelling and simulation.
4. Design of mechanical components from the aspect of friction, wear and lubrication

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction: Overview of Tribology, Lubricants selection for general application and special application such as low temperatures, high temperature, extreme pressure etc.	**6**
2	Friction and Wear: Types of wear and basic mechanism of wear, Wear properties of friction and antifriction metallic and non metallic materials, experimental techniques in evaluation of materials.	**6**
3	Fluid film journal bearing: petroff equation, Reynolds equation, short bearing and long bearing, full and partial journal bearings of infinite length, design of journal bearings for steady loads and varying loads.	**6**
4	Hydrodynamic lubrication and bearing design: Basic concept, hydrodynamic lubrication: design of plain fixed pad and tilting pad, slider bearing for study and varying loads.	**6**

5	Introduction to design of aerostatic bearings, and its applications Elasto-hydrodynamic lubrication: Principle, application to antifriction bearings, cams and gears, Fault diagonosis in bearings and its solutions.	**6**
6	Antifriction bearing: Rolling Contact Bearings, Bearing types and selection of rolling contact bearing for different applications/loading condition. Static and dynamic load capacity, left rating.	**6**
7	Application of Tribology in mechanical elements: Design of mechanical components against wear. Design of friction surfaces used in clutches and brakes. Design of IC engine component against wear, Design of seals.	**6**

Reference Books

1. Hirani, Harish. Fundamentals of Engineering Tribology with applications.Cambridge University Press, 2016.
2. Szeri, Andras Z. *Fluid film lubrication: theory and design*. Cambridge University Press, 2005.
3. ABHATIA, J. "Advance in Industrial Tribology." (1998)
4. Chattopadhyay, Ramnarayan. *Surface wear: analysis, treatment, and prevention*. ASM international, 2001.
5. Mang, Theo, Kirsten Bobzin, and Thorsten Bartels. *Industrial tribology: tribosystems, friction, wear and surface engineering, lubrication*. John Wiley & Sons, 2011.
6. Neale, Michael J., ed. *Lubrication: A Tribology Handbook*. Butterworth-Heinemann, 1993.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD05: Reliability Engineering and Design of Experiments

Course Code	Course Name
PE-MTMD05	**Program Elective: Reliability Engineering and Design of Experiments**

Course pre-requisites	BTM605, BTM 704

Course Objectives

The objectives of this course are

1. To understand the basic concepts, principles of engineering experimentation and reliability engineering.
2. To learn the various Techniques used in design of experiments and reliability engineering.
3. To analyze the engineering experiments and apply Design of experiments (DOE) techniques for case studies.

Course Outcomes

Upon successful completion of the course, students should be able

1. Understand the experimental planning, evaluation procedure and analysis used in industrial environment.
2. Apply the techniques of design of experiments (DOE) for engineering application
3. Learn the evaluation techniques (for example: MTTF and failure rates) for Reliability Engineering.
4. Use DOE and reliability techniques for engineering applications using industrial case studies.

Course Content

Module No.	***Details***	***Hrs.***
1	Design of Experiments (DOE): Introduction to Engineering experiments, Measurement of physical parameters, selection of instruments, static and dynamic characteristics of response, Planning of experiments.	6
2	Measurements and statistical estimation of errors, Basic statistics and data analysis for sample population and distributions, Hypothesis testing, Null and alternate hypothesis statements, Z test, F test, T Test, Chi square Test, Analysis of Variance (ANOVA)	6
3	Single and multi variate regression analysis, Linear and non linear regression, Randomization and Blocking, Complete and in complete block designs.	6
4	Full factorial design (2 level and 3 level experiments), Fractional factorial design, Response surface Methodology, Taguchi techniques for design of experiments.	6

5	Probability and Distributions for reliability, Reliability management, quality specifications for products/systems, redundancy and diversity evaluation techniques.	6
6	Reliability Network Modeling (series, parallel, m out of n systems), Network evaluation techniques (conditional probability , cut set, tie set, tree diagram)	6
7	Failure types, Time dependent reliability, Application of MTTF, MTBF, MTTR for reliability assessment. Design for X, Design for Reliability, FMEA	6

Reference Books
1. Jiju Antony, Design of Experiments for engineers and scientists, 2003. 2. Patrick, D. O. *Practical reliability engineering*. John Wiley, 1985. 3. Doebelin, Ernest O. *Engineering experimentation: planning, execution, reporting*. McGraw Hill College, 1995. 4. Pieruschka, Erich. *Principles of reliability*. Prentice-Hall, 1963. 5. Madhav S. Phadke, Quality Engineering using Robust Design, 1989. 6. Douglas C. Montgomery, Design and Analysis of Experiments, 2013.

Sr. No.	**Examination**	**Module**
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD06: System Modeling and Analysis

Course Code	Course Name
PE-MTMD06	**Program Elective: System Modeling and Analysis**

Course pre-requisites	BTM502, BTM 503

Course Objectives

The objectives of this course are
1. Understand what is a model, types of models, purpose of models
2. Understand the need for quantification and understand the limits of quantification
3. Be able to transform loose facts into an insightful model, to be used as input for requirements discussions and system design and verification
4. Be able to use scenario analysis as a means to cope with multiple alternative specifications and or designs
5. Apply problem-driven light-weight simulations and understand their value and purpose in early design decisions

Course Outcomes

Upon successful completion of the course, students should be able
1. Apply mathematical modelling for mechanical Elements, systems, hydraulic/pneumatic element and systems.
2. Describe transfer function representation
3. Analyse system response and stability.
4. Compute transient response of first and second order system.

Course Content

Module No.	*Details*	*Hrs.*
1	Mathematical modeling of mechanical elements – inertia, stiffness and damper	**6**
2	Mathematical modeling of mechanical systems- vehicles, articulated vehicle and other mechanical systems	**6**
3	Mathematical modeling of hydraulic elements and system- pneumatic elements and system.	**6**
4	Transfer function representation, block diagram, State variable representation, matrix equation.	**6**
5	Numerical methods and some other solution methods.	**6**
6	System response and stability – Static and dynamic stability of vehicles and articulated vehicles.	**6**

7	Transient response of first and second order system – Steady state response – step response, ramp response, impulse response, sinusoidal response, input – convolution integral, stability of system.	**6**

Reference Books
1. Vu, Hung V., and Ramin S. Esfandiari. *Dynamic systems: modeling and analysis*. McGraw-Hill Science, Engineering & Mathematics, 1997. 2. Ellis, John Ronaine. *Vehicle dynamics*. Random House Business, 1969. 3. Kobayashi, Hisashi, and Brian L. Mark. *System modeling and analysis: Foundations of system performance evaluation*. Pearson Education India, 2009.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD07: Process Equipment Design

Course Code	Course Name
PE-MTMD07	**Program Elective: Process Equipment Design**

Course pre-requisites	BTM502, BTM 801

Course Objectives
The objectives of this course are 1. Learn reading of essential design documents such as P&ID and vessel data sheets. 2. Prepare student to obtain sizes of important process equipment components subjected to different types of loading. 3. Make students to handle stress/thermal analysis of pressure components using advanced methods such as finite element method.
Course Outcomes
Upon successful completion of the course, students should be able 1. Explain and interpret essential design documents such as PFD, P&ID, vessel specification 2. Calculate size of various process equipment components using design rules as well as IT tools. 3. Design vessels, heat exchangers and allied auxiliary components. 4. Discuss loadings, failure modes for process equipment design.

Course Content

Module No.	*Details*	*Hrs.*
1	Role of process equipment engineer in Chemical industry, organization and working of EPC company, Interpretation of process diagrams such as P&ID, equipment layout drawing. Classification of vessels such as tank, flat, bottomed and vertical cylinder tank, vertical cylindrical and horizontal vessels with formed ends as well as spherical or modified spherical vessels. Classification of materials for pressure vessels, Introduction to various process equipment's, codes and standards, applications of first principle using ASME codes	**8**
2	Criteria in vessel design. Elastic bending, plastic instability, cyclic loading stress reversals. Brittle rupture and creep rupture, Membrane theory.	**6**
3	Design of pressure components such as shell, head, cone for internal pressure loading. Design of cylindrical shells against external pressure; design of stiffener rings, Stress categorization, Manufacturing aspects PWHT, weld consideration design	**6**

4	Advanced design topics such as nozzle reinforcement calculation, bolted flange design, selection of gaskets. Elementary stress analysis of pressure parts using finite element methods, Fitness for service assessment	**6**
5	Design of supports for tall vertical vessels; skirt support subjected to wind and seismic loads, design of saddle supports for horizontal vessels.	**6**
6	Design of storage tanks, Design of jacketed vessels.	**6**
7	Elementary heat exchanger design. Tubesheet thickness calculations, baffle plate design	**4**

Reference Books

1. Brownell, Lloyd E., and Edwin H. Young. *Process equipment design: vessel design*. John Wiley & Sons, 1959.
2. Harvey, John F., and H. Saunders. "Theory and design of pressure vessels." (1987)
3. Mahajan, Kanti K. "Design of process equipment: selected topics." (1985).
4. Couper, James R., W. Roy Penney, and James R. Fair. *Chemical process equipment revised 2E: selection and design*. Gulf Professional Publishing, 2009.
5. IS codes and ASME section
6. Heat Exchanger by singh and soler.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD08: Micro-Electro Mechanical Systems

Course Code	Course Name
PE-MTMD08	**Program Elective: Micro-Electro Mechanical Systems**

Course pre-requisites	BTM405, BTM 503

Course Objectives
The objectives of this course are 1. . To introduce basic concepts of MEMS and its applications. 2. To introduce sensors and actuators in Micro-domain. 3. To study modelling and simulation techniques for various applications. 4. Apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system
Course Outcomes
Upon successful completion of the course, students should be able 1. Select appropriate sensors and actuators for a given MEMS application. 2. Select a micro-fabrication technique for a specific MEMS fabrication process. 3. Model and simulate a given MEMS system 4. Design MEMS

Course Content

Module No.	***Details***	***Hrs.***
1	**Introduction to MEMS & Applications** • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators.	**6**
2	**Sensors and Actuators in Micro-domain** • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors, Chemical Sensors	**6**
3	**Fabrication Methods** Microfabrication Methods (VLSI Techniques) • Positive and Negative Photoresists,	**4**

	• Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques.	
4	**3D High Aspect Ratio Fabrication Techniques** • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc	**6**
5	**Modelling and Simulation Techniques** • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis • Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling • Modelling of Micro-channel as heat exchanger, accelerometers, microhinges, compound microstructures. • Linear & Nonlinear Model.	**6**
6	**Characterization Techniques** Topography Methods (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes),SPM (Scanning Probe Microscopes), AFM (Atomic Force Microscopes) Mechanical Structure Analysis • Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric) • Interferometry Techniques, • SPI (Speckle Pattern Interferometry), ESPI (Electronic Speckle Pattern Interferometry), • Laser Techniques, Laser Doppler Vibro-meters Fluid, Thermal	**8**

	and Chemical Analysis • Thermal Analysis Techniques (Theoretical and Experimental), • Fluid Flow Pattern Analysis, • Electro-chemical Analysis, PIV Techniques –spectroscopy	
7	**Introduction to Advances of MEMS and Nanotechnology** • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Nano-tribology, &nano-indentation techniques, • Domestic and Industrial Applications of nanotechnology • Social and Ethical Implications of nanotechnology in Society	**6**

Reference Books

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim "Microsensors MEMS and Smart devices", John Wiley and sons, Ltd.
2. Nadim Mulaf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House.
3. Nicolae Lobontiu and Ephrahim Garcia, "Mechanics of Microelectromechanical systems", Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, "Silicon Processing for the VLSI era Volume -1 Technology", Lattice press.
5. Vijay K. Varadan, K.J. Vinoy and S. Gopalkrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", John Wiley and sons Ltd.
6. Bhushan, "Springer Handbook of Nanotechnology", Springer Inc.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD09: Entrepreneurship Development and Management

Course Code	Course Name
PE-MTMD09	**Program Elective: Entrepreneurship Development and Management**

Course pre-requisites	BTM704

Course Objectives
The objectives of this course are 1. To acquaint with entrepreneurship and management of business 2. Understand Indian environment for entrepreneurship 3. Idea of EDP, MSME
Course Outcomes
Upon successful completion of the course, students should be able 1. Understand the concept of business plan and ownerships 2. Interpret key regulations and legal aspects of entrepreneurship in India 3. Understand government policies for entrepreneurs 4. Understand business operations of small and medium scale enterprises

Course Content

Module No.	***Details***	***Hrs.***
1	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	7
2	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur.	5
3	**Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	6
4	Women's Entrepreneurship Development, Social entrepreneurship-	**6**

	role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	
5	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc.	**6**
6	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	**6**
7	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	**6**

Reference Books

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson Education
2. Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr T. N. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr C. N. Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD10: Design of Power Transmission Systems

Course Code	Course Name
PE-MTMD10	**Program Elective: Design of Power Transmission Systems**

Course pre-requisites	BTM801

Course Objectives

The objectives of this course are

1. After learning this Course the student will understand the Detail Design Procedure of the Transmission Systems – Mechanical, Hydraulic, Pneumatic general description and comparison
2. The student will learn Components like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail and will be in position to design and select them suitably.
3. The student will also learn some Case studies of Design of Power Transmission System [mechanical and hydraulic systems] to reinforce their concepts.

Course Outcomes

Upon successful completion of the course, students should be able

1. Select and design various mechanical and hydraulic power transmission system.
2. Analyze vibration characteristics, wear and life of critical components of power transmission systems.
3. Calculate sizing of elements of transmission systems like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail.
4. Discuss case studies on power transmission system design.

Course Content

Module No.	***Details***	***Hrs.***
1	Different types of prime movers, characteristics, limitation application and selection	**2**
2	Transmission Systems – Mechanical, Hydraulic, Pneumatic general description and comparison Components like couplings, belts, chains, gears, etc used. Their limitations and use in specific applications. Typical example of mechanical and hydraulic systems.	**8**
3	Components like brakes, clutches, shafts, bearing, housing pumps, valves etc used. Their limitations and use in specific applications. Typical example of mechanical and hydraulic systems.	**12**

4	Analysis for applications (automobile m/c Tool, Process engineering) and data for design- Selection of components, Standard components use and selection.	**4**
5	Synthesis above and get complete solution.	**4**
6	Analysis of the solution further with respect to vibration, wear, life of critical components, reliability, assembly, maintenance and cost.	**4**
7	Case studies on Power Transmission System Design	**8**

Reference Books

1. Vicker's Industrial Hydraulics Manual, Eaton Hydraulics Training, 5th Edition, 1999.
2. Rohner, Peter. *Industrial hydraulic control: a textbook for fluid power technicians*. Prentice Hall, 1987.
3. Pippenger, John J. Hicks, Tyler G. John J. Pippenger, and Tyler G. Hicks.*Industrial hydraulics*. 1979.
4. Fundamentals of Pneumatics – Festo didactic Gmbh & Co., 2000.
5. Esposito, Anthony. *Fluid power with applications*. Prentice-Hall International, 2000.
6. Bhandari, V.B, *Design of Machine Elements*, Tata McGraw Hill Education Pvt Ltd.
7. Shigley, J.E and C R Mischke, *Mechanical engineering Design*, McGraw Hill Inc.
8. Spotts, M F and T E Shoup, *Design of Machine Elements*, Prentice Hall Inc.
9. Spotts, M F, *Mechanical Design Analysis*, Prentice Hall Inc.
10. John J .Pippenger and Dudley A. Peace, *Basic Fluid Power*, Prentice Hall Inc.
11. Fundamentals of Pneumatics, *Electro-Pneumatics and Electro-Hydraulics*, FESTO Didactic, 2000
12. Michael J. Pinches and John G. Ashby, *Power Hydraulics*, Prentice Hall Inc.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD11: Optimization Techniques in Design

Course Code	Course Name
PE-MTMD11	**Program Elective: Optimization Techniques in Design**

Course pre-requisites	BTM605, BT207

Course Objectives

The objectives of this course are

1. To introduce tools and techniques for optimization to engineering applications
2. To understand the formulation of design equations for mechanical systems.
3. To understand algorithms and methods used for optimization for design of mechanical systems.
4. To design and select optimum configuration of mechanical components and systems.

Course Outcomes

Upon successful completion of the course, students should be able

1. Explain different approaches to optimize mechanical systems.
2. Create programs based on different optimization algorithms using IT tools, such as Minitab, MATLAB, etc.
3. Calculate optimum solution to linear and non-linear problems.
4. Apply the numerical and optimization understanding for finalizing design of mechanical designs.

Course Content

Module No.	***Details***	***Hrs.***
1	Need for optimization and historical development classification and formulation of optimization problem, classical optimization methods, Calculus based methods, Enumerative schemes, Rendom search algorithms,	**7**
2	Evolutionary algorithms, Genetic algorithms, Evolutionary programming, Evaluation Strategies, Classifier Systems. Monte Carlo Simulation.	**7**
3	Optimum design of mechanical elements: Purpose and applications of optimum design. Effects of manufacturing errors, characteristics of mechanical systems	**7**
4	Selection of optimum configuration, critical regions materials and dimensions,	**5**
5	Formulation of primary and subsidiary design equations, Limit equations, Normal redundant and incompatible specifications.	**5**

	General techniques.	
6	Digital computers in optimum design. Exact and Interactive techniques	**5**
7	Optimal design of elements and systems, shafts gears, bearings, springs, high speed machinery, cams etc. Case studies.	**6**

Reference Books

1. Rao, Singiresu S., and S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.
2. Deb, Kalyanmoy. *Optimization for engineering design: Algorithms and examples*. PHI Learning Pvt. Ltd., 2012.
3. Mital, K.V., 1996. *Optimization methods in operations research and systems analysis*. New Age International.
4. Taha, Hamdy A. *Operations Research: An Introduction (For VTU)*. Pearson Education India, 1982.
5. Bury, Karl. *Statistical distributions in engineering*. Cambridge University Press, 1999.
6. Fogel, David B. *Artificial intelligence through simulated evolution*. Wiley-IEEE Press, 2009.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD12: Advanced Engineering Materials

Course Code	Course Name
PE-MTMD12	**Program Elective: Advanced Engineering Materials**

Course pre-requisites	BTM304

Course Objectives
The objectives of this course are 1. To introduce mechanics, physical and chemical properties of materials Including metals, ceramics, polymers and composites. 2. To study phase diagrams and their use in predicting phase transformation and microstructure 3. To study various types of failures using concept of fracture mechanics, creep and effect of impact **1.** To introduce nano materials, functional materials and their characterization.
Course Outcomes
Upon successful completion of the course, students should be able 4. Demonstrate an understanding of mechanics, physical and chemical properties of materials Including metals, ceramics, polymers and composites 5. Understand existence of imperfections and their effects on mechanical properties of materials and cause of failure 6. Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure 7. Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact 8. Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites 9. Understand the economic considerations in usage and recycling of materials in human use

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids: Historical perspective of Materials Science. Classification of materials. Advanced Materials, Future materials, Modern materials, Nano-materials, and materials for additive manufacturing. Atomic structure. Atomic bonding in solids, Crystal structures, Crystalline and non-crystalline materials. Miller indices. Anisotropic elasticity.	**5**

2	Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms: Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Yielding under multi-axial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice resistance to dislocation motion. Characterization of materials .	**5**
3	Phase Diagrams Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system.	**5**
4	Failure: Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects	**5**
5	Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites: Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fibre reinforced composites. Structural composites, Failure nature of composites.	**5**
6	Electrical, Thermal, Optical and Magnetic Properties and economic Considerations:	**5**

	Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behaviour. Ferro-electricity. Piezoelectricity Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Para magnetism. Ferromagnetism. Anti-ferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour. Domains and Hysteresis, Basic concepts. Optical properties of metals. Optical properties of non-metals. Application of optical phenomena.	
7	Economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design. Functional materials and applications of various engineering materials.	**6**

Reference Books
1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons, 07. 2. Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999. 3. “Essentials of Materials For Science And Engineering” by Donald R Askeland, Cengage; 2 edition (2013) 4. “Physical Metallurgy, Principles and Practices” by V Raghavan. Prentice Hall India Learning Private Limited; 2 edition (2006) 5. Mechanical Metallurgy by George E.Dieter, McGraw Hill Publications

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD13: Mechanics of Composite Materials

Course Code	Course Name
PE-MTMD13	**Mechanics of Composite Materials**

Course pre-requisites	BTM898

Course Objectives		
1. To understand basic concepts and difference between composite materials with conventional materials. 2. To understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level. 3. To understand finding failure envelopes and stress-strain plots of laminates. 4. To develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.		
Course Outcomes		
Upon successful completion of the course the student should be able to: 1. Student will be able to understand the basic concepts and difference between composite materials with conventional materials. 2. Students will be able to understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level. 3. Students will be able to apply knowledge for finding failure envelopes and stress-strain plots of laminates. 4. Students will be able to develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction** Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus	5
2	**Basic Concepts and Characteristics** Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials.	5
3	**Elastic Behavior of Unidirectional Lamina** Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters	5
4	**Strength of Unidirectional Lamina** Micromechanics of failure; failure mechanisms, Macro-mechanical	5

	strength parameters, Macromechanical failure theories, Applicability of various failure theories	
5	**Elastic Behaviour of Laminate** Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates.	5
6	**Stress and Failure Analysis of Laminates** Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates	5
7	**Micromechanics** of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials	6

Reference Books
1. Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994. 2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990. 3. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science", CRC Press, Boca Raton, 03. 4. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 04. 5. Mazumdar S. K., "Composite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 02. 6. Robert M. Jones, "Mechanics of Composite Materials", Taylor and Francis, Inc., 1999.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD14: Robotics

Course Code	Course Name
PE-MTMD14	Robotics

Course pre-requisites	BTM402

Course Outcomes		
At the end of the course students will be able to 1. Understand basic terminologies and concepts associated with Robotics and Automation 2. Demonstrate comprehension of various Robotic sub-systems 3. Understand kinematics and dynamics to explain exact working pattern of robots 4. Aware of the associated recent updates in Robotics		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction:** Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.	6
2	**Robot Grippers:** Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots: - Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.	6
3	**Drives and control systems:** Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses, Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.	6
4	**Kinematics:** Transformation matrices and their arithmetic, link and joint description, Denavit – Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics	6

	calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and static forces in manipulators: - Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations	
5	**Machine Vision System:** Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.	6
6	**Modeling and Simulation for manufacturing Plant Automation:** Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI.	6
7	**Other Topics in Robotics**: - Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics.	6

Text Books
1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04 2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986. 3. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 01. 4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education. 5. Industrial Automation: W.P. David, John Wiley and Sons.
Reference Books
1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 02. 2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Program Elective PE-MTMD15: Advance Fracture Mechanics

Course Code	Course Name
PE-MTMD15	Advance Fracture Mechanics

Course pre-requisites	MTMD101

Course Objectives

1. To expand student's knowledge in the area of linear-elastic fracture mechanics and the stress analysis of cracked bodies with a focus on metallic structurs.
2. To develop student's ability to compute crack-tip stress-intensity factors for two and three-dimensional cracked bodies of LEFM.
3. To develop student understands of the relationship between the energetic approach and the stress analysis of cracked bodies.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Analyze nature of stresses around a cracked body by applying principles of linear elastic fracture mechanics and compute stress intensity factors.
2. Interpret the result of a fracture mechanics analysis for metallic structures and relate the same to ASME/API.
3. Explain experimental methods for KIc/J- testing using various types of test specimens.
4. Evaluate the fracture related failures.

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction- background, Kinds of failure, modes of failure, brittle and ductile fracture.	4
2	Energy Consideration- Introduction, Griffith analysis, energy release rate.	6
3	Stress in cracked bodies- Stress intensity factor, determination of SIF, CTOD.	8
4	J integral- Definition, scope, path independence.	8
5	Test methods- introduction, KIc test technique, J testing, various test specimens.	4
6	Fatigue- introduction, terminology, S-N curve, fractures due to fatigue, Paris law for design of components.	4
7	Fracture mechanics design process, Principles of fracture safe design &fracture control plans, Fail safe & safe life design, Damage tolerant design &leak before break criterion, Numericals, Practical Case studies, Fibre composites & their fracture mechanics	8

Reference Books

1. Kumar, Prashant, and Kumar Prashant. *Elements of fracture mechanics*. Tata McGraw-Hill Education, 2009.
2. Anderson, Ted L. *Fracture mechanics: fundamentals and applications*. CRC press, 2005.
3. Maiti, S. K. *Fracture Mechanics: Fundamentals and Applications.* Cambridge University Press, 2015.
4. Kanninen, Melvin F., and Carl L. Popelar. "Advanced fracture mechanics." (1985).
5. Barson, J. M., and Stanley T. Rolfe. "Fracture and Fatigue Control in Structures: applications of fracture mechanics." *American Society for Testing and Materials, West Conshohocken, PA* (1999): 194.
6. Gdoutos, Emmanuel. *Fracture mechanics criteria and applications*. Vol. 10. Springer Science & Business Media, 2012.
7. KRY Simha
8. Handbook by Tada,Sih&Paris
9. Use of visual videos for the course.
10. Hull D. An Introduction to composite materials,Cambridge University Press,1981
11. Agarwal,B.D and Broutman,L.J. Analysis and performance of fibre composites,John Wiley,1980

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Ability Enhancement Course AE-MTMD201: English for Research Paper Writing

Course Code	Course Name
AE-MTMD201	**English for Research Paper Writing**

Course pre-requisites	BTM406

Course Outcomes		
Students will be able to: **1.** Understand that how to improve your writing skills and level of readability **2.** Learn about what to write in each section **3.** Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission		
Course Content		
Module No.	***Details***	***Hrs.***
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	5
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	5
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	5
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	5
5	Skills are needed when writing the Methods, skills needed when writing the Results	5
6	Skills are needed when writing the Discussion, skills are needed when writing the Conclusions	5
7	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	6

Reference Books
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.

4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Indian Knowledge System Course IK-MTMD101: Constitution of India

Course Code	**Course Name**
IK-MTMD101	**Constitution of India**
Course pre-requisites	BT025

Course Objectives
Students will be able to: 1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution
Course Outcomes
Students will be able to: 1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. 3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. 4. Discuss the passage of the Hindu Code Bill of 1956

Course Content

Module No.	***Details***	***Hrs.***
1	➢ History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	5
2	➢ Philosophy of the Indian Constitution: Preamble Salient Features	5
3	➢ Contours of Constitutional Rights & Duties: ➢ Fundamental Rights ➢ Right to Equality ➢ Right to Freedom ➢ Right against Exploitation ➢ Right to Freedom of Religion ➢ Cultural and Educational Rights ➢ Right to Constitutional Remedies ➢ Directive Principles of State Policy ➢ Fundamental Duties.	5

4	➢ Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume -II][194] ➢ Parliament ➢ Composition ➢ Qualifications and Disqualifications ➢ Powers and Functions ➢ Executive ➢ President ➢ Governor ➢ Council of Ministers ➢ Judiciary, Appointment and Transfer of Judges, Qualifications ➢ Powers and Functions	5
5	➢ Local Administration: ➢ District's Administration head: Role and Importance, ➢ Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. ➢ Pachayati raj: Introduction, PRI: Zila Pachayat.	5
6	➢ Elected officials and their roles, CEO Zila Pachayat: Position and role. ➢ Block level: Organizational Hierarchy (Different departments), ➢ Village level: Role of Elected and Appointed officials, ➢ Importance of grass root democracy	5
7	➢ Election Commission:Role and Functioning. ➢ Chief Election Commissioner and Election Commissioners. ➢ State Election Commission: Role and Functioning. ➢ Institute and Bodies for the welfare of SC/ST/OBC and women	6

Reference Books
1. The Constitution of India, 1950 (Bare Act), Government Publication. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Value Education Course VE-MTMD301: Disaster Management

Course Code	Course Name
VE-MTMD301	Disaster Management

Course pre-requisites	BTM399, BTM499

Course Outcomes
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and Humanitarian response. 2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. 4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	5
2	**Repercussions Of Disasters And Hazards:** Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	5
3	**Disaster Prone Areas In India** Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	5
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	5
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction,	5

	Global And National Disaster Risk Situation. Techniques Of Risk Assessment	
6	**Global Co-Operation** In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	5
7	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	6

Reference Books
1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company. 2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi. 3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Co-curricular Course CC-MTMD401: Stress Management by Yoga

Course Code	Course Name
CC-MTMD401	Stress Management by Yoga

Course pre-requisites	BT107

Course Objectives		
1. To achieve overall health of body and mind 2. To overcome stress		
Course Outcomes		
Students will be able to: 1. Develop healthy mind in a healthy body thus improving social health also 2. Improve efficiency		
Course Content		
Module No.	***Details***	***Hrs.***
1	➢ Definitions of Eight parts of yog. (Ashtanga)	5
2	➢ Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	5
3	Yoga & The Brain ➢ Brain Based Learning ➢ The Brain ➢ Teaching to the Developing Brain ➢ Supporting the Learning Brain with Yoga	5
4	Social Emotional Learning	5
5	POSITIVE CLASSROOM MANAGEMENT ➢ Transitions and Engagement ➢ Dynamic Teaching ➢ Understanding Behavior ➢ Classroom Boundaries	5
6	THE YOGA ENVIRONMENT ➢ Clothing ➢ Assistants • ➢ Adjustments	5
7	➢ Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- ➢ Types of pranayam	6

Reference Books
1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur 2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Value Education Course VE-MTMD302: Value Education

Course Code	**Course Name**
VE-MTMD302	Value Education

Course pre-requisites	

Course Objectives		
1. Understand value of education and self- development 2. Imbibe good values in students 3. Let the should know about the importance of character		
Course Outcomes		
Students will be able to: 1. Knowledge of self-development 2.Learn the importance of Human values 3.Developing the overall personality		
Course Content		
Module No.	**Details**	**Hrs.**
1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non-moral valuation. Standards and principles, Value judgements	3
2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness.	3
3	Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature ,Discipline.	3
4	Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour.	3
5	Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence ,Humility.	3
6	Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature	3
7	Role of Women, Women empowerment, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively	3
Reference Books		

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Ability Enhancement Course AE-MTMD203: Pedagogy Studies

Course Code	Course Name
AE-MTMD203	Pedagogy Studies

Course pre-requisites	

Course Objectives

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Course Content

Module No.	Details	Hrs.
1	Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.	3
2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.	3
3	Evidence on the effectiveness of pedagogical practices: Methodology for the in-depth stage: quality assessment of included studies, how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	3
4	Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches,	3
5	Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community,	3

6	Research gaps and future directions, Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.	3
7	Teachers' attitudes and beliefs and Pedagogic strategies, Curriculum and assessment, Barriers to learning: limited resources and large class sizes	3

Reference Books

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Ability Enhancement CourseAE-MTMD202: Personality Development through Life Enlightenment Skills

Course Code	Course Name
AE-MTMD202	Personality Development through Life Enlightenment Skills

Course pre-requisites	

Course Objectives		
1. To learn to achieve the highest goal happily 2. 2. To become a person with stable mind, pleasing personality and determination 3. 3. To awaken wisdom in students		
Course Outcomes		
Students will be able to understand: 1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life. 2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity. 3. Study of Neetishatakam will help in developing versatile personality of students.		
Course Content		
Module No.	**Details**	**Hrs.**
1	Neetisatakam-Holistic development of personality: ▪ Verses- 19,20,21,22 (wisdom) ▪ Verses- 29,31,32 (pride & heroism) ▪	3
2	▪ Verses- 26,28,63,65 (virtue) ▪ Verses- 52,53,59 (dont's) ▪ Verses- 71,73,75,78 (do's)	3
3	Approach to day-to-day work and duties: ▪ Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48, ▪ Chapter 3-Verses 13, 21, 27, 35.	3
4	▪ Chapter 6-Verses 5,13,17, 23, 35, ▪ Chapter 18-Verses 45, 46, 48.	3
5	Statements of basic knowledge: ▪ Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 ▪ Chapter 12 -Verses 13, 14, 15, 16,17, 18	3
6	▪ Personality of Role model. Shrimad Bhagwad Geeta: Chapter2 Verses 17, Chapter 3-Verses 36,37,42,	3
7	▪ Chapter 4-Verses 18, 38,39 ▪ Chapter18 – Verses 37,38,63	3

Reference Books
1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata 2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Sr. No.	Examination	Module
1	T-I	1
2	T-II	2
3	End Sem	1 to 3

Open Elective OE-MTMD201: Industrial Safety

Course Code	Course Name
OE-MTMD201	**Industrial Safety**

Course pre-requisites	BTM803/BTM898

Course Outcomes		
At the end of the course students will be able to 1. Understand basic safety norms, rules and regulations and hazards 2. Understand maintenance of utility systems and its service life expectancy 3. Understand fault and diagnostics and preventive measures 4. Understand repair cycles of machines and trouble shootings		
Course Content		
Module No.	***Details***	***Hrs.***
1	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.	5
2	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	5
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity Lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods	5
4	Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	5

5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor	5
6	Troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive Maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets	5
7	Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	6

Reference Books

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD-202: Operation Research

Course Code	Course Name
OE-MTMD202	**Operations Research**

Course pre-requisites	BTM803

Course Outcomes
At the end of the course, the student should be able to 1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables. 2. Students should able to apply the concept of non-linear programming 3. Students should able to carry out sensitivity analysis 4. Student should able to model the real world problem and simulate it.

Course Content

Module No.	*Details*	*Hrs.*
1	Optimization Techniques, Model Formulation, models, General L. R Formulation, Simplex Techniques, Sensitivity Analysis,	5
2	Formulation of a LPP - Graphical solution revised simplex method- duality theory - dual simplex method - sensitivity analysis parametric programming	6
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem – CPM/PERT	5
4	Scheduling and sequencing – single server and multiple server models – deterministic inventory models –	5
5	Inventory Control Models, Probabilistic inventory control models – Geometric Programming.	5
6	Competitive Models, Single and Multi-channel Problems, Sequencing Models	5
7	Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	5

Reference Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD203: Cost Management of Engineering Projects

Course Code	Course Name
OE-MTMD203	**Cost Management of Engineering Projects**

Course pre-requisites	BTM803

Course Outcomes		
At the end of the course students will be able to 1. Estimate project cost and project commisioning 2. Analyse cost behaviour in project 3. Know different project strategies 4. Apply quantitative techniques for cost management of engineering projects		
Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction and Overview of the Strategic Cost Management Process	4
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational Control; Provision of data for Decision-Making.	4
3	Project: meaning, Different types, why to manage, cost overruns centr various stages of project execution: conception to commissioning. Proj execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Preproj execution main clearances and Documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	6
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.	6
5	Pricing strategies: Pareto Analysis. Target Costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.	5
6	Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of	5

	Divisional profitability pricing decisions including transfer pricing.	
7	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	6

Reference Books
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD204: Waste to Energy

Course Code	Course Name
OE-MTMD204	**Waste to Energy**

Course pre-requisites	BTM504

Course Outcomes
At the end of the course students will be able to 1. Classify waste from energy recovery point of view 2. Know biomass pyrolysis and gasification 3. Understand biomass combustion 4. Understand working of biogas plant and importance of biomass energy programme in India

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	5
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	5
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	5
4	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	5
5	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion	5
6	Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion	5
7	Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	6

Reference Books
1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990. 2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983. 3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991. 4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &Sons, 1996.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD205: Internet of Things

Course Code	Course Name
EOE-MTMD205	Internet of Things

Course pre-requisites	General knowledge of networking, sensing, databases, programming, and related technology

Course Objectives		
Upon successful completion of the course, students will be • Explored to the interconnection and integration of the physical world and the cyber space. • They are also able to design & develop IOT Devices.		
Course Outcomes		
After successful completion of the course student should be able to 1. Describe the theory related to Internet of things 2. Apply theoretical knowledge of IOT in practice 3. Select the hardware & software for different applications. 4. Develop an application using IOT hardware & software		
Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain etc.	5
2	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	5
3	Programming the Microcontroller for IOT Cloud computing and IOT –Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	5
4	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	5
5	IOT PROTOCOLS Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors,	5

	Integrating with Application Platform	
6	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	6
7	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	5

Text Books
1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011.
Reference Books
1. Charalampos Doukas, “Building Internet of Things with the Arduino”, Create space, April 2002.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD206: Introduction to Big Data Analytics

Course Code	Course Name
OE-MTMD206	**Introduction to Big Data Analytics**

Course pre-requisites	BTM 301, BTM 401

Course Objectives
1. Understand the role of business analytics within an organization. 2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. 3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. 4. To become familiar with processes needed to develop, report, and analyze business data. 5. Use decision-making tools/Operations research techniques. 6. Mange business process using analytical and management tools. **7.** Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
Course Outcomes
1. Students will demonstrate knowledge of data analytics. 2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics. 3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making. 4. Students will demonstrate the ability to translate data into clear, actionable insights.

Course Content

Module No.	***Details***	***Hrs.***
1	Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	5
2	Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	5
3	Organization Structures of Business analytics, Team management,	5

	Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.	
4	Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	5
5	Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	5
6	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	5
7	Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism. Application of Big Data	6

Reference Books
1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press. 2. Business Analytics by James Evans, persons Education.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD207: Introduction to AI and Machine Learning

Course Code	Course Name
OE-MTMD207	**Introduction to AI and Machine Learning**

Course pre-requisites	Mathematics, Knowledge of programming language (Python preferred)

Course Objectives
The students after studying these topics should be able to 1. understand applications of Artificial Intelligence and Machine Learning for engineering applications 2. apply suitable algorithms for simple engineering problems
Course Outcomes
Upon successful completion of the course, students should be able to 1. discuss applications of Artificial Intelligence for engineering problem solving 2. apply fundamental concepts in machine learning and select popular machine learning algorithms for engineering problem solving 3. compose computer code for solving problems using machine learning algorithms 4. explain advanced machine learning concepts such as Neural Network, Reinforcement Learning.

Course Content

Module No.	*Details*	*Hrs.*
1	Artificial Intelligence, Intelligent agents, types of learning, steps involved in problem solving using Machine Learning	5
2	Linear regression, Decision trees, overfitting	5
3	Instance based learning, Feature reduction, Collaborative filtering-based recommendation	5
4	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	5
5	Neural network: Perceptron, multilayer network, back propagation, introduction to deep neural network	5
6	Clustering: k-means, adaptive hierarchical clustering	2
7	Introduction to Reinforcement Learning, Applications and case studies	6

Text Books
1. Tom Mitchell, Machine Learning, First Edition, McGraw- Hill (1997). 2. Stuart Russel and Peter Norvig, Artificial Intelligence – A modern approach, Pearson (2015) 3. Ethem Alpaydin, Introduction to Machine Learning, PHI (2015).

4. Gopal M., Applied Machine Learning, McGraw Hill (2018)

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Open Elective OE-MTMD208: Introduction to Augmented Reality

Course Code	Course Name
OE-MTMD208	**Introduction to Augmented Reality**

Course pre-requisites	General knowledge of CAD Modelling

Course Objectives

- Explore the basic concepts of Augmented Reality.
- They are also able to design & develop AR application.

Course Outcomes

After successful completion of the course student should be able to

1. Describe the theory related to Augmented Reality
2. Apply theoretical knowledge of AR in practice
3. Select the hardware & software for different applications.
4. Develop interactive augmented reality applications for both PC based mobile devices using a variety of novel input devices

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** History of AR, Basics of Augmented Reality, Architecture/Framework, Various applications of AR in Automotive & Auto Component industries, Construction Managemen, Educationt etc. AR Browsers, Marker & Marker less AR	5
2	**Enabling Technologies of Augmented Reality** Mobile, Camera, Cloud Computing, Unity, AR with Google Sketch up	5
3	**Remote Maintenance/Training using AR** Architecture, Benefits, Challenges	5
4	**Lighting and Illumination Issues in AR** Conversion of CAD Model to AR Model	5
5	**HOLOLENS INTERFACE**	5
6	**Integration of AR** Integration with IOT. Integrating with CRM, New market Opportunities of AR, Business models, Revenue models & AR in Other Fields	6
7	**Challenges & Opportunities of AR** New business markets in AR, Technological challenges faced by AR	5

Text Books
1.Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006. 2. Steve Aukstakalnis Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR 3. Jonathan Linowes, Krystian, Augmented Reality for Developers, 2017. 4. Stephen Cawood and Mark Fiala, Augmented Reality: A practical guide

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD209: Composite Materials

Course Code	Course Name
ECOE-MTMD209	**Composite Materials**

Course pre-requisites	**Manufacturing Science, Material Science**

Course Objectives		
• Explain types of composite materials and their applications • Describe manufacturing processes for composite materials • Discuss mechanical properties of composites		
Course Outcomes		
After successful completion of the course student should be able to 1. explain types of composite materials and identify its applications to mechanical engineering systems 2. discuss constituents of different types of composites 3. describe manufacturing processes for composite materials 4. define simple mechanical properties of composites		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Overview of composite materials** Historical background, Classification based on structure and matrix, Advantages and limitations, industry applications,	06
2	**Composite materials** Reinforcement fibers, whiskers, polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC),	06
3	**Composite Science** Material and microstructure parameters of layered and phased composites, micro and macro approaches to study and prediction of structure property relations.	06
4	**Introduction to micromechanics** Anisotropy of composites, anisotropic elastic constants, failure criteria under multiaxial loading, interlaminar failure mechanism	06
5	**Composite manufacturing processes** Manufacturing of reinforcement fibers and whiskers, preparation of fillers, additives and pigments for PMC, manufacturing of matrix polymers, manufacture of metallic matrices, processing of ceramics, manufacture of foams, honeycombs and adhesives.	06
6	**Composite post processing operation** Machining, cutting, polishing, welding of thermoplastic PMC, bonding, riveting and painting	06
7	**Composite product design**	06

	Material considerations in composite product design, material design of thermal, optical, acoustic, electrical design requirements, design exercise for design of simple structural element such as tension bar and ring,	

Text Books
1. K.K. Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York, 1987. 2. Analysis and Performance of Fiber Composites, Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, Wiley, 2006 3. Handbook of Composites, George Lubin, Van Nostrand, Reinhold Co., 1982

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTMD210: Digital Twin

Course Code	Course Name
OE-MTMD210	Digital Twin

Course pre-requisites	CAD, Sensors, Simulation

Course Objectives

- To understand the fundamentals of industry 4.0 & digital twin
- To understand the enabling technologies for digital twin
- To understand how to build a digital twin
- To study application areas of digital twin
- To understand digital twin as an interdisciplinary technology along with its integrtaion
- To understand New business and Revenue models of digital twin

Course Outcomes

Upon successful completion of the course, students should be able

1. Explain & write basic concepts of digital twin
2. Identify various enabling technologies of digital twin.
3. Apply theoretical knowledge in practice
4. Develop small application using digital twin related software

Course Content

Module No.	*Details*	*Hrs.*
1	INDUSTRY 4.0: Introduction to industry 4.0, Technologies drivers & enablers of industry 4.0 like sensors, computing power, speed of data, connectivity, accessibility, advanced analytics.	4
2	Evolution of Digital Twins, Introduction to Digital twin, Basic concepts of Digital twins ,Growth drivers for digital twin, Product & Process digital twins, Digital Model, Digital Shadow, Digital twin Prototype (DTP), Digital Twin Instance (DTI), Digital Twin Aggregate (DTA), Partial digital twin, Clone digital twin, Augmented digital twin, Smart & Connected design, accelerating industry 4.0 using Digital Twin	6
3	Enabling technologies for Digital Twin like Artificial Intelligence (AI), Machine Learning(ML), Deep Learning (DL), Big Data Analytics, Internet of Things (IOT), Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Cloud Computing Services (CCS) etc.	6
4	How to build a digital Twin, Steps in building digital twin, integration of IOT & CAD, integration of IOT, BIM data & machine Learning, Hardware & Software related to digital twin, working of a digital twin, Digital Twin Platforms Concurrent engineering & digital twin, digital twin as a smart service to	6

	industries.	
5	Use cases of Digital Twin in Product development, Logistics Manufacturing, Simulation, Predictive Maintenance, Asset Maintenance, Construction industry, Facility Management Architecture, Electrical engineering, digital twin driven power transformer service, Health Care & etc.	5
6	Integration of Digital Twin with Product Life Cycle Management (PLM), Big Data Analytics, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supplier Relationship Management(SRM), Manufacturing Execution Systems (MES) etc.	4
7	Building New business/Revenue models, Developing maturity model of digital twin, Benefits of Digital Twins, Challenges in applying & implementing digital twins Future research areas of digital twin, Careers in Digital twin, Digital Twin Engineer, Application and case studies	5

Text Books

1. Digital Twin: Possibilities of the new Digital twin technology, Anand Iyer, 2017, 35 Pages
2. Digital Twin Development & Deployment on the Cloud, Ist edition, Nassim Khaled Bibin Pattel Affan Siddiqu, ISBN**:** 9780128216316, ELSEVIER, pages 592
3. Digital Twin Technologies & Smart Cities, Maryam Farsi, Alireza Daneshkhah, Amin Hosseinian-Far, Hamid Jahankahani, Springer, ISBN 978-3-030-18731-6
4. Digital Twin Driven Smart Manufacturing, By Fei Tao, Meng Zhang, A.Y.C. Nee, ISBN 978-0-12-817630-6, ELSEVIER, pages 257
5. Advances in Computers, The Digital Twin Paradigm for Smarter Systems and Environments: The Industry, Pethuraj & Preetha Evanjaline, ELSEVIER, pages 257, ISBN 978-0-12-818756-2, ISSN 0065-2458

Reference Books

1. Digital Twin Driven Smart Design by Fei Tao, Ang Liu, Tianliang Hu, A.Y.C. Nee, ELSEVIER, ISBN 978-0-12-818918-4, Pages 333
2. Handbook Of Digital Enterprise Systems: Digital Twins, Simulation And Ai, by Wolfgang Kühn, world scientific publishing co., ISBN 978-981-120-073-1, Pages 229.
3. Digital Twin Complete Self-Assesment Guide, 1976302927, 9781976302923sment Guide, Geradus Blokdyk, CreateSpace Independent Publishing Platform, 2017, Pages 120.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3 & 4
3	End Sem	1 to 7

Open Elective OE-MTMD211: Industry 4.0

Course Code	**Course Name**
OE-MTMD211	INDUSTRY 4.0

Course pre-requisites	CAD, BIM, Sensors, Data base

Course Objectives

- To understand the various industrial revolutions
- To understand the enabling technologies for industry 4.0
- To understand the power of data analytics
- To understand importance of Connectivity
- To understand interdisciplinary concept & technology convergence
- To understand New business and Revenue models in light of industry4.0

Course Outcomes

Upon successful completion of the course, students should be able

5. Explain & write basic concepts of industry 4.0
6. Identify various enabling technologies of industry4.0.
7. Apply theoretical knowledge in practice
8. Develop small application using various technologies of industry4.0.

Course Content

Module No.	***Details***	***Hrs.***
1	**Introduction to Industry 4.0:** Evolution of industry 4.0, Technologies drivers & enablers of industry 4.0 like sensors, computing power, speed of data, connectivity, accessibility, advanced analytics & enabling technologies of industry 4.0. Relevance of industry4.0 to Mechanical & Civil engineering.	4
2	**Introduction to Augmented Reality:** Basics of AR, Mixed Reality, Enabling technologies of AR, Marker based & Marker less AR. Software & Hardware of AR, Creating AR experience, Applications of AR in Mechanical & Civil engineering, Challenges	6
3	**Introduction to Virtual Reality:** Basics of VR, Software & Hardware of VR, Challenges, Applications in Mechanical & Civil engineering, Robotic automation & Collaborative robots (COBOTS)	6
4	**Introduction to Artificial Intelligence:** Knowledge Based, Rules based **Introduction to Machine Learning:** Overview of Supervised, Unsupervised & Reinforced learning Algorithms **Introduction to Deep Learning:** Overview of Artificial Neural Network (ANN), Convolutional Neural Network (CNN), AUTOENCODERS Algorithms	6

5	**Introduction to Internet of Things (IOT):** Sensors, IOT Protocols, IOT Platforms, Selection of sensors & IOT Platform, enabling technologies, micro controller, micro processer, Arduino board, Raspberry Pi, Sending Analog Data on Cloud Server, Smart Product Development, Smart Cities, Smart Manufacturing, Smart Logistics etc.	5
6	**Introduction to Big Data Analytics:** Evolution of big data, big data tools, 6V of big data, Basics of big data, HADOOP Ecosystem, HDFS data storage, data processing, RDBMS & NOSQL data base management, Challenges of big data, Sentiment Analytics, Predictive Analytics, Graph Analytics etc.	4
7	**Introduction to Cloud Computing:** Cloud Computing basics, Cloud deployment models like Software as a Service (SAAS), Platform as a Service (PAAS), Infrastructure as a Service (IAAS), Mobile Computing Virtualization, Technology providers vs. Cloud providers vs. Cloud vendors, Cyber Security Business Issues in industry4.0, Opportunities, Challenges, Skillsets, Startegies	5

Text Books

1. Industry 4.0: Managing The Digital Transformation Book by Alp Ustundag and Emre Cevikcan, Publisher:Springer International Publishing, ISBN:9783319578705, 3319578707
2. Shaping the Fourth Industrial Revolution A Guide to Building a Better World, by Klaus Schwab, Nicholas Davis, Publisher:Penguin Books Limited, ISBN:9780241366394, 0241366399
3. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011
4. Data Analytics : The Complete Beginner's Guide - Step By Step Instructions (The Black Book) Kindle Edition, by Byron Francis
5. The Enterprise Cloud: Best Practices for Transforming Legacy IT, by James Bond
6. Augmented Reality: Principles & Practice Paperback, by Schmalstieg/Hollerer
7. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, by Tony Parisi, Publisher:O'Reilly Media, ISBN:9781491922781, 1491922788

Reference Books

1. Charalampos Doukas , “Building Internet of Things with the Arduino”, Create space, April 2002
2. Big Data and Analytics 1st Edition, Kindle Edition, by Subhashini Chellappan Seema Acharya
3. Cloud Computing: Concepts, Technology & Architecture, by Richardo Puttini, Thomas Erl, and Zaigham Mahmood
4. Handbook of Augmented Reality, by Borko Furht, Publisher:Springer New York, ISBN:9781461400646, 1461400643

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3 & 4
3	End Sem	1 to 7

Open Elective OE-MTMD212: Generative Design

Course Code	Course Name
OE-MTMD212	GENERATIVE DESIGN

Course pre-requisites	CAD, BIM, MACHINE LEARNING, FEA

Course Objectives

- To understand the fundamentals of generative design
- To understand the enabling technologies for generative design
- To understand how to develop generative design
- To study application areas of generative design
- To understand generative design as an interdisciplinary technology
- To understand, how ML & DL can be used in generative design
- To understand, how evolutionary & genetic algorithms help generate multiple design solutions

Course Outcomes

Upon successful completion of the course, students should be able

9. Explain & write basic concepts of generative design
10. Identify various enabling technologies of generative design.
11. Apply theoretical knowledge in practice
12. Develop multiple design solutions using related software

Course Content

Module No.	***Details***	***Hrs.***
1	**Introduction to Industry 4.0:** Technologies drivers & enablers of industry 4.0 like sensors, computing power, speed of data, connectivity, accessibility, advanced analytics & enabling technologies of industry 4.0, Relevance of GE in INDUSTRY4.0	4
2	**Overview of Generative Design (GE):** Introduction to Generative Design,, Components of GE, Significance of GE in Mechanical & Civil Engineering structures & components, Enabling Technologies, Generative Design Framework, CAD & BIM models in GE, CAD & FEA integration, Additive Manufacturing	6
3	**Artificial Intelligence:** Overview of AI, Rule based design **Machine Learning based Design Generation:** Overview of Supervised, Unsupervised & Reinforced learning Algorithms for Generative Design **Deep Neural Design Generation:** Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Auto Encoders & Decoders for Generative Design (GE) & Generative Adversarial Networks (GAN)	6
4	**Topology Optimization:** Problem Formulation, Design Parameterization, Structural Optimization, Sensitivity Analysis, Algorithms for solving problems & implementation, Convergence of solution, Optimal solution	6

5	**Evolutionary & Genetic Algorithms:** Biological evolution, Fitness evaluation, Selection, Crossover/recombination, mutation, next generation, evolutionary strategies, overview of Genetic & evolutionary programming	5
6	**CASE STUDIES on Generative Design for Mechanical & Civil Engineering.** Defining Generative Objects, Defining Obstacle regions, Defining Preserve regions, selecting load, Selecting Manufacturing method, solving generative study, viewing generative outcomes. FEA Analysis of multiple design solutions for various results like stress, deformation etc.	6
7	**Benefits & Applications:** benefits & applications of Generative Design in Mechanical & Civil Engineering, Future Scope. New Business & Revenue models.	3

Text Books

1. "Topology Optimization: Theory, Methods, and Applications" by Bendsoe and Sigmund
2. "Generative Design" Visualize, Program, and Create with JavaScript in P5.js
   by Benedikt Gross, Hartmut Bohnacker, Julia Laub, Claudius Lazzeroni · 2018,
   ISBN: 9781616897840, 1616897848, Publisher: Princeton Architectural Press
3. "Generative Design: Form-finding Techniques in Architecture" , By Asterios Agkathidis · 2016, Publisher:Laurence King Publishing, ISBN: 9781780676913
4. "Deep Learning with Python" by François Chollet,
5. "Introduction to evolutionary computing" by Agoston E Eibe, Publisher:Springer Berlin Heidelberg, ISBN:9783662448748, 3662448742
6. "Genetic algorithms in search, optimization, and machine learning" Book by David E. Goldberg
7. Python Machine Learning, Machine Learning and Deep Learning with Python, Scikit-learn, and TensorFlow 2, 3rd Edition By Sebastian Raschka, Vahid Mirjalili · 2019, ISBN:9781789958294, 1789958296, Publisher:Packt Publishing

Reference Books

1. "A Hands-On Introduction to Topology Optimization" by Amir M. Mirzendehdel and Krishnan Suresh "Homogenization and Structural Topology Optimization: Theory, Practice and Software" by Behrooz Hassani and Ernest Hinton
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurelien Geron, ISBN-10 : 1492032646, Publisher : O'Reilly Media; 2nd edition (October 15, 2019)

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3 & 4
3	End Sem	1 to 7

DS-MTMD301: Dissertation Phase-I

Course Code	Course Name
DS-MTMD301	Dissertation Phase-I

Course pre-requisites	MTMD 299

Course Outcomes

1. Student will be able to search literature related to the project topic
2. Student will be able to analyse finding of literature review
3. Student will be able to identify research gap
4. Student will be able to integrate the knowledge to define the problem statement appropriately and devise solution
5. Student will be able to analyze the available resources and to select most appropriate one
6. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques

Course Content

Module No.	***Details***	***Hrs.***
1	The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a report for evaluation. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report during mid of the term. Student shall finalize a theme and problem definition after literature review, related to mechanical engineering (design engineering area) for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report at the end of the term.	48

Guidelines for Dissertation

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

Dissertation I should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Principles of ethics and standards and communication techniques

DS-MTMD401: Dissertation Phase-II

Course Code	Course Name
DS-MTMD401	**Dissertation Phase-II**

Course pre-requisites	**DS-**MTMD301

Course Outcomes

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for execution of the desired project and validation of the results obtained
4. Student will be able to use knowledge for formulation / fabrication of the desired project
5. Student will be able to analyze the experimental data/ findings and discuss the merits and limitations of the project work

Course Content

Module No.	***Details***	***Hrs.***
1	Student shall study the problem of dissertation in the light of outcome of Phase-I seminars. On completion of data collection, analysis, and inferencing, the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis. On finalization of the dissertation student shall submit the dissertation report. The student shall have to appear for a Viva-voce examination for the dissertation.	48

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization or current Research / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

M. Tech. in Mechanical Engineering with
Thermal Engineering Courses

Course Contents

Academic Year 2023-24

Table of Contents

PC-MTTH101 Transport Phenomena

Course Code	Course Name
PC-MTTH101	Transport Phenomena

Course pre-requisites	PC-BTM403

Course Objective

1. How to use fundamental principles of fluid mechanics to solve thermal problem.
2. How to use basic principles of thermodynamics to solve thermal problem.
3. How to use basic principles of heat transfer to solve thermal problem.
4. How to use basic principles of mass transfer to solve thermal problem.

Course Outcome

Upon successful completion of the course, students should be able to

1. have knowledge of advanced features of fluid mechanics, thermodynamics, heat and momentum transfer pertaining to thermo-fluid problem,
2. Understand the significance of course content for thermo-fluid problems,
3. Apply knowledge in analysis and interpretation of thermo-fluid problem
4. Analyze and evaluate an existing thermal system and recommend their ideas.

Course Content

Module No.	*Description*	*Hrs.*
1.	Introduction to transport phenomena: Basic transport quantities in thermal system; Conservation principle of mass, momentum, energy and species; **Thermodynamics:** Thermodynamic terms; laws; energy, entropy and exergy analysis;	6
2.	**Fluid Mechanics:** Types of flow, Integral and differential form of governing equation. Navier-Stokes equation, Dimensionless form of conservation equation and their use. Common flow boundary conditions. Boundary layer	6
3.	**Turbulence:** Laminar and turbulent transport of fluid. Characteristics, RANS Equation, Turbulence models.	5
4	**Momentum Transport: Internal** Internal incompressible viscous flow –Developing and developed flow. Estimating laminar velocity profile of flow between infinite parallel plates Fully developed laminar pipe flow. Turbulent velocity profile. Head loss estimation, Flow through Non-circular ducts.	6
5	**Momentum Transport: External** External incompressible viscous flow –Blasius solution of flow over plates, Von-Karmon’s momentum integral equation. Flow separation, lift	6

	and drag. Flow over cylinders and spheres.	
6	**Energy Transport:** Thermal boundary conditions. Diffusion transport: Energy equation, conduction through plane and cylindrical surfaces, Fins, Transient conduction – lumped and distributed model. Convective transport: Energy equation, heat transfer coefficient, non-dimensional numbers, Nu correlations –external flow over flat plate, cylinders and spheres, Internal flow -developing and developed for isothermal and constant heat flux boundary conditions.	6
7	**Mass Transport:** Diffusivity and the mechanism of mass transport –Fick's law of diffusion, mass diffusivity, Mass transfer in non-stationary media, Stationary medium approximation, conservation of species for a stationary medium, boundary condition and discontinuous concentration at interfaces, Mass diffusion with homogeneous chemical reaction	5

Recommended books:

1. White, F. M. *Fluid Mechanics*, McGraw-Hill, New York, 1986.
2. Ozisik, M. Necati. *Heat transfer: a basic approach*. (1985).
3. Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey. *Fundamentals of engineering thermodynamics*.John Wiley & Sons, 2010.
4. Incropera, F.P. and Dewitt, D.P. *Fundamentals of Heat and Mass Transfer*, Wiley
5. Fox, Robert W., Alan T. McDonald, and Philip J. Pritchard. *Introduction to fluid mechanics*.Vol. 7. New York: John Wiley & Sons, 1985.
6. Cengel, Yunus A., and Michael A. Boles. "*Thermodynamics: an engineering approach*." *Sea* 1000 (1994): 8862.
7. Eckert, Ernst Rudolf Georg, and Robert M. Drake Jr. "*Analysis of heat and mass transfer*." (1987).
8. SadıkKakaç, YamanYener, Carolina P Naveira-Cotta. "*Heat Conduction",*5th Edition, (2018), CRC Press.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH102 Energy Resources, Storage and Management

Course Code	Course Name
PC-MTTH102	Energy Resources, Storage and Management

Course pre-requisites	PC-BTM305, PC-BTM504

Course Objective

1. To know the different energy resources
2. Understand thermodynamic power cycles and the associated processes and fuels
3. Understand the basic principles of nuclear energy, solar energy, fuel cells, and wind energy
4. Understand the economics of energy conversion

Course Outcomes

Upon successful completion of the course, students should be able to

1. Develop knowledge to identify, explain and compare competing energy resources, conversion technologies on an economic and efficiency basis
2. Understand the significance of energy conversion and develop capability to apply different tools to assess the validity of energy conversion claims
3. Analyze different energy systems and related economics.
4. Evaluate different energy resources, their conversion, storage and management

Course Content

Module No.	*Description*	*Hrs.*
1.	**Current Energy Scenario:** Global and India **Conventional Energy Resources** – Efficient use of Solid Fuels, Manufactured Fuels, Agro Fuels, Indian coals, Petroleum, Refining and Other Conversion Processes, Nature of Indian Crudes & Petroleum Refining in India, Refinery Gas, LPG, pet coke.	8
2.	**Non – conventional Renewable Energy Sources** - Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy.	6
3.	**Analyzing Tools for energy conversion:** Pinch analysis, energy entropy and exergy analysis.	6
4.	**Thermal Energy Storage**: Types and Material Selection, Sizing of Storage system for various applications, Hydrogen Storage, Storage in vehicles, Chilled Energy storage for HVAC and Refrigeration Application.	6
5.	**Electrochemical energy Storage** –Major Types of Electrochemical Cells. Lead-Acid Batteries, Negative Electrodes in Lithium Systems, Positive Electrodes in Lithium Systems, Primary, Non-rechargeable Batteries, Energy Storage for Medium-to-Large Scale Applications	4
6.	**Energy Economics**Economic analysis of power generation-Investment	6

	cost – economic concepts – measures of economic performance – procedure for economic analysis – examples –procedure for optimized system selection and design – load curves - sensitivity analysis – regulatory and financial frame work of power generation.	
7.	**Energy Auditing**–Definition, need, types of energy audit methodologies, barriers. Role, Duties and responsibilities of energy managers and auditors. Energy audit questionnaire, Energy Conservation Act 2003.	6

Recommended Books

1. Weston, Kenneth C. "*Energy conversion–the ebook*." University of Tulsa(2000).
2. A Culp, Jr ,*Principles of Energy Conversion*, 2nd ed., McGraw-Hill, Inc., 1991.
3. Smith, Craig B., and Kelly E. Parmenter. *Energy, Management, Principles: Applications, Benefits, Savings*. Elsevier, 2013.
4. Hamies, *Energy Auditing and Conservation; Methods, Measurements, Management and Case study*, Hemisphere, Washington, 1980.
5. Witte, Larry C, *Industrial Energy Management and Utilization*, Hemisphere Publishers, Washington, 1988.
6. S. P. Sukhatme, Solar Energy.
7. Huggins ESS

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH151 Thermal Laboratory-I

Course Code	Course Name
PC-MTTH103	Thermal Laboratory-I

Course pre-requisites	PC-BTM305, PC-BTM403

Course Objective

The course intends to provide opportunity to student for performing actual experiments on heat transfer mechanism and related phenomenon.

Course Outcomes

1. Student will be able to apply the skill learnt in theory subjects to do hands on experiments.
2. Students will be able to analyze and do basic calculations on thermos-fluid related problems.
3. Students will be able to collect, analyse and interpret the data.
4. Student will be able to analyze and evaluate different thermal equipment's

List of Experiments (Any 8)

Sr. No.	*Details*	*Hrs.*
1.	Experiment on transient heat transfer	**2**
2.	Experiment on convective heat conduction	**2**
3.	Experiments on plate heat exchanger	**4**
4.	Experiments on Shell and Tube type heat exchanger	**4**
5.	Experiments on fluidized bed combustion system	**2**
6.	Experiments on cooling tower	**4**

PC-MTTH152 Thermal Laboratory-II

Course Code	**Course Name**
PC-MTTH104	**Thermal Laboratory-II**

Course pre-requisites	PC-BTM403

Course Objective
The course intends to provide opportunity to student for performing actual experiments on heat transfer mechanism and related phenomenon.
Course Outcomes
1. Student will be able to apply the skill learnt in theory subjects to do hands on experiments. 2. Students will be able to analyze and do basic calculations on thermos-fluid related problems. 3. Students will be able to collect, analyse and interpret the data. 4. Student will be able to analyze and evaluate different thermal equipment's

List of Experiments (Any 8)

Sr. No.	***Details***	***Hrs.***
1.	Experiment on Laminar boundary layer	**2**
2.	Experiment on Turbulent boundary layer	**2**
3.	Experiments on Solar Energy	**4**
4.	Experiments on Wind Energy	**4**
5.	Energy analysis tutorials	**2**
6.	Energy storage systems	**2**
7.	Experiment on multiphase flow phenomena	**2**
8..	Visit to non-conventional power plant	**4**

PC-MTTH103 Research Methodology& IPR

Course Code	Course Name
PC-MTTH103	Research Methodology& IPR

Course pre-requisites	

Course Objectives
1. To develop an ability to identify, formulate research problem. 2. To develop an ability to apply knowledge of research methodology to engineering Problems. 3. To carry out research on engineering problems. 4. To develop an ability to investigate the phenomenon in a critical manner. 5. Develop critical thinking to find business opportunities and to solve questions related to industries. 6. To get knowledge on various kinds of research questions and research designs
Course Outcomes
Learner shall be able. 1. To carry out literature survey by using various research considerations 2. To formulate the problem statement using research considerations. 3. Understanding that when IPR would take such important place in growth of individuals &nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. 4. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Content

Module No.	*Description*	*Hrs.*
1	**Introduction** Definition of Research: Research Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Definition and Dimension of a Theory, Functions and Characteristics; Types of Theory: General Theory and Particular/Empirical Theory. Cases and their Limitations; Causal Relations. Philosophy and validity of research. Objectives of research.	**8**
2	**Characteristics of research** Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.	**4**
3	**Types of research** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.	**6**
4	**Research Procedure** Formulating the Research Problem, Literature Review, Developing the objectives, preparing the research design including sample Design, Sample size.	**6**
5	**Considerations in selecting research problem** Relevance, interest, available data, choice of data, Analysis of data,	**6**

	generalization and interpretation of analysis	
6	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	**6**
7	**New Developments in IPR:** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**6**

Recommended Books
1. Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers'   a. Distributors.   2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques*, New Delhi,   a. Wiley Eastern Limited.   3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*,   a. (2nd ed), Singapore, Pearson Education.   4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New   5. Technological Age", 2016.   6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH201 Design of Heat Exchanger

Course Code	Course Name
PC-MTTH201	**Design of Heat Exchanger**

Course pre-requisites	PC- BTM501

Course objectives
1. It provides exposure to different kind of heat exchanger, their working and selection for a given application. 2. Students will come to know about different techniques of heat exchanger analysis. 3. Student will be able to learn construction and thermal design methodology of shell and tube, Plate and compact heat exchanger

Course outcomes
Upon successful completion of the course, students should be able to 1. have knowledge of different techniques of heat exchanger analysis and be aware of common heat exchangers with their constructions, working principles andperformance parameters, 2. Understand the significance of contents of the course for the design and development of heat exchangers. 3. Apply their knowledge for thermal design of a heat exchanger such as shell and tubes, compact and plate heat exchanger, 4. Analyze an existing heat exchanger with reference to rating and sizing.

Course Content

Module No.	*Description*	*Hrs.*
1	**Introduction to Heat Exchangers:** Mechanism of heat exchange, Classification, Geometrical construction of Tubular, plat and compact heat exchanger, Applications and Selection.	04
2	**Basic Design Methods of Heat Exchanger:** Heat exchanger design calculation- heat transfer and pressure drop calculation including pumping power, Heat exchangers design methodology- rating and sizing.	06
3	**Fouling of Heat Exchangers:** Effect of fouling, Process of Fouling, Prediction of fouling, Operation of heat exchanger under fouling, Control of fouling and cleaning of heat exchanger..	04
4	**Shell And Tube Heat Exchanger:** Basic components, TEMA and other standards, Basic design methodology – heat transfer and pressure drop calculation, Shell side	06

	calculation- KERN'S and Bell-Delaware Method.	
5	**Compact Heat Exchanger:** Plate fin and tube fin heat exchanger- application, construction and heat transfer and pressure drop calculation.	06
6	**Plate Heat Exchangers, Helical Coil Heat Exchangers and Air Cooled Heat Exchanger:** Application, mechanical features, operational characteristics, flow arrangement, heat transfer and pressure drop calculation.	08
7	**Heat Exchangers for Phase Change Applications:** Condensers and Evaporators, Features, types, construction, working, design and operational considerations, and thermal analysis.	06

Recommended books

1. Kakac, Sadik, Hongtan Liu, and Anchasa Pramuanjaroenkij. *Heat exchangers: selection, rating, and thermal design*. CRC press, 2012.R K Shah, Fundamental of Heat Exchanger Design
2. Kays and London, *Compact heat exchanger*, Krieger Pub Co,., 1998
3. Hesselgreaves, John E. *Compact heat exchangers: selection, design and operation*. Gulf Professional Publishing, 2001.T. Taborek, G.F. Hewitt and N. Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980
4. Taborek, Jerry. "Industrial Heat Exchangers: A Basic Guide By G. Walker, Hemisphere Pub L. Corp. Washington Dc, 1982, $41.50, 408 Pg." *AIChE Journal* 29, no. 2 (1983): 349-350.
5. Fraas, Arthur P. *Heat exchanger design*. John Wiley & Sons, 1989.

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PC-MTTH202 Computational Fluid Dynamics

Course Code	Course Name
PC-MTTH202	**Computational Fluid Dynamics**

Course pre-requisites	PC-MTTH101, BTM403, BTM501

Course Objective		
1. To learn the methodology of numerical analysis of heat and fluid flow problems. 2. To learn methods of direct and iterative methods of solving linear equations. 3. To learn methods of domain discretization – FDM and FVM. 4. To learn about the numerical treatment of diffusive, convective and transient heat transfer. 5. To learn about the numerical treatment of fluid flow problem.		
Course Outcome:		
Upon successful completion of the course, students should be able to 1. have good knowledge and understanding of computational aspects of fluid dynamics, 2. Describe need of modeling and simulation and its overall methodology of execution, 3. Apply their knowledge to solve a system of linear algebraic equation using standard direct and iterative technique, 4. Examine, analyze and formulate a thermal and fluid flow problem using techniques of computational fluid dynamics		
Course Content		
Module No.	***Description***	***Hrs.***
1.	**Introduction to Modeling and Simulation:** Experimental and Analytical approach, Physical, Mathematical and Numerical modeling, Model validation, Simulation. Introduction and Methodology of Numerical simulation. Computational fluid dynamics and its application, merits and limitations	**06**
2.	**Solution of Linear Algebraic Equation:** Direct methods: Gauss Elimination, LU decomposition, TDMA etc. Iterative methods: Jordon method and Gauss Seidel Method, SOR and SUR, ill-conditioned system, condition number.	**06**
3.	**Mathematical Modeling:** Integral and differential form of governing equation of steady and unsteady incompressible flow and heat transfer system. Mathematical nature of PDE, Initial condition and boundary conditions (thermal and flow).	**06**
4	**Discretization Schemes:** Introduction to Finite difference method, Finite Element Method and Finite Volume Method. Developing discretized form of partial derivative terms of different order by FDM and FVM techniques. Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	06

5	**Numerical Modeling of Diffusive Heat Transfer:** Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one- dimensional problem, Two-dimensional Transient Problems. Stability condition under different condition.	**06**
6	**Numerical Modeling of Convective Heat Transfer:** Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection - Diffusion, Unsteady two-dimensional convection - Diffusion Upwind Schemes- Central Difference, First order, second order, QUICK and Power law scheme.	**06**
7	**Numerical Modeling of Fluid Flow:** Complexities in numerical modeling of fluid flow. Common flow modeling technique- MAC, SIMPLE, SIMPLEC and PISO. Turbulence models: Algebraic Models - One equation model, K-ε Models, K-ω Models, SST Model, Standard and High and Low Reynolds number models.	**06**

Recommended books

1. Muralidhar, K., Sundararajan,T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House ,New Delhi1995.
2. Ghoshdastidar, ParthaSarathi. *Computer Simulation of flow and heat transfer*. Tata McGraw-Hill Publishing Company Limited, 1998.
3. Patankar, Suhas. *Numerical heat transfer and fluid flow*. CRC press, 1980.
4. Taylor, Cedric, and T. G. Hughes. *Finite element programming of the Navier-Stokes equations*.PineridgePressLtd, 1981.
5. Anderson, Dale Arden, John C. Tannehill, and Richard H. Pletcher. "Computational fluid mechanics and heat transfer." (1984).
6. Fletcher, Clive. *Computational techniques for fluid dynamics 2: Specific techniques for different flow categories*. Springer Science & Business Media, 2012.
7. Bose,T.K.,*Numerical Fluid Dynamics,*Narosa Publishing House, 1997

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

SE-MTTH201 Skill Based Thermal Laboratory I

Course Code	Course Name
SE-MTTH201	**Skill Based Thermal Laboratory I**

Course pre-requisites	PC-MTTH201, PC-MTTH202

Course Objective

1. To learn 2-D and 3-D modelling
2. To learn hand on simulation of fluid flow and heat transfer problems.
3. To do hand on simulation of internal and external flow.
4. Derive results from numerical simulation

Course Outcomes

1. Students will be able to do 2-D and 3-D modelling.
2. Student will be able to apply the skills learnt in theory subjects to do hands on simulations of fluid flow and heat transfer problems.
3. Students will be able to do simulations of internal and external flow.
4. Students will be able to analyze results of numerical simulation of thermal and fluid flow problems.

List of Experiments

Sr. No.	*Details*	*Hrs.*
1.	2-D Modelling and meshing	**4**
2.	3-D Modelling and meshing	**4**
3.	Simulation of conductive steady state heat transfer 2-Dimensional	**4**
4.	Simulation of conductive steady state heat transfer 3-Dimensional	**4**
5.	Simulation of convective heat transfer 2-Dimensional	**4**
6.	Simulation of convective heat transfer 3-Dimensional	**4**
7.	Internal flow simulation	**4**
8.	External flow simulation	**4**

SE-MTTH202 Skill Based Thermal Laboratory II

Course Code	Course Name
SE-MTTH202	**Sill Based Thermal Laboratory II**

Course pre-requisites	PC-MTTH201, PC-MTTH202

Course Objective

1. To learn hand on simulation of fluid flow problems.
2. To learn 2-D and 3-D modelling and meshing.
3. Derive results from numerical simulation

Course Outcomes

1. Students will acquire hands on experience on the various test rigs, experimental set up.
2. Students should be able to measure the various technical parameters by instrument and by mathematical relationship.
3. Students will be able to identify the effect of various parameters on the system and able to co-relate them.

List of Experiments (Any 8)

Sr. No.	*Details*	*Hrs.*
1.	Simulation of double pipe Heat Exchanger	**4**
2.	Simulation of shell and tube heat exchanger	**4**
3.	Simulation of helical coil Heat Exchanger	**4**
4.	Simulation of plate fin heat exchanger	**4**
5.	Simulation of tube fin heat exchanger	**4**
6.	Simulation of heat transfer with phase change	**4**
7.	Simulation of flow with turbulence model	**4**
8.	Simulation of flow with k-ω model	**4**
9.	Simulation of flow with k-ε model	**4**
10.	Simulation of flow with low standard high and low Reynold’s number model	**4**

PC-MTTH223 Seminar/ Mini Project

Course Code	Course Name
PC-MTTH203	Seminar/ Mini Project

Course pre-requisites	PC-MTTH103

Course Objective

The course intends to provide opportunity to the student for self-learning to beyond syllabus contents related to thrust area of engineering and technology. This will inculcate the habit of lifelong learning.

Course Outcomes

1. Student will be able to apply the skill of presentation and communication techniques.
2. Student will be able to use the knowledge of the fundamentals of subjects to search the related literature.
3. Student will be able to analyze and evaluate the available resources and to select/design/create most appropriate one.

Course content (Seminar)

Sr.no.	Description	Hrs.
1	The student gathers and presents information/data about seminar topic allotted to him/her. The report and presentation shall include review of literature, case studies if applicable and findings about recent trends in the area of seminar topic. On completion of the work the student shall prepare a report and will give a Seminar on the report.	48

Course Content (Mini Project)

Sr.no.	Description	Hrs.
1	The mini project work extends for a single semester and exposes the student to develop and present his/her work related to specific topic. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	48

Guidelines for Seminar-II/Mini Project

1. Seminar/mini project should be based on thrust areas in Mechanical Engineering (Thermal Engineering aspect is appreciated)
2. Students should do literature survey and identify the topic of seminar/mini project and finalize in Consultation with mentor/Guide/Supervisor.
3. Students should use multiple literature and understand the topic and compile the report in standard format as in front of Examiners.

Assessment Guidelines
1. Quality of Literature survey and Novelty in the topic 2. Relevance to the specialization 3. Understanding of the topic 4. Quality of Written and Oral Presentation

PE-MTTH01 Refrigeration System Design

Course Code	Course Name
PE-MTTH01	Refrigeration System Design

Course pre-requisites	

Course Objective

1. To know about the different refrigeration cycles
2. Understand the hardware related to the refrigeration systems
3. Understand how the different components harmonize together
4. Understand the importance of the auxiliary systems.

Course Outcomes

Upon successful completion of the course, students should be able to

1. have a review of refrigeration cycles and alternate refrigeration system to enhance their knowledge of refrigeration, and will be able to explain them,
2. Understand and solve the problem of component selection, refrigerant related issues and system balancing and control
3. Apply their knowledge to appraise different refrigeration system components and environmental issues caused by refrigerant.
4. Analyze a refrigeration problem to carryout necessary calculation.

Course Content

Module No	*Description*	*Hrs.*
1	**Refrigeration Cycles – Analysis** Evolving vapour compression cycle from basic Carnot cycle -analysis of multi- pressure systems – cascade systems	05
2	**Refrigeration System Components** Compressors, condensers-evaporators- expansion devices- types, performance, and their selection, **condensers:** estimation of heat transfer coefficient – fouling factor – friction factor – design procedures – Wilson plots – designing different types of condensers – bis standards – optimization studies – design of evaporative condensers. **evaporators:** design procedure – thermal stress calculations – matching of components	07
3	**Refrigerants-** Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact- ODP, GWP, TEWI Montreal/Kyoto protocols, Paris Agreement, Phase out plans, -eco-friendly Refrigerants, Natural Refrigerants	05
5	**Refrigeration System Design** Estimation of cooling load – systemcold storage, cold chain, low temperature chillers, equilibrium, balancing and matching of components – cycling controls – different defrosting and capacity control methods – electronic controls in refrigerators	08
4	**Refrigeration System Components** System Capacity control – piping – Oil return – Oil separators –	05

	Different types- Refrigerant driers- strainers – Receivers – Accumulators – Low pressure receivers – Refrigerant Pumps. Cooling Tower components-Air Washers – Spray ponds.	
6	**Alternate Refrigeration Systems**– Aqua Ammonia & Li-Br Systems Thermo-Electric Refrigeration- Solar vapour absorption refrigeration system – Pulsetuberefrigeration	06
7	**Tools**-Different Types of Refrigeration Tools – Evacuation and Charging Unit – Recovery and Recycling Unit.	06

Recommended books

1 Dossat, Roy J. *Principles of refrigeration*.No. 621.56 D68 1978. 1978.
2. Stoecker, Wilbert F. *Refrigeration and air conditioning*. Vol. 3. London: McGraw-Hill, 1958.
3. Ananthanarayanan, P. N. *Basic refrigeration and air conditioning*. Tata McGraw-Hill Education, 2013.
4. Goshnay W.B., Principles and Refrigeration, Cambridge, University Press, 1982.
5. Langley, Billy C., Solid state electronic controls for HVACR, Prentice-Hall 1989.
6. ASHRAE Handbook.

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH02 Advanced Combustion Techniques

Course Code	Course Name
PE-MTTH02	Advanced Combustion Techniques

Course pre-requisites	

Course Objectives

The objective of this course to make student aware of-

1. the fundamental of combustion phenomena in general,
2. the different combustion process, its thermodynamics and kinetics,
3. the combustion mechanism in different types of combustion,
4. the burner design for efficient combustion,
5. different combustion models.

Course Outcomes

Upon successful completion of the course, students should be able to

1. have knowledge of fundamentals of combustion, thermodynamics of combustion, different combustion processes,
2. understand the significance of contents of the course for combustion technology,
3. be able to apply knowledge to solve simple/advance numerical problem of a combustion system,
4. be able to analyze and design a combustion system such as furnace and burner

Course Content

Module No.	*Description*	*Hrs.*
01	**Stoichiometry** Combustion Reactions, Gravimetric & Volumetric Analysis,Stoichiometric Relations, Theoretical air required for complete combustion of solid, liquid and gaseous fuels	06
02	**Combustion Process (Stoichiometry)** Combustion Stoichiometry: Application of General Methods, Rapid Methods (Use of Fundamental Formulae) and Empirical Co-Relations for solution of combustion problems, Combustion problems involving Loss of Combustibles with flue gases and ash, Air Ratio, Combustion calculations involving humid air in place of dry air for combustion.	06
03	**Combustion Process (Thermodynamics)** Heat of Combustion, Hess's Law, Combustion Efficiency, Enthalpy of Combustion System & calculations using these concepts, Equilibrium Constants of Combustion Reactions, Phenomenon of Dissociation, Degree of Dissociation, Enthalpy-Temperature (h-t) Diagrams, Concepts of Theoretical, Adiabatic, Actual& Maximum Adiabatic Flame Temperature, Combustion problems based on these concepts.	06

04	**Combustion Process (Kinetics)** Nature of Combustion Process, Types of Combustion Processes: Combustion with Stationary Flames, Surface Combustion, Submerged Combustion, Combustion with Explosion flame, Pulsating Combustion, Slow Combustion, Combustion of Solid Fuels on grate, Mechanism of Combustion Reactions:- Chain Reaction, Thermal Mechanism, Hydrogen-Oxygen Reaction, Combustion of Elementary Carbon.	06
05	**Ignition** Concept of Ignition, Spontaneous Ignition Temperature (SIT):- Influencing factors, Methods of determination, Flame Propagation, Velocity of Flame Propagation:-Influencing Factors, Methods of measuring, Limits of Inflammability:-Influencing Factors, Methods of determination, Combustion Problems to determine Limits of Inflammability, Structure & Nomenclature of Flames, Types of Flames, Flame Stability:- Influencing Factors, Methods.	06
06	**Burners for Combustion Process** Detailed Classification of Gas Burner & Oil Burners with constructional features, design considerations, Advantages, Limitations & Applications, Coal Burning Equipment, Pulverized Coal Firing, Cyclone Firing, Fluidized bed Combustor, Recuperative & Regenerative Burners.	06
07	**Combustion Models and Modeling** Classification, zero-dimensional modeling, quasi-dimensional modeling, multidimensional, comparison of different combustion systems, combustion efficiency, applications Different standard Combustion Models	06

Recommended books

1. Sarkar, Samir. *Fuels and combustion*. Universities Press, 1974.
2. Mishra, D. P. *Fundamentals of combustion*. PHI Learning Pvt. Ltd., 2007.
3. Bhatt, B. I., and S. M. Vora. *Stoichiometry:(si units)*. Tata McGraw-Hill Pub.Co., 1996.
4. Oppenheim, A. K. *Advanced combustion methods*: Felix J. Weinberg, Editor, Academic Press, New York, 1986, (1988)
5. Kuo, Kenneth K. "Principles of combustion." (1986).

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH03 Fuel Cells

Course Code	Course Name
PE-MTTH03	**Fuel Cells**

Course pre-requisites	PC-BTM305, PC-BTM501

Course Objectives

1. To understand the basics of Fuel Cell operation
2. To know how the fuels are prepared to be used in fuel cells
3. Know about different applications

Course Outcomes

Upon successful completion of the course, students should be able to

1. have good knowledge and understanding of Fuel cells,
2. Describe working principle and process of a fuel cell storage system,
3. Express different methods to preparing and processing fuel for fuel cell,
4. Use and identify application of fuel cell with knowledge to new generation fuel cells.

Course Content

Module No.	*Description*	*Hrs.*
1	**Introduction**- Fuel Cell Basic- Physics, Power Generation , Loss Mechanism, Equivalent Circuit , Power Conditioning,Fuel Cell Systems Storage System	05
2.	**Voltage Regulation-** DC/DC and DC/AC Converters., Power Transistors DC/DC,DC/AC. Small Scale Systems, Increased Available Power, Size and Weight Reduction	06
3	**Solid Oxide Fuel Cells-** Materials, SOFC stack, Micro-tubular SOFC,PEM Fuel Cells, Components and Their Properties,Stack Design Principles, System Design .	06
4	**Fuel Cell Applications**- Residential Application, Power Plant and Grid Support , Auxiliary Power Unit Automotive Applications, Stationary Power Applications, Portable Power Applications	05
5	**Fuels and Fuel Processing -** Feedstocks for H_2 Production - Natural Gas- Liquid Petroleum Gas, Liquid Hydrocarbon Fuels: Gasoline and Diesel Alcohols: Methanol and Ethanol Ammonia BiomassFuel Processing for Fuel Cell Application Desulfurization Fuel Reforming.	06
6	New Generation of Catalyst Layers for PEMFCs Basedon Carbon Aerogel Supported Pt Catalyst (CASPC)	06
7.	**Microbial Fuel Cells** Introduction- Historical Perspective -MFC Performance -MFC Applications Microbiology Overview-Bacterial Structure Nutrient Transport	06

Recommended books
1. Sammes, Nigel, ed. *Fuel cell technology: reaching towards commercialization*. Springer Science & Business Media, 2006. 2. Handbook of Fuel Cells, Wiley on line library 3. Viswanathan, Balasubramanian, and M. AuliceScibioh. *Fuel cells: principles and applications*. CRC PressILlc, 2007. 4. Fuel Cell Systems Explained (Second Edition) by James Larminie, Wiley,2003 5. Kordesch, Karl, and Günter R. Simader. *Fuel cells and their applications*. (1996).

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH04 Design and Analysis of Thermal Systems

Course Code	Course Name
PE-MTTH04	**Design and Analysis of Thermal Systems**

Course pre-requisites	PC-BTM403, PC-BTM501, PC-BTM505

Course Objective

1. To learn overall design requirement and methodology of a thermal system.
2. To learn tools and techniques of analysis of a thermal system.
3. How to do modeling of a thermal system.
4. To techniques of economic analysis of thermal system.
5. How to do optimization of a thermal system

Course Outcome

Upon successful completion of the course, students should be able to
1. have knowledge of different aspects of designing of a thermal system,
2. Identify and examine a design problem associated to a thermal system,
3. Understand basics of modeling and their associated techniques,
4. Explain economic aspect of designing and able to apply different techniques of optimization applicable to thermal system.

Course Content

Module No.	*Description*	*Hrs.*
1.	Requirement of engineering design, Other similar terms: Analysis, Synthesis, Selection and Optimization. Characteristics of a thermal system, types and analysis.	6
2.	Formulation of the Design Problem, Conceptual Design, Steps in the Design Process, Computer-Aided Design, Material Selection	6
3.	**Modelling Basics:** Importance of Modelling in Design, basic features of modelling, Types of Models- Analogue, Mathematical, Physical and Numerical. Mathematical modelling – general procedure, final model and validation.	6
4.	**Modelling Techniques:** Physical modelling and dimensional analysis, Curve fitting – exact and best fit. Synthesis of Different Design Steps – Initial design, Design strategies- commonly used design approach and Iterative design procedure.	6
5.	**Economic Considerations:** Calculation of interest- simple, compound, continuous compounding and effective. Worth of money as function of time. Types of payments. Bonds and stocks, Taxes and depreciations. Cost comparison and rate of return. Application to thermal system.	5
6.	**Optimization- Introduction:** Need of optimization, Basic concepts- Objective function, constraints, mathematical formulation for optimization.	5

7.	**Methods of Optimization:** Calculus method, Search method and Geometrical programming Practical aspect of Optimal design – choice of variables, sensitivity analysis, dependence on objective function, multi-objective optimization.	6

Recommended books

1. Jaluria, Yogesh. *Design and optimization of thermal systems*. CRC press, 2007.
2. Stoecker, W.F. Design of Thermal Systems, McGraw-Hill, New York.
3. Dieter, G.E.,*Engineering Design: A Materials and Processing Approach*, McGraw-Hill, 2008.
4. Janna, William S. *Design of Fluid Thermal Systems-SI Version*. Cengage learning, 2010.
5. Rieder, W.G. and Busby, H.R. Introductory Engineering Modelling Emphasizing differential Models and Computer Simulation, Wiley, 1986.
6. Collier, Courtland A., and William Burl Ledbetter. *Engineering economic and cost analysis*. Harpercollins College Division, 1988.
7. Fox, R.L. *Optimization Methods for Engineering Design*, Addison-Wesley, 1971.
8. Rao, Singiresu S., and S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.

Course Evaluation Scheme.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH05 Fundamentals of Gas Dynamics

Course Code	Course Name
PE-MTTH05	**Fundamentals of Gas Dynamics**

Course pre-requisites	PC-BTM305, PC-BTM403, PC-BTM504

Course Objectives

1. To understand fundamental of gas dynamics
2. To know types of compressors and turbines used in aircrafts
3. Know different jet propulsion cycles.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand fundamental of gas dynamics
2. Understand working of compressors, turbines etc.
3. Understand working of jet propulsion cycles.
4. Able to do analysis of jet propulsion systems.

Course Content

Module No.	*Description*	*Hrs.*
1.	Introduction, Cycles, Performance characteristics and improvement, Gas dynamics	05
2.	Centrifugal, axial and mixed flow compressor, principles and characteristics	05
3.	Turbine construction, Blade materials, manufacturing techniques, blade fixing, problems of high temperature operation, blade cooling	06
4	Practical air cooled blades Combustion Systems, various fuels and fuel systems	05
5.	Jet propulsion cycles and their analysis, parameters affecting performance,	05
6	Thrust augmentation, environmental considerations	05
7	Applications of gas dynamics in aeroplanes.	05

Recommended books

1.H Cohen, GFC Rogers and HIH Saravanamuttoo, “Gas Turbine Theory”, Pearson Education,2000.
2.V. Ganesan, “Gas Turbines”, Tata McGraw Hill, 2003.
3.S.M.Yahya “Turbines, Compressors and Fans”, Tata McGraw Hill, 1992.
4.Vincent “The theory and design of Gas Turbine and Jet Engines”, McGrawHill, 1950.

5. W WBathic, “Fundamentals of Gas Turbines”, John Wiley and Sons.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH06: Hydraulic and Pneumatic control systems

Course Code	Course Name
PE-MTTH06	**Hydraulic and Pneumatic control systems**

Course pre-requisites	PC-BTM403, PC-BTM503, PC-BTM505

Course Objectives

1. To understand fundamental principles of hydraulic and pneumatic machines
2. Know about design and operation of hydraulic and pneumatic machines
3. Know different components used in hydraulic and pneumatic machines

Course Outcomes

Upon successful completion of the course, students should be able to

1. Have good knowledge and understanding of hydraulic and pneumatic machines
2. Identify hydraulic and pneumatic components
3. Ability to design hydraulic circuits
4. Ability to design pneumatic circuits.

Course Content

Module No.	*Description*	*Hrs.*
1.	Introduction: - Introduction to Fluid power- Advantages and Applications- Fluid power systems – Types of fluids- Properties of fluids Basics of Hydraulics – Pascal's Law- Principles of flow – Work, Power and Torque. Properties of air– Perfect Gas Laws.	05
2.	Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps, Hydraulic Actuators: Cylinders – Types and construction.	06
3.	Hydraulic motors Control Components: Direction control, Flow control and Pressure control valves- Types, Construction and Operation- Applications – Types of actuation. Accessories: Reservoirs, Accumulators, Intensifiers, Pressure Switches- Applications- Fluid Power ANSI Symbol.	06
4	Industrial hydraulic circuits- Regenerative, Pump Unloading, Double-pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Accumulators, Electro hydraulic circuits, Mechanical Hydraulic servo systems.	06
5.	Pneumatic Systems: Compressors, Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Servo systems. Introduction to Fluidics, Pneumatic logic circuits.	06

6.	Design of Hydraulic Circuits: Design of circuits using the components of hydraulic system for Drilling, Planning, Shaping, Punching, Press. – Selection, fault finding and maintenance of hydraulic components- Sequential circuit design for simple application using cascade method	06
7.	Design of pneumatic circuits: Electro pneumatic circuits. Selection criteria of pneumatic components – Installation fault finding and maintenance of pneumatic components. Microprocessor and PLC- Applications in Hydraulic and Pneumatics- Low cost Automation – Hydraulic and Pneumatic power packs.	06

Recommended books

1. Anthony Esposito," Fluid Power with Applications", PHI / Pearson Education, 2005..
2. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
3. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001
4. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
5. Micheal J, Pinches and Ashby, J.G., "Power Hydraulics", Prentice Hall, 1989.
6. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
7. Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education,

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH07 Air-Conditioning System Design

Course Code	**Course Name**
PE-MTTH07	**Air-Conditioning System Design**

Course pre-requisites	PC-BTM601

Course Objectives

1. Understand basics of air conditioning
2. Estimate the capacity of an air conditioning system
3. Select the equipment for the system

Course Outcomes

Upon successful completion of the course, students should be able to

1. Develop knowledge and understanding of air conditioning system design,
2. Describe the fundamental of psychometrics and different air condition system
3. Analyze an air conditioning system, carryout related calculation and select appropriate components
4. Apply knowledge their knowledge to solve many real life problems of air conditioning system

Course Content

Module No.	*Description*	*Hrs.*
1.	**Psychometrics:** Introduction, properties of air and water vapour mixture, psychrometric chart and its use in air-conditioning, air and human comfort.	**04**
2.	**Air-conditioning system:** Window type, package type, split type, central units-direct and indirect, VRF systems, construction details, specification and testing, evaporative cooling system.	**06**
3.	**Heat Load Calculations:** Load calculation for residential, commercial and industrial applications.	**08**
4.	**System selection:** Selection of Chillers, VRF, Packaged etc. based on heat load calculation of module 3 including details of each of the above systems.	**06**
5.	**Air distribution**: Air handling units, types of AHU, Duct system, pressure drop calculations, air distribution devices-air circuits-design of supply system, noise consideration	**06**
6	**Air-conditioning controls:** Instruments and sensors for air conditioning equipment's and their incorporation with Building Management System	**06**
7	**Trends in HVAC:** Green Building, Net Zero Buildings, Radiant Cooling, Chilled Beams, Direct outdoor air systems Recent. Hybrid Air-conditioning.	**06**

Recommended books
1. Edward Pita, *Air-conditioning-An Energy Approach*, Pearson Press, 2002 2. Wang, Shan Kuo, and Shan K. Wang. "*Handbook of air conditioning and refrigeration*." (2000). 3 Carrier Air Conditioning Co., *Handbook of Air Conditioning Systems design*, McGraw Hill. 4. Langley, Billy C. *Refrigeration and Air Conditioning* Ed. 3, Engle wood Cliffs (N.J) Prentice Hall, 1995. 5. ASHRAE, Handbooks. All volumes 6. Jones, William Peter. Air conditioning engineering. Routledge, 2007.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH08 Advanced Turbo machinery

Course Code	Course Name
PE-MTTH08	**Advanced Turbo machinery**

Course pre-requisites	PC-MTTH101

Course Objective

1. To make students familiar with different type of common turbo machinery involving gas.
2. To impart knowledge about construction, working and performance of centrifugal, axial and radial turbo machines.
3. To understand the blade theory and apply it to develop understanding of turbo machines.

Course Outcome

Upon successful completion of the course, students should be able to

1. Develop an advance knowledge and understanding of turbomachinery,
2. Explain the working principle and different terminology used in turbo machinery
3. Compare different system and select an appropriate turbo machines for a given application
4. Organize his understanding and apply for the analysis a given turbo system

Course Content

Module No.	*Description*	*Hrs.*
1	**Introduction:** Introduction to turbo machinery, Classification and Selection, Dimensional analysis, Model testing, Prototype and model efficiency	**06**
2	**Energy transfer in turbo-machines:** Basic thermodynamics and fluid mechanics for turbo machines. Different efficiency terms, Energy transfer in turbo machines, Euler Turbine Equation, Component of energy transfer. Specific speed	**06**
3	**Blade theory:** Aero-foil Section, Drag and lift, Energy transfer in terms of lift and drag, Blade terminology, Cascade Nomenclature, Turbine Cascade Nomenclature, Cascade testing and curves, Cascade lift and drag coefficient, Losses in cascade.	**06**
4	**Centrifugal compressor and fans:** Construction, working, velocity diagram, slip factor, energy transfer, Stage pressure rise and loading coefficient, pressure coefficient, Diffuser, Degree of reaction, Effect of blade shape on performance, Pre-whirl, Centrifugal compressor characteristics-Surging, Stall and choking, characteristic curves, losses	**06**
5	**Axial compressor and fans:** Advantages of axial flow turbo system, Construction and working principle, Stage work, pressure rise, Range of operation, efficiency,	**06**

	Pressure coefficient and Reaction ratio, characteristic curves, Multistage compression	
6	**Axial flow and radial flow gas turbines:** Construction and working, Velocity triangle and work output, Blade loading coefficient, degree of reaction, stator and rotor losses. Efficiency	**06**
7.	**Power transmitting turbo-machines:** Introduction, Hydraulic coupling, working principle, efficiency, slip, Torque converter, Characteristics of fluid coupling and converter.	**06**

Recommended books
1. Stepanoff A.J. Turboblowers, John Wiley & sons, 1970. 2. Gorla, Rama SR, and Aijaz A. Khan. *Turbomachinery: design and theory*. CRC Press, 2003. 3. Austin, H. Chruch. "Centrifugal pumps and blowers." (1980). 4. Dixon, S. Larry, and Cesare Hall. *Fluid mechanics and thermodynamics of turbomachinery*.Butterworth-Heinemann, 2013.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH09 Advanced Fluid Dynamics

Course Code	Course Name
PE-MTTH09	**Advanced Fluid Dynamics**

Course pre-requisites	PC-BTM403

Course objectives

1. To learn different governing equations in fluid dynamics
2. To understand exact solution of Navier-Strokes equations and potential flow theory.
3. To learn laminar boundary layer theory and characteristics of turbulent flows
4. To know about experimental techniques in fluid dynamics

Course outcomes

Upon successful completion of the course, students should be able to

1. The student shall be able to understand and define the fluid flow problems along with range of governing parameters
2. The students shall be eligible to take a fluid flow problems of industrial base
3. The students shall be able to device experiments in the field of fluid mechanics
4. The students shall be able to understand different flow patterns and differentiate between different flow regimes and its effects.

Course Content

Module No.	***Description***	***Hrs.***
01	**Governing equations:** Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities	08
02	**Exact Solutions of Navier-Stokes Equations**: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows.	08
03	**Potential Flow:** Kelvin's theorem, Irrotational flow, Stream function-vorticity approach,	06
04	**Laminar Boundary layers:** Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations	06
05	**Turbulent Flow**: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution	06
06	**Experimental Techniques:** Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers,	04

07	**Instruments:** Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry	04

Recommended books
1. Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005 2. Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003 3. Fox R.W., McDonald A.T , Introduction to Fluid Mechanics, John Wiley and Sons Inc, 1985 4. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, Fluid Mechanics, Fifth Edition, 2005

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH10: Experimental Analysis and Instrumentation

Course Code	Course Name
PE-MTTH10	**Experimental Analysis and Instrumentation**

Course pre-requisites	PC-BTM404

Course objectives

1. To learn different techniques of instrumentation involved in thermal quantity measurement.
2. To understand the static and dynamic behavior of a measuring system.
3. To learn different kind of errors involved in experimentation and their analysis.
4. To know about the transducers for different types of thermo-physical quantities.

Course outcomes

1. have good knowledge and understanding of experimental analysis and Instrumentation related to thermal system,
2. Apply general concept of measurement, statistical analysis of experimental data and performance analysis of a measuring system
3. Examine a given experimental requirement and recommend a correct measurement procedure and device pertaining to kinetic and thermo-physical measurement
4. Understand the integration of digital to analog way of measurement

Course Content

Module No.	*Description*	*Hrs.*
01	**General Concepts and Statistical Analysis** General Concepts:- Types of Instruments, Functional Elements & Input-Output configuration of Measurement System / Instrument, Desired, Modifying & Interfering Inputs, Methods of correction for Interfering & Modifying Inputs. Statistical Analysis:- Gross, Systematic & Random, Causes and methods of elimination, Limiting Errors, Mean value, Deviation, Mean Deviation, Standard Deviation , Variance, Probable Errors, Probable Errors of Combination of Components, Uncertainty Analysis & Propagation of Uncertainties.	06
02	**Performance Characteristics** Static Characteristics: Important parameters. Dynamic Characteristics:-Standard inputs, Mathematical Model of Linear & Non Linear systems, Electrical Networks, Mechanical Systems, Thermal Systems, Liquid Level Systems & Pneumatic Systems, Transfer Function, Zero, First & Second order systems, First Order Electrical, Thermal & Liquid Level Systems, Differential Equation of a General First Order System, Time Domain Analysis:- Response of First and Second order system to Step, Ramp &Impulse Input, Frequency Domain Analysis:-Frequency Response of First and Second order system.	06

03	**Displacement, Velocity and Acceleration Measurement:** Classification & Characteristics of Transducers, Choice of Transducers,Displacement Measurement:-Resistive (Potentiometric), Resistance Strain Gauge, Inductive, LVDT, Capacitive, Piezo-Electric type devices, Shaft Encoder, Optical Encoder. Velocity Measurement: Doppler Effect, Mechanical, Electrical & Digital Tachometers, Non Contacting Methods, Stroboscope. Acceleration: Seismic Transducers, Resistive (Potentiometric), Resistance Strain Gauge, LVDT, Variable Reluctance, Piezo-Electric type	06
04	**Pressure, Temperature and Flow Measurement** Pressure Measurement: Pressure Transducers- Potentiometric, Resistance Strain Gauge, Inductive, LVDT, Capacitive, Piezo-Electric, Photoelectric type, High Pressure Measurement: Bridgman Gauge, Vacuum Measurement:- McLeod Gauge, Knudsen Gauge, Viscosity Gauge, Thermal Conductivity Gauge, Ionization Gauge. Temperature Measurement: Electrical Methods - RTD, Thermistor, Thermocouples, Pyrometry: Total Radiation and Optical Pyrometers, Quartz Crystal Thermometer, Liquid Crystal Thermography. Flow Measurement: Orifice, Flow Nozzles, Pitot Tube, Rotameter, Vortex Meter, Hot Wire Anemometer, Turbine Flow Meter, Ultrasonic Flow Meter, Laser Doppler Anemometer,	06
05	**Measurement of Thermo-Physical Properties** Thermal Conductivity Measurement:-Steady State Methods- Guarded Hot Plate Apparatus for Solid and Liquid Samples, Radial Heat Conduction Apparatus for Liquids and Gases, Thermal Conductivity Comparators, Transient Methods: Laser Flash Method. Measurement of Heat Capacity: Solid & Liquid Samples. Measurement of Heat Transfer Coefficient: Film Coefficient Transducer, Cylindrical Heat Transfer Coefficient probe.	06
06	**Strain , Viscosity and Humidity Measurement** Strain Measurement:Theoryand Types of Strain Gauges, Gauge Factor, Gauge Sensitivity, Temperature compensation: Need & Methods. Measurement of Viscosity: Rotating cylinder, Capillary Tube, Saybolt& Redwood Viscometers. Measurement of Humidity:Terms used, Galvanometric and Electrical Hygrometers, Sling Psychrometer, Use of Dew Point Temperature.	06
07	**Instrumentation** Bridge Circuits: Wheatstone Bridge Types, Filters: Types, Operational Amplifiers: Various modes, Analog to Digital & Digital to Analog Convertors, Types of Recorders, Devices indicating & recording Voltage, Data acquisition & processing.	06

Recommended books

1. Dobelin E.O ,*Measurement Systems, Application & Design*,., McGraw Hill, New York, 2001.
2. Holman, J. P. J. P. *Experimental methods for engineers*. 2001.
3. Beckwith T.N. Buck L., Roy M.,*Mechanical Engineering Measurement*, Narosa Publishing House, .
4. Venkateshan, S. P. *Mechanical measurements*. John Wiley & Sons, 2015.
5. Rangan, C. S., Garimella R. Sarma, and V. S. V. Mani. *Instrumentation: devices and systems*. Tata McGraw-Hill, 1983.
6. Sawhney, A. K., and PuneetSawhney. "A Course on Mechanical Measurements, Instrumentation and Control." *Dhanpath Rai and Co* (2004).
7. Nakra, B. C., and K. K. Chaudhry. *Instrumentation, measurement and analysis*.Tata McGraw-Hill Education, 2003.
8. Thaval A.K., *Instrumentation and Mechanical Measurements*.
9. Anderson, Norman A. *Instrumentation for Process Measurement and Control, Third Editon*. Crc Press, 1997.
10. Morris, Alan S. *Principles of measurement and instrumentation*. Prentice-Hall, Inc., 1994.

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH11: Piping Engineering

Course Code	Course Name
PE-MTTH11	**Piping Engineering**

Course pre-requisites	BTM305, BTM505

Course Objectives

The piping engineering forms the backbone of industrial development & growth. Transportation of raw materials, basic energy inputs, finished products, utilities, wastes, etc. are utmost important to almost every industry. Even a small failure or malfunctioning of piping systems may bring industries to halt. Therefore, ensuring reliable, safe & cost effective pipeline & piping system is crucially important.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Discuss needs and requirements of a piping system
2. Explain the fundamental of piping such as reading pipe layout, materials for construction-fabrication, fittings and supports, and different codes associated to piping
3. Select and analyze a pipe network for specified application
4. Calculate pressure drop in piping system using fluid mechanics fundamentals

Course Content

Module No.	*Description*	*Hrs.*
1	**Introduction** Overview of Industry and role of piping engineering in various fields. Inputs received & outputs given by piping engineering department. Role of piping designer, engineer, analyst, etc. Preparation of fundamental drawings/diagrams such as PFD, P& ID, Plot plans, Layouts, Isometrics, etc.	**4**
2	**Materials of Construction and Fabrication** Material classification &selection of material for various processes, Preparation of Material Specification Sheets. Metallurgy of piping materials. Review of fabrication methods; their precautions, preparations & requirements relevant to pipes & piping system.	**6**
3	**Codes and Standards** Brief study of various codes/standards & rules/regulations relevant to piping engineering such as ASME B 31.1 & 31.3, IBR, Indian Explosives Act, Factories Act, NFPA rules, etc.	**6**
4	**Design of Pipes and Pipe Fittings** Pipe specification, Line designation list, Calculations for piping and pipeline sizing, Pressure drop in pipelines, piping and pipeline pressure integrity regarding thickness, including straight pipe, curved pipe, and intersections. Design of branch pipe & miter bends. Stress Intensification Factors& Flexibility Factors for pipe fittings.	**6**

5	**Valves and allied Fittings** Study & selection of various types of valves for various services such as On-Off, Throttling, Non-return, Safety, etc. Preparation of Valve data Sheets. Use of vendor data in design. Study & selection of various types of steam traps, expansion devices, etc.	**6**
6	**Pipe Supports** Study & selection of various types of pipe supports. Design considerations, supporting span of overhead pipelines. Calculations for occasional loadings such as wind and earthquake. Piping flexibility, reactions, for sustained, thermal and occasional loading. Calculations for high frequency vibration as opposed to low frequencyslug flow and fluid transients.	**8**
7	**Standard Piping Arrangements and Software** Various standard piping arrangements such as Pump piping, Compressor piping, Heat exchanger piping, Tank farm piping, Storage vessel piping, Reactor piping, Distillation Column piping, etc. Relevant software hands on training.	**6**

Recommended books

1. MW Kellogg Co. *Design of Piping Systems*. Wiley, 1961.
2. Silowash, Brian. *Piping systems manual*.McGraw Hill Professional, 2009.
3. Peng, Liang-Chuan, and Tsen-Loong Peng. *Pipe stress engineering*. ASME press, 2009.
4. Menon, Shashi. *Piping calculations manual*.McGraw Hill Professional, 2004.
5. Wilson, B. *Detail engineering and layout of piping systems,* 2011.

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH12 Nuclear Engineering

Course Code	Course Name
PE-MTTH12	**Nuclear Engineering**

Course pre-requisites	BTM305, BTM403, BTM501, PC- MTTH102

Course Objectives

1. General awareness of fundamentals of Nuclear energy
2. Learn about effects of nuclear radiation on materials of construction
3. Know about the positive and negative aspects of Nuclear Energy

Course Outcomes

Upon successful completion of the course, students should be able to

1. Develop knowledge and understanding of nuclear engineering
2. Describe the mechanism of nuclear reaction, different type of nuclear reactors, nuclear materials and their processing and reprocessing etc.
3. Assess the significance of nuclear waste disposal and will be able to understand the need of safety and pollution control in nuclear power station
4. Discuss international safety standard practiced by the world

Course Content

Module No.	*Description*	*Hrs.*
1.	**Nuclear reactions** :Mechanism of nuclear fission - nuclides - radioactivity – decay chains - neutron reactions - the fission process	06
2.	**Nuclear reactors** - types - design and construction of nuclear reactors - fast breeder reactors- heat transfer techniques in nuclear reactors - reactor shielding	06
3.	**Reactor materials nuclear fuel cycles** - characteristics of nuclear fuels - Uranium - production and purification of Uranium - conversion to UF4 and UF6 - other fuels like Zirconium, Thorium - Beryllium.	06
4.	**Reprocessing: Nuclear fuel cycles - spent fuel characteristics** - role of solvent extraction in reprocessing - solvent extraction equipment.	06
5.	**Separation of reactor products :** Processes to be considered - 'Fuel Element' dissolution - precipitation process – ion exchange - redox - purex - TTA - chelation -U235 - Hexone - TBP and thorax Processes - oxidative slaging and electro - refining - Isotopes - principles of Isotope separation.	06
6.	**Waste disposal and radiation protection** Types of nuclear wastes - safety control and pollution control and abatement	06
7.	**International conventions**- on safety aspects - radiation hazards and prevention	06

Recommended books
1. Glasstone, Samuel, and Alexander Sesonske. *Nuclear reactor engineering: reactor systems engineering*. Springer Science & Business Media, 2012. 2. Duderstadt, James J., and Louis J. Hamilton. "Nuclear reactor analysis." (1976). 3. Lamarsh, J.R., Introduction to Nuclear Reactor Theory, Wesley, 1996. 4. Waltar, Alan Edward, and Albert Barnett Reynolds. *Fast breeder reactors*. Alan E. Waltar, 1981. 5. Winterton, Richard HS. *Thermal design of nuclear reactors*.Elsevier, 2014.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH13 Cryogenics Engineering

Course Code	Course Name
PE-MTTH13	**Cryogenics Engineering**

Course pre-requisites	BTM601

Course Objectives
The objective of this course is to: 1. To outline the history, developments, pre-requisite principles, scope and applications of Cryogenic Engineering. 2. To explain concepts and principles of fundamental knowledge areas such as behavior of engineering materials and fluids at cryogenic temperatures, cryogenic insulation, vacuum technology as well safety aspects in the domain of Cryogenic Engineering. 3. To explain fundamental principles, detailed features of arrangements and operation of various cryogen liquefaction systems with critical components involved. 4.To develop understanding and insight for the field of Cryogenic Engineering
Course Outcomes
Upon successful completion of the course, the students should be able 1. To explain and exemplify the history and developments as well as scope and applications of Cryogenic Engineering. 2.To explain and interpret principles of behavior of engineering materials and fluids at cryogenic temperatures, explain and compare various cryogenic insulations, vacuum technology, explain and apply various safety aspects in Cryogenic Engineering. 3. To explain fundamental principles, discuss detailed features of arrangements, interpret and compare the operation of various cryogen liquefaction systems with critical components involved. 4. To apply the acquired knowledge to analyze and evaluate the problems in the field of Cryogenic Engineering.

Course Contents

Module No.	***Details***	***Hrs.***
1.	**Introduction to Cryogenic Engineering:** Introduction, Historical background, Developments, Scope of application, Present areas involving Cryogenic Engineering, Principles of Thermodynamics, Heat Transfer, Momentum Transfer, Cool down.	02
2.	**Low Temperature Properties of Engineering Materials:** **Properties of Solids:-**Mechanical Properties, Thermal Properties, Electrical and Magnetic Properties of solids including metals and non-metals (insulators), Design considerations, Material selection criterion for Cryogenic Applications. **Cryogenic Fluids: -** P-V-T Behaviour of a Pure substance, T-s and T-h diagrams of a Pure substance, Properties of cryogenic fluids:- Fluids other than Hydrogen and Helium, Hydrogen , Helium.	04

3.	**Gas Liquefaction Systems-I:** Introduction, System performance parameters, The thermodynamically ideal system, Production of low temperatures: - Joule-Thompson effect, Adiabatic expansion. Simple Linde-Hampson system, Pre-cooled Linde- Hampson system, Linde dual pressure system, Cascade system, Claude system, Kapitza system, Heylandt system. Liquefaction systems for LNG, Comparison of liquefaction systems.	06
4.	**Gas Liquefaction Systems-II:** Liquefaction systems for Neon and Hydrogen:- Pre-cooled Linde-Hampson system for Neon and Hydrogen, Claude system for Neon and Hydrogen, Helium refrigerated Hydrogen liquefaction system, Ortho-Para Hydrogen conversion. Liquefaction systems for Helium:-Collins Helium liquefaction system, Simon Helium liquefaction system. Critical components of liquefaction systems:-Heat Exchangers, Compressors and expanders, Losses for real machines and effect on system performance, Effect of heat transfer to system.	06
5.	**Cryogenic Insulations:** Introduction, Heat transfer, Concept of apparent thermal conductivity, Different types of cryogenic insulations:-Expanded foam insulations, Gas-filled powders and fibrous insulations, Vacuum insulation, Evacuated powder and fibrous insulations, Opacified-powder insulations, Multilayer insulations, Comparison of insulations. Composite insulation, Adhesives and other materials, Placement of cryogenic insulation.	04
6.	**Vacuum Technology:** Importance of vacuum technology in cryogenic, Flow regimes in vacuum systems, Conductance in vacuum system, Components of vacuum system, Differrent types of vacuum pumps:- Mechanical vacuum pumps, Difussion pumps, Ion pumps, Cryopumping, Getters and sorption pumping, Vacuum gauges, Vacuum valves.	04
7.	**Safety with Cryogenic Systems:** Introduction, Physiological hazards, Suitability of materials and construction techniques, Explosions and flammability, Excessive pressure gas, Special considerations for Hydrogen and Oxygen gas, General safety principles, Safety checklist.	02

Recommended books
1. Barrron, Randall F, *Cryogenic Systems*, 2nd edn, Oxford University Press, New York, 1987.
2. Flynn, Thomas M 2005, Cryogenic Engineering, *2nd edn*, CRC Press, New York, 2000

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

PE-MTTH14 Advanced I. C. Engines

Course Code	Course Name
PE-MTTH14	**Advanced I. C. Engines**

Course pre-requisites	PC-BTM604

Course Objectives		
1. To understand the function and fundamental designs of I. C. engine components. 2. To understand the requirements of materials of engine components 3. To understand the mechanical limitations of obtaining ideal performance. 4. To learn and analysis of the performance and emission problems of I. C. engines		
Course Outcomes		
Upon successful completion of the course, students should be able to 1. Design the components of I.C. engines. 2. Apply the knowledge for analyzing and calculating emission and performances of I.C. engines. 3. Understand and apply the knowledge of supercharger and turbocharger during design. 4. Understand advanced and modified I.C. engine		
Course Content		
Module No.	***Details***	***Hrs.***
01	**Need of Basic Engine Design:** Design of I C engine components. Design of combustion chamber. Basic Engine Design Fundamentals.	**02**
02	**Fuels and Bio-Diesel Fuels:** Effect of fuel characteristic on engine performance. Introduction of biodiesel in the engines. Performance and emission analysis of I. C. Engines.	**02**
03	**Engine Basic Theory** Overall engine system parameters and configuration, Factors affecting combustion phenomenon. Engine Modification for alternative fuels**.**	**02**
04	**Engine Block and Cylinder Head** General design considerations, Design of Engine Bolck and Cylinder head. Material Selcetion, 2 Valve & 4 valve cylinder heads. Bolts loads and gasket design.	**02**
05	**Crank Train and Valve train** Design of Crank Train and Valve Train Mechanism, Function, Requirements, Materials – Piston and crankshaft. Recent trends in design of piston assembly – Piston, Piston rings, Piston pin, Connecting rod assembly and Crankshaft.	**02**
06	**Fuel Injection, Cooling & Lubrication** Functional requirement, Fuel Filter, Types of Injectors, Pump-line-injector, injector system, Unit Injection, CRDI, Injection Pressure, Multiple Injections.	**02**

	Cooling system, Cooling Circuits, Water Pump and Thermostat and its types. Lubrication – Types & Layout, Requirement of Lubricants, Oil Filters, Oil Pan, Oil pump types.	
07	**Recent Trends in Design of I C Engine Parts:** Hybrid electric technology, Functional Requirement of intake and Exhaust system, Air Induction, Swirl &Turbulance, Swirl Generation, Air Filter, Intake Manifold, Exhaust Manifold, Turbochargers, EGR, EGR Cooler, Silencer etc, Part design philosophy.	**02**

Recommended books

Text Books:
1. Sharma, R. P., and M. L. Mathur. "Internal Combustion Engine." (1980).
2. Obert, Edward F. "Internal combustion engines and air pollution." (1973).
3. Domkundwar, V. M. "A course in internal combustion engines."*Dhanpat Rai and CO.(P) Ltd* (2000).
4. Ganesan, V. *Internal combustion engines*. McGraw Hill Education (India) Pvt Ltd, 2012.

Reference Books:
1. Stone, Richard. *Introduction to internal combustion engines*. (1999).
2. Beohar S.L., *Internal Combustion Engine*,
3. Gill, Paul W., James H. Smith, and Eugene Ziurys.*Fundamentals of Internal Combustion Engines*. United States Naval Institute, 1952.
4. Heldt, Peter Martin. *High-speed combustion engines: design, production, tests*. Chilton Co., 1956.
5. Morse, Frederick T. *Power plant engineering*. Van Nostrand, 1963.
6. Maleev, Vladimir Leonidas. *Internal-combustion engines: theory and design*. 1945.
7. Taylor, Charles Fayette, and Edward Story Taylor. *The internal-combustion engine*.Vol. 1. International Textbook Co., 1961.
8. Heywood, J. B. "Internal combustion engine fundamentals/John B. Heywood." (1988).
9. Thipse, S. S. *Internal Combustion Engines*. Jaico, 2010.
10. Willard, W. Pulkrabek. *Engineering fundamentals of the internal combustion engine.* Prentice Hall.New Jersey (2004).

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Ability Enhancement Course AE-MTTH201 : English for Research Paper Writing

Course Code	Course Name
AE-MTTH201	**English for Research Paper Writing**
Course pre-requisites	BTM406

Course Outcomes		
Students will be able to: **1.** Understand that how to improve your writing skills and level of readability **2.** Learn about what to write in each section **3.** Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission		
Course Content		
Module No.	***Details***	***Hrs.***
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	3
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	3
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	3
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	3
5	Skills are needed when writing the Methods, skills needed when writing the Results	3
6	Skills are needed when writing the Discussion, skills are needed when writing the Conclusions	3
7	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	3

Reference Books

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Indian Knowledge System IK-MTTH101: Constitution of India

Course Code	Course Name
IK-MTTH101	**Constitution of India**

Course pre-requisites	BT025

Course Objectives		
Students will be able to: 1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution		
Course Outcomes		
Students will be able to: 1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. 3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. 4. Discuss the passage of the Hindu Code Bill of 1956		
Course Content		
Module No.	***Details***	***Hrs.***
1	➢ History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	3
2	➢ Philosophy of the Indian Constitution: Preamble Salient Features	3
3	➢ Contours of Constitutional Rights & Duties: ➢ Fundamental Rights ➢ Right to Equality ➢ Right to Freedom ➢ Right against Exploitation ➢ Right to Freedom of Religion ➢ Cultural and Educational Rights ➢ Right to Constitutional Remedies ➢ Directive Principles of State Policy ➢ Fundamental Duties.	3
4	➢ Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume -II][194] ➢ Parliament ➢ Composition	3

	➢ Qualifications and Disqualifications ➢ Powers and Functions ➢ Executive ➢ President ➢ Governor ➢ Council of Ministers ➢ Judiciary, Appointment and Transfer of Judges, Qualifications ➢ Powers and Functions	
5	➢ Local Administration: ➢ District's Administration head: Role and Importance, ➢ Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. ➢ Pachayati raj: Introduction, PRI: Zila Pachayat.	3
6	➢ Elected officials and their roles, CEO Zila Pachayat: Position and role. ➢ Block level: Organizational Hierarchy (Different departments), ➢ Village level: Role of Elected and Appointed officials, ➢ Importance of grass root democracy	3
7	➢ Election Commission: ➢ Election Commission: Role and Functioning. ➢ Chief Election Commissioner and Election Commissioners. ➢ State Election Commission: Role and Functioning. ➢ Institute and Bodies for the welfare of SC/ST/OBC and women	3

Reference Books
1. The Constitution of India, 1950 (Bare Act), Government Publication. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Value Education Course VE-MTTH301: Disaster Management

Course Code	Course Name
VE-MTTH301	Disaster Management

Course pre-requisites	BTM399, BTM499

Course Outcomes		
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and Humanitarian response. 2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. 4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	3
2	**Repercussions Of Disasters And Hazards:** Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods,Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	3
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	3
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	3
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment	3
6	**Global Co-Operation** In Risk Assessment And Warning,	3

	People's Participation In Risk Assessment. Strategies for Survival.	
7	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	3

Reference Books

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Co-Curricular Course CC-MTTH401: Stress Management by Yoga

Course Code	Course Name
CC-MTTH401	Stress Management by Yoga

Course pre-requisites	BT107

Course Objectives		
1. To achieve overall health of body and mind 2. To overcome stress		
Course Outcomes		
Students will be able to: 1. Develop healthy mind in a healthy body thus improving social health also 2. Improve efficiency		
Course Content		
Module No.	***Details***	***Hrs.***
1	➢ Definitions of Eight parts of yog. (Ashtanga)	3
2	➢ Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	3
3	Yoga & The Brain ➢ Brain Based Learning ➢ The Brain ➢ Teaching to the Developing Brain ➢ Supporting the Learning Brain with Yoga	3
4	Social Emotional Learning	3
5	POSITIVE CLASSROOM MANAGEMENT ➢ Transitions and Engagement ➢ Dynamic Teaching ➢ Understanding Behavior ➢ Classroom Boundaries	3
6	THE YOGA ENVIRONMENT ➢ Clothing ➢ Assistants • ➢ Adjustments	3
7	➢ Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- ➢ Types of pranayam	3

Reference Books
1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur 2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Value Education Course VE-MTTH302: Value Education

Course Code	Course Name
VE-MTTH302	Value Education

Course pre-requisites	

Course Objectives		
1. Understand value of education and self- development 2. Imbibe good values in students 3. Let the should know about the importance of character		
Course Outcomes		
Students will be able to: 1. Knowledge of self-development 2.Learn the importance of Human values 3.Developing the overall personality		
Course Content		
Module No.	***Details***	***Hrs.***
1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism, Moral and non-moral valuation. Standards and principles, Value judgements	3
2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness.	3
3	Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature ,Discipline.	3
4	Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour.	3
5	Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence ,Humility.	3
6	Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature	3
7	Role of Women, Women empowerment, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively	3

Reference Books
1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Ability Enhancement Course AE-MTTH203: Pedagogy Studies

Course Code	Course Name
AE-MTTH203	Pedagogy Studies

Course pre-requisites	

Course Objectives		
1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers. 2. Identify critical evidence gaps to guide the development.		
Course Outcomes		
Students will be able to understand: 1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries? 2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? 3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?		
Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.	3
2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.	3
3	Evidence on the effectiveness of pedagogical practices: Methodology for the in-depth stage: quality assessment of included studies, how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	3
4	Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches,	3
5	Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community,	3
6	Research gaps and future directions, Research design, Contexts Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.	3
7	Teachers' attitudes and beliefs and Pedagogic strategies, Curriculum and assessment, Barriers to learning: limited resources and large class sizes	3

Reference Books
1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261. 2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379. 3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID. 4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282. 5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell. 6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Ability Enhancement Course AE-MTTH202: Personality Development through Life Enlightenment Skills

Course Code	Course Name
AE-MTTH202	Personality Development through Life Enlightenment Skills

Course pre-requisites	

<table>
<tr><th colspan="3">Course Objectives</th></tr>
<tr><td colspan="3">1. To learn to achieve the highest goal happily
2. 2. To become a person with stable mind, pleasing personality and determination
3. 3. To awaken wisdom in students</td></tr>
<tr><th colspan="3">Course Outcomes</th></tr>
<tr><td colspan="3">Students will be able to understand:
1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
3. Study of Neetishatakam will help in developing versatile personality of students.</td></tr>
<tr><th colspan="3">Course Content</th></tr>
<tr><th>Module No.</th><th>Details</th><th>Hrs.</th></tr>
<tr><td>1</td><td>Neetisatakam-Holistic development of personality:
▪ Verses- 19,20,21,22 (wisdom)
▪ Verses- 29,31,32 (pride & heroism)
▪</td><td>3</td></tr>
<tr><td>2</td><td>▪ Verses- 26,28,63,65 (virtue)
▪ Verses- 52,53,59 (dont’s)
▪ Verses- 71,73,75,78 (do’s)</td><td>3</td></tr>
<tr><td>3</td><td>Approach to day-to-day work and duties:
▪ Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
▪ Chapter 3-Verses 13, 21, 27, 35.</td><td>3</td></tr>
<tr><td>4</td><td>▪ Chapter 6-Verses 5,13,17, 23, 35,
▪ Chapter 18-Verses 45, 46, 48.</td><td>3</td></tr>
<tr><td>5</td><td>Statements of basic knowledge:
▪ Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68
▪ Chapter 12 -Verses 13, 14, 15, 16,17, 18</td><td>3</td></tr>
<tr><td>6</td><td>▪ Personality of Role model. Shrimad Bhagwad Geeta: Chapter2 Verses 17, Chapter 3-Verses 36,37,42,</td><td>3</td></tr>
<tr><td>7</td><td>▪ Chapter 4-Verses 18, 38,39
▪ Chapter18 – Verses 37,38,63</td><td>3</td></tr>
</table>

Reference Books
1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata 2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Sr. No.	Examination	Module
1	T-I	1
2	T-II	2
3	End Sem	1 to 3

Open Elective OE-MTTH201: Industrial Safety

Course Code	Course Name
OE-MTTH201	**Industrial Safety**

Course pre-requisites	BTM803/BTM898

Course Outcomes		
At the end of the course students will be able to 1. Understand basic safety norms, rules and regulations and hazards 2. Understand maintenance of utility systems and its service life expectancy 3. Understand fault and diagnostics and preventive measures 4. Understand repair cycles of machines and trouble shootings		
Course Content		
Module No.	***Details***	***Hrs.***
1	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	4
2	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	4
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity Lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods	4
4	Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	4
5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor	4

6	Troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive Maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets	4
7	Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	4

Reference Books

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Open Elective OE-MTTH202: Operation Research

Course Code	Course Name
OE-MTTH202	**Operations Research**

Course pre-requisites	BTM803

Course Outcomes		
At the end of the course, the student should be able to 1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables. 2. Students should able to apply the concept of non-linear programming 3. Students should able to carry out sensitivity analysis 4. Student should able to model the real world problem and simulate it.		
Course Content		
Module No.	***Details***	***Hrs.***
1	Optimization Techniques, Model Formulation, models, General L. R Formulation, Simplex Techniques, Sensitivity Analysis,	5
2	Formulation of a LPP - Graphical solution revised simplex method- duality theory - dual simplex method - sensitivity analysis parametric programming	6
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem – CPM/PERT	5
4	Scheduling and sequencing – single server and multiple server models – deterministic inventory models –	5
5	Inventory Control Models, Probabilistic inventory control models – Geometric Programming.	5
6	Competitive Models, Single and Multi-channel Problems, Sequencing Models	5
7	Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	5

Reference Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Open Elective OE-MTTH203: Cost Management of Engineering Projects

Course Code	Course Name
OE-MTTH203	**Cost Management of Engineering Projects**

Course pre-requisites	BTM803

Course Outcomes		
At the end of the course students will be able to 1. Estimate project cost and project commisioning 2. Analyse cost behaviour in project 3. Know different project strategies 4. Apply quantitative techniques for cost management of engineering projects		
	Course Content	
Module No.	***Details***	***Hrs.***
1	Introduction and Overview of the Strategic Cost Management Process	4
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunitycost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational Control; Provision of data for Decision-Making.	4
3	Project: meaning, Different types, why to manage, cost overru centres, various stages of project execution: conception commissioning. Project execution as conglomeration of technical and nontechnicalactivities. Detailed Engineering activities. Preproj execution main clearances and Documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar chartsand Network diagram. Project commissioning: mechanical and process	8
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.	8
5	Pricing strategies: Pareto Analysis. Target Costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.	6
6	Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	6
7	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems,	6

	Simulation, Learning Curve Theory.	

Reference Books

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Course Evaluation Scheme

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Open Elective OE-MTTH204: Waste to Energy

Course Code	Course Name
OE-MTTH204	**Waste to Energy**

Course pre-requisites	BTM504

Course Outcomes		
At the end of the course students will be able to 1. Classify waste from ebergy recovery point of view 2. Know biomass pyrolysis and gasification 3. Understand biomass combustion 4. Understand working of biogas plant and importance of biomass energy programme in India		
Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	6
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	6
4	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	6
5	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion	6
6	Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion	
7	Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	6

Reference Books
1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990. 2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983. 3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991. 4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &Sons, 1996.

Course Evaluation Scheme		
Sr. No.	**Examination**	**Module**
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Open Elective OE-MTTH205: Internet of Things

Course Code	**Course Name**
OE-MTTH205	Internet of Things

Course pre-requisites	General knowledge of networking, sensing, databases, programming, and related technology

Course Objectives		
Upon successful completion of the course, students will be • Explored to the interconnection and integration of the physical world and the cyber space. • They are also able to design & develop IOT Devices.		
Course Outcomes		
After successful completion of the course student should be able to 1. Describe the theory related to Internet of things 2. Apply theoretical knowledge of IOT in practice 3. Select the hardware & software for different applications. 4. Develop an application using IOT hardware & software		
Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain etc.	2
2	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	2
3	Programming the Microcontroller for IOT Cloud computing and IOT –Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	2
4	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	2
5	IOT PROTOCOLS Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	2
6	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	2

7	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	2

Text Books
1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011.
Reference Books
1. Charalampos Doukas, “Building Internet of Things with the Arduino”, Create space, April 2002.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTTH206: Introduction to Big Data Analytics

Course Code	Course Name
OE-MTTH206	**Introduction to Big Data Analytics**

Course pre-requisites	BTM 301, BTM 401

Course Objectives		
1. Understand the role of business analytics within an organization. 2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. 3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. 4. To become familiar with processes needed to develop, report, and analyze business data. 5. Use decision-making tools/Operations research techniques. 6. Mange business process using analytical and management tools. **7.** Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.		
Course Outcomes		
1. Students will demonstrate knowledge of data analytics. 2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics. 3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making. 4. Students will demonstrate the ability to translate data into clear, actionable insights.		
Course Content		
Module No.	***Details***	***Hrs.***
1	Business analytics: Overview of Business analytics, Scope of Business analytics,Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	2
2	Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	2
3	Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.	2

4	Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	2
5	Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	2
6	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	2
7	Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	2

Reference Books
1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press. 2. Business Analytics by James Evans, persons Education.

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTTH207: Introduction to AI and Machine Learning

Course Code	Course Name
OE-MTTH207	**Introduction to AI and Machine Learning**

Course pre-requisites	Mathematics, Knowledge of programming language (Python preferred)

Course Objectives

The students after studying these topics should be able to

1. understand applications of Artificial Intelligence and Machine Learning for engineering applications
2. apply suitable algorithms for simple engineering problems

Course Outcomes

Upon successful completion of the course, students should be able to

1. discuss applications of Artificial Intelligence for engineering problem solving
2. apply fundamental concepts in machine learning and select popular machine learning algorithms for engineering problem solving
3. compose computer code for solving problems using machine learning algorithms
4. explain advanced machine learning concepts such as Neural Network, Reinforcement Learning.

Course Content

Module No.	*Details*	*Hrs.*
1	Artificial Intelligence, Intelligent agents, types of learning, steps involved in problem solving using Machine Learning	2
2	Linear regression, Decision trees, overfitting	2
3	Instance based learning, Feature reduction, Collaborative filtering-based recommendation	2
4	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	2
5	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network	2
6	Clustering: k-means, adaptive hierarchical clustering	2
7	Introduction to Reinforcement Learning	2

Text Books

1. Tom Mitchell, Machine Learning, First Edition, McGraw- Hill (1997).
2. Stuart Russel and Peter Norvig, Artificial Intelligence – A modern approach, Pearson (2015)
3. Ethem Alpaydin, Introduction to Machine Learning, PHI (2015).
4. Gopal M., Applied Machine Learning, McGraw Hill (2018)

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Open Elective OE-MTTH208: Introduction to Augmented Reality

Course Code	Course Name
OE-MTTH208	**Introduction to Augmented Reality**

Course pre-requisites	General knowledge of CAD Modelling

Course Objectives
• Explore the basic concepts of Augmented Reality. • They are also able to design & develop AR application.
Course Outcomes
After successful completion of the course student should be able to 1. Describe the theory related to Augmented Reality 2. Apply theoretical knowledge of AR in practice 3. Select the hardware & software for different applications. 4. Develop interactive augmented reality applications for both PC based mobile devices using a variety of novel input devices

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** History of AR, Basics of Augmented Reality, Architecture/Framework, Various applications of AR in Automotive & Auto Component industries, Construction Managemen, Educationt etc. AR Browsers, Marker & Marker less AR	2
2	**Enabling Technologies of Augmented Reality** Mobile, Camera, Cloud Computing, Unity, AR with Google Sketch up	2
3	**Remote Maintainence/Training using AR** Architecture, Benefits, Challenges	2
4	**Lighting and Illumination Issues in AR** Conversion of CAD Model to AR Model	2
5	**HOLOLENS INTERFACE**	2
6	**Integration of AR** Integration with IOT. Integarting with CRM, New market Opportunities of AR, Business models, Revenue models & AR in Other Fields	2
7	**Challenges & Opportunities of AR** New business markets in AR, Technological challenges faced by AR	2

Text Books

1.Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.

2. Steve Aukstakalnis Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR

3. Jonathan Linowes, Krystian, Augmented Reality for Developers, 2017.
4. Stephen Cawood and Mark Fiala, Augmented Reality: A practical guide

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTTH209: Composite Materials

Course Code	Course Name
OE-MTTH209	**Composite Materials**

Course pre-requisites	**Manufacturing Science, Material Science**

Course Objectives

- Explain types of composite materials and their applications
- Describe manufacturing processes for composite materials
- Discuss mechanical properties of composites

Course Outcomes

After successful completion of the course student should be able to

1. explain types of composite materials and identify its applications to mechanical engineering systems
2. discuss constituents of different types of composites
3. describe manufacturing processes for composite materials
4. define simple mechanical properties of composites

Course Content

Module No.	*Details*	*Hrs.*
1	**Overview of composite materials** Historical background, Classification based on structure and matrix, Advantages and limitations, industry applications,	06
2	**Composite materials** Reinforcement fibers, whiskers, polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC),	06
3	**Composite Science** Material and microstructure parameters of layered and phased composites, micro and macro approaches to study and prediction of structure property relations.	06
4	**Introduction to micromechanics** Anisotropy of composites, anisotropic elastic constants, failure criteria under multiaxial loading, interlaminar failure mechanism	06
5	**Composite manufacturing processes** Manufacturing of reinforcement fibers and whiskers, preparation of fillers, additives and pigments for PMC, manufacturing of matrix polymers, manufacture of metallic matrices, processing of ceramics, manufacture of foams, honeycombs and adhesives.	06
6	**Composite post processing operation** Machining, cutting, polishing, welding of thermoplastic PMC, bonding, riveting and painting	06
7	**Composite product design** Material considerations in composite product design, material design of thermal, optical, acoustic, electrical design requirements, design exercise for design of simple structural element such as tension bar and ring, Embedded sensors	06

Text Books
1. K.K. Chawla, Composite Materials – Science & Engineering, Springer-Verlag, New York, 1987.
2. Analysis and Performance of Fiber Composites, Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, Wiley, 2006
3. Handbook of Composites, George Lubin, Van Nostrand, Reinhold Co., 1982

Sr. No.	Examination	Module
1	T-I	1,2 and part of 3
2	T-II	Remaining part of 3,4 and part of module 5
3	End Sem	1 to 7

Open Elective OE-MTTH210: Digital Twin

Course Code	Course Name
OE-MTTH210	Digital Twin

Course pre-requisites	CAD, Sensors, Simulation

Course Objectives		
• To understand the fundamentals of industry 4.0 & digital twin • To understand the enabling technologies for digital twin • To understand how to build a digital twin • To study application areas of digital twin • To understand digital twin as an interdisciplinary technology along with its integrtaion • To understand New business and Revenue models of digital twin		
Course Outcomes		
Upon successful completion of the course, students should be able 1. Explain & write basic concepts of digital twin 2. Identify various enabling technologies of digital twin. 3. Apply theoretical knowledge in practice 4. Develop small application using digital twin related software		
Course Content		
Module No.	***Details***	***Hrs.***
1	INDUSTRY 4.0: Introduction to industry 4.0, Technologies drivers & enablers of industry 4.0 like sensors, computing power, speed of data, connectivity, accessibility, advanced analytics.	4
2	Evolution of Digital Twins, Introduction to Digital twin, Basic concepts of Digital twins, Growth drivers for digital twin, Product & Process digital twins, Digital Model, Digital Shadow, Digital twin Prototype (DTP), Digital Twin Instance (DTI), Digital Twin Aggregate (DTA), Partial digital twin, Clone digital twin, augmented digital twin, Smart & Connected design, accelerating industry 4.0 using Digital Twin	6
3	Enabling technologies for Digital Twin like Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL), Big Data Analytics, Internet of Things (IOT), Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Cloud Computing Services (CCS) etc.	6
4	How to build a digital Twin, Steps in building digital twin, integration of IOT & CAD, integration of IOT, BIM data & machine Learning, Hardware & Software related to digital twin, working of a digital twin, Digital Twin Platforms Concurrent engineering & digital twin, digital twin as a smart service to industries.	6
5	Use cases of Digital Twin in Product development, Logistics Manufacturing, Simulation, Predictive Maintenance, Asset Maintenance, Construction industry, Facility Management Architecture, Electrical engineering, digital twin driven power	5

	transformer service, Health Care & etc.	
6	Integration of Digital Twin with Product Life Cycle Management (PLM), Big Data Analytics, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supplier Relationship Management (SRM), Manufacturing Execution Systems (MES) etc.	4
7	Building New business/Revenue models, developing maturity model of digital twin, Benefits of Digital Twins, Challenges in applying & implementing digital twins Future research areas of digital twin, Careers in Digital twin, Digital Twin Engineer	5

Text Books

1. Digital Twin: Possibilities of the new Digital twin technology, Anand Iyer, 2017, 35 Pages
2. Digital Twin Development & Deployment on the Cloud, Ist edition, Nassim Khaled Bibin Pattel Affan Siddiqu, ISBN: 9780128216316, ELSEVIER, pages 592
3. Digital Twin Technologies & Smart Cities, Maryam Farsi, Alireza Daneshkhah, Amin Hosseinian-Far, Hamid Jahankahani, Springer, ISBN 978-3-030-18731-6
4. Digital Twin Driven Smart Manufacturing, By Fei Tao, Meng Zhang, A.Y.C. Nee, ISBN 978-0-12-817630-6, ELSEVIER, pages 257
5. Advances in Computers, The Digital Twin Paradigm for Smarter Systems and Environments: The Industry, Pethuraj & Preetha Evanjaline, ELSEVIER, pages 257, ISBN 978-0-12-818756-2, ISSN 0065-2458

Reference Books

1. Digital Twin Driven Smart Design by Fei Tao, Ang Liu, Tianliang Hu, A.Y.C. Nee, ELSEVIER, ISBN 978-0-12-818918-4, Pages 333
2. Handbook Of Digital Enterprise Systems: Digital Twins, Simulation and Ai, by Wolfgang Kühn, world scientific publishing co., ISBN 978-981-120-073-1, Pages 229.
3. Digital Twin Complete Self-Assesment Guide, 1976302927, 9781976302923sment Guide, Geradus Blokdyk, CreateSpace Independent Publishing Platform, 2017, Pages 120.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3 & 4
3	End Sem	1 to 7

Open Elective OE-MTTH211: Industry 4.0

Course Code	Course Name
OE-MTTH211	INDUSTRY 4.0

Course pre-requisites	CAD, BIM, Sensors, Data base

Course Objectives

- To understand the various industrial revolutions
- To understand the enabling technologies for industry 4.0
- To understand the power of data analytics
- To understand importance of Connectivity
- To understand interdisciplinary concept & technology convergence
- To understand New business and Revenue models in light of industry4.0

Course Outcomes

Upon successful completion of the course, students should be able

5. Explain & write basic concepts of industry 4.0
6. Identify various enabling technologies of industry4.0.
7. Apply theoretical knowledge in practice
8. Develop small application using various technologies of industry4.0.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction to Industry 4.0:** Evolution of industry 4.0, Technologies drivers & enablers of industry 4.0 like sensors, computing power, speed of data, connectivity, accessibility, advanced analytics & enabling technologies of industry 4.0. Relevance of industry4.0 to Mechanical & Civil engineering.	4
2	**Introduction to Augmented Reality:** Basics of AR, Mixed Reality, Enabling technologies of AR, Marker based & Marker less AR. Software & Hardware of AR, Creating AR experience, Applications of AR in Mechanical & Civil engineering, Challenges	6
3	**Introduction to Virtual Reality:** Basics of VR, Software & Hardware of VR, Challenges, Applications in Mechanical & Civil engineering, Robotic automation & Collaborative robots (COBOTS)	6
4	**Introduction to Artificial Intelligence:** Knowledge Based, Rules based **Introduction to Machine Learning:** Overview of Supervised, Unsupervised & Reinforced learning Algorithms **Introduction to Deep Learning:** Overview of Artificial Neural Network (ANN), Convolutional Neural Network (CNN), AUTOENCODERS Algorithms	6
5	**Introduction to Internet of Things (IOT):** Sensors, IOT Protocols, IOT Platforms, Selection of sensors & IOT Platform, enabling technologies, micro controller, micro processer, Arduino board, Raspberry Pi, Sending Analog Data on Cloud Server, Smart Product	5

	Development, Smart Cities, Smart Manufacturing, Smart Logistics etc.	
6	**Introduction to Big Data Analytics:** Evolution of big data, big data tools, 6V of big data, Basics of big data, HADOOP Ecosystem, HDFS data storage, data processing, RDBMS & NOSQL data base management, Challenges of big data, Sentiment Analytics, Predictive Analytics, Graph Analytics etc.	4
7	**Introduction to Cloud Computing:** Cloud Computing basics, Cloud deployment models like Software as a Service (SAAS), Platform as a Service (PAAS), Infrastructure as a Service (IAAS), Mobile Computing Virtualization, Technology providers vs. Cloud providers vs. Cloud vendors, Cyber Security Business Issues in industry4.0, Opportunities, Challenges, Skillsets, Startegies	5

Text Books

1. Industry 4.0: Managing The Digital Transformation Book by Alp Ustundag and Emre Cevikcan, Publisher:Springer International Publishing, ISBN:9783319578705, 3319578707
2. Shaping the Fourth Industrial Revolution A Guide to Building a Better World, by Klaus Schwab, Nicholas Davis, Publisher:Penguin Books Limited, ISBN:9780241366394, 0241366399
3. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011
4. Data Analytics : The Complete Beginner's Guide - Step By Step Instructions (The Black Book) Kindle Edition, by Byron Francis
5. The Enterprise Cloud: Best Practices for Transforming Legacy IT, by James Bond
6. Augmented Reality: Principles & Practice Paperback, by Schmalstieg/Hollerer
7. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, by Tony Parisi, Publisher:O'Reilly Media, ISBN:9781491922781, 1491922788

Reference Books

1. Charalampos Doukas , “Building Internet of Things with the Arduino”, Create space, April 2002
2. Big Data and Analytics 1st Edition, Kindle Edition, by Subhashini Chellappan Seema Acharya
3. Cloud Computing: Concepts, Technology & Architecture, by Richardo Puttini, Thomas Erl, and Zaigham Mahmood
4. Handbook of Augmented Reality, by Borko Furht, Publisher:Springer New York, ISBN:9781461400646, 1461400643

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3 & 4
3	End Sem	1 to 7

Open Elective OE-MTTH212: Generative Design

Course Code	Course Name
OE-MTTH212	GENERATIVE DESIGN

Course pre-requisites	CAD, BIM, MACHINE LEARNING, FEA

Course Objectives

- To understand the fundamentals of generative design
- To understand the enabling technologies for generative design
- To understand how to develop generative design
- To study application areas of generative design
- To understand generative design as an interdisciplinary technology
- To understand, how ML & DL can be used in generative design
- To understand, how evolutionary & genetic algorithms help generate multiple design solutions

Course Outcomes

Upon successful completion of the course, students should be able

1. Explain & write basic concepts of generative design
2. Identify various enabling technologies of generative design.
3. Apply theoretical knowledge in practice
4. Develop multiple design solutions using related software

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction to Industry 4.0:** Technologies drivers & enablers of industry 4.0 like sensors, computing power, speed of data, connectivity, accessibility, advanced analytics & enabling technologies of industry 4.0, Relevance of GE in INDUSTRY4.0	4
2	**Overview of Generative Design (GE):** Introduction to Generative Design,, Components of GE, Significance of GE in Mechanical & Civil Engineering structures & components, Enabling Technologies, Generative Design Framework, CAD & BIM models in GE, CAD & FEA integration, Additive Manufacturing	6
3	**Topology Optimization:** Problem Formulation, Design Parameterization, Structural Optimization, Sensitivity Analysis, Algorithms for solving problems & implementation, Convergence of solution, Optimal solution	6
4	**Artificial Intelligence:** Overview of AI, Rule based design **Machine Learning based Design Generation:** Overview of Supervised, Unsupervised & Reinforced learning Algorithms for Generative Design **Deep Neural Design Generation:** Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Auto Encoders & Decoders for Generative Design (GE)	6
5	**Evolutionary & Genetic Algorithms:** Biological evolution, Fitness evaluation, Selection, Crossover/recombination, mutation, next generation, evolutionary strategies, overview of Genetic & evolutionary	5

	programming	
6	**CASE STUDIES on Generative Design for Mechanical & Civil Engineering.** Defining Generative Objects, Defining Obstacle regions, Defining Preserve regions, Selecting load, Selecting Manufacturing method, solving generative study, viewing generative outcomes. FEA Analysis of multiple design solutions for various results like stress, deformation etc.	6
7	**Benefits & Applications:** benefits & applications of Generative Design in Mechanical & Civil Engineering, Future Scope.	3

Text Books

1. "Topology Optimization: Theory, Methods, and Applications" by Bendsoe and Sigmund
2. “Generative Design” Visualize, Program, and Create with JavaScript in P5.js by Benedikt Gross, Hartmut Bohnacker, Julia Laub, Claudius Lazzeroni · 2018, ISBN: 9781616897840, 1616897848, Publisher: Princeton Architectural Press
3. “Generative Design: Form-finding Techniques in Architecture” , By Asterios Agkathidis · 2016, Publisher:Laurence King Publishing, ISBN: 9781780676913
4. “Deep Learning with Python” by François Chollet,
5. “Introduction to evolutionary computing” by Agoston E Eibe, Publisher:Springer Berlin Heidelberg, ISBN:9783662448748, 3662448742
6. “Genetic algorithms in search, optimization, and machine learning” Book by David E. Goldberg
7. Python Machine Learning, Machine Learning and Deep Learning with Python, Scikit-learn, and TensorFlow 2, 3rd Edition By Sebastian Raschka, Vahid Mirjalili · 2019, ISBN:9781789958294, 1789958296, Publisher:Packt Publishing

Reference Books

1. "A Hands-On Introduction to Topology Optimization" by Amir M. Mirzendehdel and Krishnan Suresh "Homogenization and Structural Topology Optimization: Theory, Practice and Software" by Behrooz Hassani and Ernest Hinton
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurelien Geron, ISBN-10 : 1492032646, Publisher : O'Reilly Media; 2nd edition (October 15, 2019)

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3 & 4
3	End Sem	1 to 7

Open Elective OE-MTTH213: Thermal and Flow Analysis

Course Code	Course Name
OE-MTTH213	**Thermal and Flow Analysis**

Course pre-requisites	None

Course Objectives

1. Fundamentals of Heat Transfer.
2. Understanding Energy Equations.
3. Analyze Thermal and Flow problems

Course Outcomes

Upon successful completion of the course, Participants should be able to

1. Apply Finite Element Method to solve Thermal Problems.
2. Apply Finite Volume Method to solve Flow Problems.
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze the Coupled Thermal Fluid problems.

Course Content

Module No.	*Details*	*Hrs.*
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	8
2	Meshing and Applying loading and boundary conditions	8
3	Simulation and Validation	8
4	Introduction to Thermal Analysis (Conduction, Convection and Radiation)	8
5	Thermal Simulation	8
6	Introduction to Flow analysis and Creating Fluid Volumn	8
7	Flow Simulation and Mapping Results	8

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

DS-MTTH301: Dissertation Phase-I

Course Code	**Course Name**
DS-MTTH301	Dissertation Phase-I

Course pre-requisites	PC-MTTH 203

<table>
<tr><th colspan="3">Course Outcomes</th></tr>
<tr><td colspan="3">1. Student will be able to search literature related to the project topic
2. Student will be able to analyse finding of literature review
3. Student will be able to identify research gap
4. Student will be able to integrate the knowledge to define the problem statement appropriately and devise solution
5. Student will be able to analyze the available resources and to select most appropriate one
6. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques</td></tr>
<tr><th colspan="3">Course Content</th></tr>
<tr><th>Module No.</th><th>Details</th><th>Hrs.</th></tr>
<tr><td>1</td><td>The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a report for evaluation. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report during mid of the term.
Student shall finalize a theme and problem definition after literature review, related to mechanical engineering (design engineering area) for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report at the end of the term.</td><td>48</td></tr>
<tr><td colspan="3">Guidelines for Dissertation
Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.
Guidelines for Assessment of Dissertation I
Dissertation I should be assessed based on following points</td></tr>
</table>

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Principles of ethics and standards and communication techniques

DS-MTTH401: Dissertation Phase-II

Course Code	Course Name
DS-MTTH401	**Dissertation Phase-II**

Course pre-requisites	**DS-**MTTH301

Course Outcomes		
1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques 2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution 3. Student will be able to use knowledge for execution of the desired project and validation of the results obtained 4. Student will be able to use knowledge for formulation / fabrication of the desired project 5. Student will be able to analyze the experimental data/ findings and discuss the merits and limitations of the project work		
Course Content		
Module No.	***Details***	***Hrs.***
1	Student shall study the problem of dissertation in the light of outcome of Phase-I seminars. On completion of data collection, analysis, and inferencing, the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis. On finalization of the dissertation student shall submit the dissertation report. The student shall have to appear for a Viva-voce examination for the dissertation.	48
Guidelines for Assessment of Dissertation II Dissertation II should be assessed based on following points 1. Quality of Literature survey and Novelty in the problem 2. Clarity of Problem definition and Feasibility of problem solution 3. Relevance to the specialization or current Research / Industrial trends 4. Clarity of objective and scope 5. Quality of work attempted 6. Validation of results 7. Quality of Written and Oral Presentation		

M. Tech. in Civil Engineering with Construction Management

Course Contents
Academic Year 2023-24

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-24

Contents

M.Tech. in Civil Engineering with Construction Management

SEMESTER I

PC-MTCM101 Construction Organisation and Safety Management

Course Code	Course Name
PC-MTCM101	Construction Organisation and Safety Management

Course pre-requisites	Construction Management

Course Objectives

The objectives of this course are

1. Discuss principles of management and its functions in construction organization.
2. Knowledge of organization's working procedures and organizational developments and group decision making.
3. Identify quality of team leader and qualities of project leader.

Course Outcomes

Upon successful completion of the course, students should be able

1. To apply fundamentals of management to utilize functions of management in construction. Like Demonstrate leadership qualities by implementing construction project processes with control.
2. Implement planning strategies and policies.
3. Carry out organization and execute work in group in an organization

Course Content

Module No.	*Details*	*Hrs.*
1	Management: Need, what is it, systems approach, and emergence of management thought, Theory by Fredrick Taylor, Henry Fayol, emergence of behavioral sciences, and that of the modern management thought.	04
2	Construction Management: Planning: Planning process, objectives, strategies and policies, making planning effective, and Organizing; Need and objectives, nature and purpose, types of construction organizations, Staffing: Need and objectives, Nature and purpose, selection, appraisal. Leading; Need and objectives, Managing and human factor, motivation, leadership, team development, communication, managing conflicts, qualities of project manager; Controlling Need and objectives, Process of controlling,	06
3	Work study Definition, Objective, Procedure for selecting the work, recording facts, symbols, flow process charts, multiple activity charts, string diagrams. Work Measurement: Time and motion studies, Concept of standard time and various allowances, time study, equipment performance rating. Activity sampling, time-lapse photography technique, Analytical production studies	05

4	Construction Safety Management, role & importance of safety management – Role of various parties, duties and responsibilities of top management, site managers, supervisors etc. role of safety officers, responsibilities of general employees, safety committee, safety training, incentives and monitoring. Writing safety manuals, preparing safety checklists and inspection reports.	05
5	Safety in construction operations – Accidents on various construction sites such as buildings, dams, tunnels, bridges, roads, etc. safety at various stages of construction. Prevention of accidents. Safety protocols. Occupational diseases and hazards. Safety in use of construction equipment e.g. vehicles, cranes, hoists and lifts etc. safety while using scaffolding and working platforms. Safety while using electrical appliances. Managing fire, electricity and Explosives	05
6	Various safety equipment and gear used on site, safety measures while handling machinery, tools and equipment's. First aid on site. Labour laws, legal requirement and cost aspects of accidents on site.	05
7	Study of safety policies, methods, equipment and training provided on any ISO approved construction company, safety audits and OSHA guidelines, international labour standard on occupational safety and health	06

Text Books

1. Koontz, O'Donnell &Weihrich (2010); "Management", Mcgraw Hill. ISBN-13: 9780070144958. 464p.
2. Chinowsky, Paul S. & Songer, Anthony D. (2011) "Organization Management in Construction". Routledge. ISBN-13: 978-0415572613. 216p.
3. Sears, Keoki S, (2008) "Construction Project Management: A Practical Guide to Field Construction Management". Wiley. ASIN: B00HQ1CNE2.
4. Frank Harris (2013); "Modern Construction Management", Ronald Mccaffer Wiley Blackwell Publications. ISBN-13: 978-0470672174. 572p.
5. Wagner.Harvey M (1975) "Principles of Management Science" Prentice Hall College Div. ISBN-13: 978-0137095353. 612p.
6. Snell, Scott & Bohlander George (2009) "Managing Human Resources" South-Western Cengage Learning; ISBN-13: 978-0324593310. 864p.
7. Dessler, Gary (2008) "Human Resource Management" Prentice Hall. ISBN-13: 978-0131746176. 801p.
8. Dharwadkar P. P (1992); "Management In Construction Industry" Oxford & IBH

Luthans.

9. V. J. Davies, K. Tomasin (1996); "Construction Safety Handbook", Thomas Telford, London. Isbn-13: 9780727725196. 303p.
    1. PSG Design Data Book, PSG College, Coimbatore (2012)

Reference Books

1. Construction Safety Manual Published By National Safety Commission of India.
2. "Safety Management in Construction Industry" – A Manual for Project Managers. Nicmar Mumbai.
3. "IS For Safety In Construction – Bureau Of Indian Standards.
4. Girimaldi and Simonds (1989); "Safety management", AITBS, New Delhi. ISBN: 9780939874989.651p.
5. Stranks, Jeremy (2010) "Health and Safety at Work: An Essential Guide for Managers", Kogan Page Publishers. ISBN 13: 9780749461201. 352p.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-MTCM102 Applied Statistics and Quantitative Techniques

Course Code	Course Name
PC-MTCM102	Applied Statistics and Quantitative Techniques

Course pre-requisites	Construction Management

Course Objectives

The objectives of this course are

1. Describe probability theory and Different methods of statistics.
2. Identify different methods of data collections with its analysis as well as decision making.
3. Discuss the application of linear programming problem and transportation problem and simulation in construction industry.

Course Outcomes

Upon successful completion of the course, students should be able

1. Practice different methods of statistics, probability distribution and its applications in civil engineering, different methods of data collection and presentation.
2. Make decisions and carry out simulation of various systems.
3. Implement the concept of linear Programming Problem and Transportation Problem in getting the optimum solution for civil engineering problem.

Course Content

Module No.	*Details*	*Hrs.*
1	Review of basic statistics, probability and Probability Distributions: Theoretical, binomial, poisson, normal, exponential, hypergeometric, uniform. Statistical Quality Control, Total cost & Trade off analysis	08
2	Sampling and Sampling Distributions: Probability and non-probability samples, sampling and non-sampling errors, sample size, sampling distributions : t, F and x2 distributions	05
3	Hypothesis Testing: Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, 2 test for goodness of fit, ANOVA (one way classification), Non parametric tests : sign test, U test	05
4	Correlation and Regression: Karl Pearson's and Rank Correlation coefficient, simple linear regression: least squares method. Multiple Regression Analysis. Regression problem, use of excel for solving.	05
5	Simulation: Random number generation. Monte Carlo method, Application of Design of Experiments(DOE) and Kappa Coefficient in construction industry	04
6	Transportation, Assignment and Transshipment Problems	03
7	Linear Programming: Graphical solution, simplex method, dual,	

	Sensitivity analysis, use of MS excel for solving LPP.	06

Term Work

Term work shall comprise of

1. Report on assignments including problems based on the above syllabus shall be submitted as term work.
2. One assignment on each module is to be submitted.
3. Reports of assignments : 25 points

Text Books

1. Shrivastava, Shenoy& Sharma (1989); “Quantitative Techniques for Managerial Decisions” New Age International. ISBN-13: 9788122401899. 941p.
2. Kothari C R (2004); “Research Methodology: Methods and Techniques”, New Age International. ISBN-13: 978-8122415223. 401p.
3. Goode W J &Hatt P K (2006) “Methods in Social Research” Surjeet Publication. 386p.

Reference Books

1. Quantitative Technique for Managerial decision by L.C. Jhamb
2. D.S. Hira and Gupta “Operation Research”, S.Chand Publication

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-MTCM103: Research Methodology and IPR

Course Code	Course Name
PC-MTCM103	Research Methodology and IPR

Course pre-requisites	

Course Objectives		
1. Understand research problem formulation. 2. Analyze research related information 3. Follow research ethics		
Course Outcomes		
Understand that today's world is controlled by Computer, Information 1. Technology, but tomorrow world will be ruled by ideas, concept, and creativity. 2. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. 3. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Meaning of research problem**. Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research Problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	05
2	**Effective literature studies approaches, analysis** Plagiarism, Research ethics,.	05
3	**Effective technical writing, how to write report, Paper** Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	05
4	**Nature of Intellectual Property** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, Patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	05
5	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of	

	technology. Patent information and databases. Geographical Indications. **New Developments in IPR** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	05

Term Work

Term work shall comprise of

- Report on assignments including problems based on the above syllabus shall be submitted as term work.
- One assignment on each module is to be submitted.

Reports of assignments : 25 points

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.

Reference Books

1. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Sr. No.	Examination	Module
1	T-I	1 and 2
2	T-II	3 and 4
3	End Sem	1 to 5

PE-MTCM101 Building Services and Maintenance

Course Code	Course Name
PE-MTCM101	Programme Elective – I : Building Services and Maintenance

Course pre-requisites	

Course Objectives		
The objectives of this course are 1. To discuss the concept of various machineries like lift, escalators, vibrators, concrete mixers etc. 2. To explain utility services in building like pluming system, electrical system, fire safty installation and rainwater harvesting system etc.		
Course Outcomes		
Upon successful completion of the course, students should be able 1. To implement installation of utility services. 2. To identify drawback if all service lines are not install properly or used any faulty materials. 3. To carry out water audit.		
Course Content		
Module No.	***Details***	***Hrs.***
1	Machineries: Lifts and Escalators – Special features required for physically handicapped and elderly – Conveyors – Vibrators – Concrete mixers – DC/AC motors – Generators – Laboratory services – Gas, water, air and electricity -Hot Water Boilers – Pumps	06
2	Plumbing Systems in Building: Plumbing services:-Water distribution system-Material for service pipesService connection-size of service pipe-Water meter-Valves-Storage tanksDrainage system:-Pipe and traps-Sanitary fittings-system of plumbingHouse drainage plans-Septic tank-Soak pit	05
3	Electrical Systems& Illumination Design in Buildings: Electrical Systems in Buildings: Basics of electricity – Single / Three phase supply – Protective devices in electrical installations – Earthing for safety – Types of earthing – ISI specifications – Types of wires, wiring systems and their choice – Planning electrical wiring for building – Main and distribution boards – Transformers and switch gears – Layout of substations Principles of Illumination Design: Visual tasks – Factors affecting visual tasks – Modern theory of light and colour – Synthesis of light – Additive and subtractive synthesis of colour – Luminous flux – Candela – Solid angle illumination – Utilisation factor – Depreciation factor – MSCP – MHCP – Lans of illumination – Classification of lighting – Artificial light sources – Spectral energy distribution – Luminous efficiency – Colour temperature – Colour rendering. Design of modern lighting – Lighting for stores, offices, schools, hospitals	06

	and house lighting. Elementary idea of special features required and minimum level of illumination required for physically handicapped and elderly in building types.	
4	Refrigeration Principles & Applications: Thermodynamics – Heat – Temperature, measurement transfer – Change of state – Sensible heat – Latent heat of fusion, evaporation, sublimation – saturation temperature – Super heated vapour – Sub cooled liquid – Pressure temperature relationship for liquids – Refrigerants – Vapour compression cycle – Compressors – Evaporators – Refrigerant control devices – Electric motors – Starters – Air handling units – Cooling towers – Window type and packaged air-conditioners – Chilled water plant – Fan coil systems – Water piping – Cooling load – Air conditioning systems for different types of buildings – Protection against fire to be caused by A.C. Systems	06
5	Fire Safety Installation: Causes of fire in buildings – Safety regulations – NBC – Planning considerations in buildings like non-combustible materials, construction, staircases and lift lobbies, fire escapes and A.C. systems. Special features required for physically handicapped and elderly in building types – Heat and smoke detectors – Fire alarm system, snorkel ladder – Fire lighting pump and water storage – Dry and wet risers – Automatic sprinklers	05
6	Rain Water Harvesting: Water Audit of India, Concept of rain water harvesting, Methodologies for Percolation/ recharge bore pit, Percolation/ recharge bore well, Percolation/ recharge well cum bore pit, Harvesting rooftop rainwater, Harvesting driveway runoff. National water harvesters network (NWHN). Some case studies.	04
7	Introduction to Green Building: Need for a green building, planning and design of green buildings, obstacles, Materials used in green building technology, Rating System (According to LEED-INDIA)	04

Text Books
1.Heat Pumps and Electric Heating: E.R.Ambrose, John and Wiley and Sons, Inc., New York, 1968. 2. Handbook for Building Engineers in Metric systems, NBC, New Delhi, 1968. 3. Philips Lighting in Architectural Design, McGraw-Hill, New York, 1964. 4. The Lighting of buildings: R.G.Hopkinson and J.D.Kay, Faber and Faber, London, 1969. 5. Air-conditioning and Refrigeration: William H.Severns and Julian R.Fellows, John Wiley and Sons, London, 1988. 6. Air-conditioning and Energy Conservation: A.F.C. Sherratt, the Architectural Press, London, 1980. 7. National Building Code. 8. Building Construction: Dr. B.C. Punmia, Ashol K Jain, A.K Jain 9. Construction Engineering and Management: S. SeetharamanUmeshPublicatins, Delhi.

10. Water supply and Sanitory Installations: A. C. Panchdhari New age international publication, Delhi
11. Fire Safety in Building: V. K. Jain, New age international publication, Delhi

Reference Books

1. Green remodeling: David Johnston.
2. Green Building , Project Planning and Cost Estimation: R.S.Means
3. LEED – INDIA (Abridged Reference guide for Core and Shell, Version 1.0).

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM102 Construction Materials

Course Code	Course Name
PE-MTCM102	Elective – I : Construction Materials

Course pre-requisites	

Course Objectives

The objectives of this course are

1. Describe commonly used building materials
2. Develop knowledge of material science and behaviour of various building materials used in.
3. Discuss and understand the properties of building Materials.

Course Outcomes

Upon successful completion of the course, students should be able

1. To familiarize students about the characteristics of construction materials used in civil engineering.
2. To select eco-friendly and sustainable building materials.

Course Content

Module No.	*Details*	*Hrs.*
1	Various construction chemicals/admixtures.	06
2	Flyash and its use in concrete , Silica fume concrete	05
3	Fibre Reinforced plastics and concrete, Smart materials	04
4	Self compacting concrete, High performance concrete; composite decking and hollow core slab	05
5	Materials used in nuclear-containment structures	06
6	Glenium Concrete	04
7	Crumb modified bitumen Rubber	06

Text Books

1. Neville (2008);” Concrete Technology”, Pearson Education India. ISBN: 9788131705360.452p.
2. M.S.Shetty (2005);” Concrete Technology”,ISBN:9788121900034.624p.
3. Ghosh (1991);” Building Materials”,ISBN:9788185522005.494p.
4. New Building Materials and Construction World magazine

Reference Books

1. Civil Engineering and Construction Review magazine
2. Construction Materials Reference Book (2018), edited by David Doran, Bob Cather, Routledge Publications, London and Newyork, second edition.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM103** Accounting and Finance Management

Course Code	Course Name
PE-MTCM103**	Elective I : Accounting and Finance Management(Online Course)

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To explain the basic concept of accounting mechanics with financial statements.
2. To summarize use of policies of project finance & financial analysis.
3. To report long term investment decisions
4. To describe the management of current assets

Course Outcomes

Upon successful completion of the course, students should be able

1. Practice basic accounting mechanics
2. Carry out financial statement
3. Implement various techniques of financial analysis
4. Utilize various policies of project finance & investment decisions and appraise the management of current assets

Course Content

Module No.	*Details*	*Hrs.*
1	**Basic accounting mechanics** Generally accepted accounting principles, books of original entry	03
2	**Preparation of financial statements** Income statement, balance sheet, preparing bills, issues.	04
3	**Techniques of financial analysis** Statement of changes in financial position (working capital / cash flow / total resources basis)Ratio analysis, internal rate of IIR, net present value.	06
4	**Project financing** Means, norms, and policies of financial institutions, sources of finance, equity, debentures, debit, bond, fixed deposit, mega project finance policy.	06
5	**Long term investment decisions** Cash flow estimates, evaluating techniques, alternative selection, basic concepts of analysis of risk and uncertainty, cost of capital, lease financing, selection from alternative options, management of inflations.	06

6	**Management of current assets-I** Planning, financing and control of working capital, cash flow statement.	06
7	**Management of current assets-II** Management of cash, receivables management, inventory management	05

Text Books

1. S. K. Bhattacharyya, John Dearden (1996); "Accounting for Management: Text and Cases" South Asia Books. ISBN 13: 9780706928976.
2. Prasanna Chandra (2011); "Financial Management", Tata McGraw-Hill Education. ISBN 13: 9780071078405. 1026p.

Reference Books

1. Construction Safety Manual Published By National Safety Commission of India. "Safety
2. **Handbook of Finance, Financial Markets and Instruments(2008),** edited by Frank J. Fabozzi, Volume (I), John Wiley and sons, New Jersy.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM111 Management of Infrastructure Services

Course Code	Course Name
PE-MTCM111	Elective – II : Management of Infrastructure Services

Course pre-requisites	

Course Objectives		
The objectives of this course are 1. To study the necessity of infrastructure & its management 2. To understand various concepts of infrastructure planning and management.		
Course Outcomes		
Upon successful completion of the course, students should be able 1. Design integrated framework for infrastructure planning and management. 2. Analyse the strategies for Infrastructure Project implementation. 3. Perform Infrastructure modelling and Life Cycle Analysis Techniques.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Infrastructure management** Need and concept, expected performance, survey and Scheme of evaluation of distresses, inspection checklists, organization for rehabilitation, policies, funding	04
2	**Concept of infrastructure upkeep**	06
3	**Buildings** Post occupancy Scheme of evaluation of buildings, deformation and common defects in buildings, restoration & rehabilitation measures	05
4	**Pipelines (water/ sewage/ air/ gas)** Purpose and methods of Scheme of evaluation, Scheme of evaluation of physical condition, methods of rehabilitation	05
5	**Pavements (roadways / runways)** Scheme of evaluation and performance surveys, distress Scheme of evaluation, methods of resurfacing, overlays, restoring and rehabilitation, up-gradation and maintenance of permanent way	05
6	**Bridges,** Inspection and reporting methods, rehabilitation measures,	05
7	**Ports & Harbours** Inspection and reporting methods, Maintenance of ports, port	06

	buildings, and services.	

Text Books
1. Grigg, Neil, Infrastructure engineering and management, Wiley, (1988). 2. Haas, Hudson, Zaniewski, Modern Pavement Management, Krieger, Malabar,(1994). 3. Hudson, Haas, Uddin, Infrastructure management: integrating design, 4. construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).
Reference Books
1. Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs etc. 2. Munnell, Alicia, Editor, Is There a Shortfall in Public Capital Investment, Proceedings of a Conference Held in June (1990). 3. World Development Report 1994: Infrastructure for Development (1994). 4. Zimmerman, K. and F. Botelho, "Pavement Management Trends in the United States," 1st European Pavement Management Systems Conference, Budapest, September (2000).

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM112 Advanced Construction Techniques

Course Code	Course Name
PE-MTCM112	Elective 1I : Advanced Construction Techniques

Course pre-requisites	Construction Management

Course Objectives

The objectives of this course are
1. To introduce various advanced construction techniques currently used in the industry
2. To make students aware of state of the art construction practices with the help of case studies

Course Outcomes

Upon successful completion of the course, students should be
1. Able to select and apply suitable advanced construction techniques for a given project.
2. Motivated to learn about emerging trends such as sustainable construction and pre-engineered buildings.
3. Aware of current problems and innovative solutions offered by the industry through case studies.

Course Content

Module No.	*Details*	*Hrs.*
1	Review of subsurface soil explorations and geophysical methods for expansive soils, landslide hazards, liquefaction of soils, karst topography. Soil stabilization: mechanical, thermal and chemical.	05
2	Excavation and Tunneling: trenching machines, blasting method, dewatering methods. Tunnel ventilation, lighting and drainage, cut and cover, rock tunneling, shield tunneling in free air, compressed air tunneling, linings, machine tunneling, supporting systems, micro tunneling.	06
3	Construction methods for drilled shafts, caissons, cofferdams, Shores, needles, grillages	06
4	Special topics of concrete construction: Formwork: types, design criteria, patented systems. Fabrication of precast and pre-stressed components Pre-stressing: Plants, Equipment for Pre-stressed Construction, Different types of Pre-stressing. Pumped and sprayed concrete, roller compacted, self-compacted, fiber compacted concrete.	06
5	Advanced Pavement Construction Techniques: Pavement Construction using Bitumen, Hot mix plant, Concrete Road Construction, Fiber Reinforced Pavement Construction, Low Cost Road Construction Techniques.	05
6	Sustainable construction: Building materials from Agricultural &	05

	Industrial wastes. Recycled concrete and aggregates Pre-engineered Buildings: need, type, advantages and disadvantages.	
7	Construction of Transit Camps and 3-D Printing; Case study of heavy structures/construction projects like thermal/hydro / nuclear power plants/refineries, etc.	03

Text Books
1. Jonathan Ricketts, M. Loftin, Frederick Merritt (2004); "Standard Handbook for Civil Engineers", Mcgraw Hill. ISBN-13: 978-0071433372. 1600p. 2. Waddell (1974); "Concrete Construction Handbook", Mcgraw Hill 3. J.R. Illingworth (2002);"Construction Methods and Planning" CRC Press. ISBN 13: 9780203478578. 440p. 4. Varma Mahesh (1975); "Construction Equipment, Its Planning & Application" Metropolitan. 539p.

Reference Books
1. Relevant Journal papers and International Conference papers 2. Roger Greeno , R. Chudley), Mike Hurst , Simon Topliss (2012) Advanced Construction Technology, 5th edition, Pearson Education.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM113 Construction Marketing

Course Code	Course Name
PE-MTCM113	Elective – II : Construction Marketing

Course pre-requisites	

Course Objectives
The objectives of this course are 1. Students will learn the components and construction of a strategic marketing. 2. Explore potential marketing areas in the building construction industry
Course Outcomes
Upon successful completion of the course, students should be able 1. To identify core concepts of marketing and the rile of marketing in society. 2. To collect, process, and analyze consumer and market data to make informed decisions. 3. To create branding and integrated marketing communications plans that include value propositions.

Course Content

Module No.	***Details***	***Hrs.***
1	**Marketing environment:** impact of internal and external environment, socio-economic, demographic, political, technological and legal environment, nature and impact of competition, marketing strategy	04
2	**Basics of marketing:** Features of marketing of consumer goods, industrial products and services, product and marketing, marketing organization structures, societal role of marketing	06
3	**Marketing projects I:** Characteristics of construction projects, sources of information, pre-qualification documents, bid preparation – estimating, provision for overheads and profit, bidding models, bidding strategy, pre-bid meetings, negotiation,	05
4	**Marketing projects II:** Legal aspects, impact of joint ventures, collaborations and alliances, impact of globalization and privatization, strategies for project export.	05
5	**Marketing real estate:** Characteristics of real estate, demand and supply relationship, segmentation, product mix, pricing strategies, advertising strategies, legal aspects	05
6	**Marketing products for construction:** Characteristics of construction materials and equipment, strategies for marketing of materials and equipment for construction, demand	05

	surveys, advertising strategies, communication, exhibitions and product demonstrations,	
7	Pricing strategies, financing arrangements for marketing products for construction	06

Text Books
1. Christopher Peerce and Paul Smith (2003), Construction Business Development: Meeting New Challenges, Seeking Opportunities, A Butterworth-Heinemann publisher.
Reference Books
1. Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs etc.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM121 Repair, Rehabilitation and Retrofitting Techniques

Course Code	Course Name
PE-MTCM121	Elective – III : Repair, Rehabilitation and Retrofitting Techniques

Course pre-requisites	

Course Objectives
1. To understand need for repair and rehabilitation. 2. To develop clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques. 3. To encourage students and faculty to interact with industry, alumni and other reputed institutes for purpose of better understanding of industry requirements and different materials used. 4. To deal with social, environmental and economic issues when applying various techniques.
Course Outcomes
At the end of the course the student shall be able to develop collaborative skills to work in a team/group and technical skills to 1. Select and apply various repair techniques and appropriate materials as per the requirement of the problem. 2. Select and apply various structural strengthening techniques and appropriate materials. 3. Select and apply appropriate materials for repair and restoration of heritage structures. 4. Prepare protection & maintenance schedule against environmental distress

Course Content

Module No.	*Details*	*Hrs.*
1	Importance of rehabilitation as a part of construction engineering.	05
2	Rehabilitation studies of buildings, underground construction, bridges, streets and highways, sewage treatment plants – masonry work, R.C.C. works, steel structures- types of distress.	05
3	Numerical condition surveys for foundation, structural and functional deterioration, design criteria, materials and techniques.	06
4	Predictive performance models, evaluating alternatives based on technical, commercial, management, financial feasibilities, data collection and database management, maintenance of rehabilitated structures.	08
5	Procedure adopted by BIFR (Board of Industrial and Financial Reconstruction).	07
6	Earthquake damages of buildings,their retrofitting, restoration, effects of earthquakes, response of buildings to earthquake motion,	03

	factors related to building damages due to earthquake.	
7	Methods of seismic retrofitting, restoration of buildings.	02

Text / Reference Books
1.R. Dodge Woodson (2009);" Concrete Structures: Protection, Repair and Rehabilitation", ISBN: 9780080949819. 280p.

Sr. No.	**Examination**	**Module**
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM122 Appraisal & Implementation of Infrastructure Projects

Course Code	Course Name
PE-MTCM122	Elective – III: Appraisal & Implementation of Infrastructure Projects

Course pre-requisites	

Course Objectives
student will be able to 1. To discuss about Infrastructure project and their feasibility. 2. To explain appraisal of construction project. 3. To describe the need of financial and environmental appraisal of project. 4. To outline project audit, financing and its implementation.
Course Outcomes
1. To carry out construction project appraisal. 2. To evaluate construction economic and environmental analysis. 3. To practice various method for implementation of construction project including arrangement of finance.

Course Content

Module No.	*Details*	*Hrs.*
1	Components of Infrastructure, Infrastructure scenario in India, Key issues sector wise, Urban Infrastructure, Rural infrastructure, characteristics of construction project, stakeholders in Infrastructure projects, Phases of infrastructure project	04
2	Project Feasibility Project management cycle, Detailed Project report, project formulation project implementation, Agencies involved in implementation, methods of implementation like Build, operate and transfer (BOT) method and its variants like BOO, BOOT, BOLT etc, SWOT analysis of project.	04
3	Project Appraisal Introduction, Need of appraisal, steps of appraisal Market appraisal, Demand analysis, forecasting demand, sources of information, market survey, uncertainties in demand forecasting Technical appraisal Location, land, buildings, technology and its appropriateness, size of plant, plant and machinery, raw materials, energy requirements, water supply, effluent disposal Management appraisal	08
4	Financial and Environmental Appraisal of project Break-even analysis, financial projections, financial appraisal tools: payback period, accounting rate of return, net present value,	08

	internal rate of return, benefit cost ratio, cost of capital, risk analysis, social cost benefit analysis. Guidelines for environmental Appraisal for infrastructure project	
5	Project Audit Project budget and schedule, causes of project failure, reason for audit, Construction Contract audit and phases of project audit.	08
6	Project financing Norms and policies of financial institutions, Types of financing, sources (local and international),Cash flows by financial institutions, planning commission/Niti Aayog, various issues in financing	04
7	Road and bridge Infrastructure Development Issues and challenges in construction and maintenance of road and bridge Infrastructure, sustainable development of Infrastructure, role of PPP in road and bridge infrastructure development.	04

Text / Reference Books
1.Project Preparation, Appraisal, Budgeting, and Implementation: Prasanna Chandra, Tata McGraw Hill.

Sr. No.	**Examination**	**Module**
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM123 Management of Housing Projects

Course Code	Course Name
PE-MTCM123	Elective –III : Management of Housing Projects

Course pre-requisites	

Course Objectives

1. To make them understand the concepts of Project Management for planning to execution of projects.
2. To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.

Course Outcomes

At the end of the course,

1. The students shall have acquired knowledge of the process involved in addressing a design problem with emphasis on site planning.
2. Can address socio-cultural, and economic issues connected with. Integrated approach to design.

Course Content

Module No.	*Details*	*Hrs.*
1	**National housing policy** Need and importance of housing, role of various state and national level agencies, local bodies etc., rural and urban housing, systems approach to housing and urban planning	06
2	**Managing technology** New developments: materials, construction techniques, low cost housing, mass housing, industrialized housing, appropriate technology	08
3	**Planning** Pre-execution phase, project phase and post-execution phase	04
4	**Management of building services** Water supply, waste disposal, lifts, HVAC systems	06
5	**Maintenance of buildings** Need and importance, organization and management	05
6	**Estate management** Policy and organization	04
7	Introduction to RERA, Government policies for slum Rehabilitation	03

Text / Reference Books
Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs etc.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-MTCM151 Advanced Materials Testing Lab

Course Code	Course Name
PC-MTCM151	Advanced Materials Testing Lab

Course pre-requisites	

Course Objectives

Course Objective: Students will learn

1. To understand the type of tests conducted to measure distress in the buildings.
2. To educate the student about the damage identification and repairing techniques.

Course Outcomes

After completion of course, student will be able to :

1. Determine the degree of deterioration of concrete structures.
2. Suggest the remedial measures to strengthen the structural elements.
3. Carry out modern tests to evaluate concrete quality.

Expt. No.	***Details***

Course Content:

Laboratory work to includes Experimental work on

1. Carbonation test
2. Rebound Hammer Test
3. Half Cell Potentiometeric Test
4. Core Test
5. Ultrasonic Pulse Velocity test
6. Chemical Analysis of concrete
7. Retrofitting Techniques- (Materials and methods)
8. static and dynamic plate bearing tests
9. Dynamic and integrity test on concrete piles

Lab Work

Lab work shall comprise of

at least seven practical’s performed from the list given above : 50 points

1. Neha Jamwal and M L Gambhir (2007)Building and Construction Materials: Testing and Quality Control (Lab Manual Series
2. Bhargava A K (2008) mechanical Behaviour and Testing of Materials.

Reference Books

1. Relevant Indian/American standards for testing of materials

SE-MTCM152 Geo-Informatics Lab

Course Code	Course Name
SE-MTCM152	Geo-Informatics Lab

Course pre-requisites	

Course Objectives

Course Objective: Students will learn

1. About GIS technology, various softwares of GIS, and their utility.
2. To apply engineering knowledge with GIS technology to conduct small projects.

Course Outcomes

After completion of course, student will be able to :

1. Describe spatial and non-spatial database
2. Acquire and extract various types of spatial data from Global positioning System (GPS), satellite imageries, printed maps, and online sources.
3. Develop spatial and thematic maps for analysis, decision-making and display it in various forms

Course Content

Expt. No.	*Details*

Laboratory work to include at least TEN practicals performed from the list given below:

1. Installation of GIS software and getting familiarized with GIS menu and Tools.
2. Map Projections and Map digitization.
3. Georeferencing.
4. Creating Vector and Creating Raster data / data layers.
5. Creating attribute table.
6. Measurements; length and area.
7. Data viewing based on Single Symbol, Graduated Symbol.
8. Data viewing on Continuous color and unique value.
9. Labeling the features.
10. Selection tool and Geo-processing tool (Buffer, Clip, intersect and difference).
11. Coordinate capture – to save in notepad.
12. Joining layers based on common field.
13. Data conversion (raster to vector), polygon to polyline.
14. Add Graphic overlay to a vector layer.

Import and export data and Map Layout

Lab Work

Lab work shall comprise of

at least TEN practical's performed from the list given above : 50 points

IK-MTCM101 Constitution of India (Indian Knowledge System Course)

Course Code	Course Name
IK-MTCM101	**Constitution of India**

Course pre-requisites	

Course Objectives
Students will be able to: 1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution
Course Outcomes
Students will be able to: 1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. 3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. 4. Discuss the passage of the Hindu Code Bill of 1956

Course Content

Module No.	***Details***	***Hrs.***
1	➢ History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	5
2	➢ Philosophy of the Indian Constitution: Preamble Salient Features	5
3	➢ Contours of Constitutional Rights & Duties: ➢ Fundamental Rights ➢ Right to Equality ➢ Right to Freedom ➢ Right against Exploitation ➢ Right to Freedom of Religion ➢ Cultural and Educational Rights ➢ Right to Constitutional Remedies ➢ Directive Principles of State Policy ➢ Fundamental Duties.	5
4	➢ Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume -II][194] ➢ Parliament ➢ Composition ➢ Qualifications and Disqualifications ➢ Powers and Functions ➢ Executive ➢ President	5

	➢ Governor ➢ Council of Ministers ➢ Judiciary, Appointment and Transfer of Judges, Qualifications ➢ Powers and Functions	
5	➢ Local Administration: ➢ District's Administration head: Role and Importance, ➢ Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. ➢ Pachayati raj: Introduction, PRI: Zila Pachayat.	5
6	➢ Elected officials and their roles, CEO Zila Pachayat: Position and role. ➢ Block level: Organizational Hierarchy (Different departments), ➢ Village level: Role of Elected and Appointed officials, ➢ Importance of grass root democracy	5
7	➢ Election Commission:Role and Functioning. ➢ Chief Election Commissioner and Election Commissioners. ➢ State Election Commission: Role and Functioning. ➢ Institute and Bodies for the welfare of SC/ST/OBC and women	6

Reference Books
1. The Constitution of India, 1950 (Bare Act), Government Publication. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

M.Tech. in Civil Engineering with

Construction Management

SEMESTER II

PC-MTCM201 Project Monitoring and Control

Course Code	Course Name
PC-MTCM201	Project Monitoring and Control

Course pre-requisites	Construction Management

Course Objectives

1. To describe concept of project monitoring and control.
2. To explain concept of cost and quality management
3. To summarize concept of project safety and management information system

Course Outcomes

1. Carry out project monitoring and control
2. Practice cost and quality management
3. Execute project safety and management information system

Course Content

Module No.	*Details*	*Hrs.*
1	**Project monitoring** Progress reporting,, review meetings, updating plans, formatting progress review report.	06
2	**Schedule control** Common causes of schedule delays, measuring productivity, methods of enhancing productivity, issue in project delays.	06
3	**Cost control** Cost codification, earned value concept, variance analysis, alarm reports, control measures, client and contractor point of view	06
4	**Quality management** Concept of quality, aspects of quality, quality control and assurance, inspection, preparation of manuals and checklists	06
5	**Types of Hazards:** occupational health hazards, general precautions to be followed for avoiding accidents, safety campaign, training for safety	03
6	**Safety management** Types of accidents on construction work sites and their common causes, direct and indirect costs of accidents,	04
7	**Integrated approach to project control** Project management information systems, computer networking, and introduction to related computer software's.	06

Text Books

1. Harold Kerzner, Ph.D., Kerzner (2009); "Project Management" John Wiley & Sons, ISBN 13: 9780470548486.
2. Pilcher R (1994); "Project Cost Control in Construction", John Wiley & Sons. ISBN 13: 9780632036370. 400p.
3. Jack R. Meredith, Samuel J. Mantel, Jr (2011); "Project Management: A Managerial Approach" John Wiley & Sons. ISBN 13: 9780470533024. 600p.
4. Ralph W. King, Roland Hudson (2008); "Construction Hazard & Safety Handbook" Butterworths. ISBN 13: 9780408013475. 477p.
5. Brian Thorpe, Peter Sumner, John M. Duncan (1996); "Quality Assurance in Construction" Gower Press. ISBN 13: 9780566077586. 153p

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-MTCM202 Project Appraisal, Planning and Scheduling

Course Code	Course Name
PC-MTCM202	Project Appraisal, Planning and Scheduling

Course pre-requisites	Construction Management

Course Objectives

1. Discuss project preparation, Analysis and Appraisal and Risk analysis with its types, measures & tools for assessment.
2. Identify Value analysis including job plan, function analysis, creative thinking, cost
3. To summarize Modeling, life cycle costing, value engineering and management.
4. To report Project planning and scheduling with reference to scheduling tools like bar Chart and Network techniques such as CPM and PERT.

Course Outcomes

1. Carry out planning, execution and controlling of projects in Civil Engineering with developing capability of preparing project networks
2. Determine time cost relationship by using life cycle costing, value engineering and management.
3. Utilize Project planning and scheduling with reference to scheduling tools like bar Chart and network techniques such as CPM and PERT.

Course Content

Module No.	*Details*	*Hrs.*
1	**Project Preparation, Analysis and Appraisal** Project development cycle, project ideas, preliminary screening Analysis and appraisal: market and demand, technical, financial, economic, ecological	05
2	**Project Planning:** Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, estimating durations, sequence of activities, activity utility data. Application of MS-Project and PrimaVera for planning	05
3	**Project Scheduling** Bar charts, Networks: basic terminology, single and overlapping relationships preparation of CPM networks: activity on link and activity on node representation, analysis of single relationship (finish to start) networks, computation of float values, critical and semi-critical paths, calendaring the events.	05

	PERT: Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion	
4	**Resource Scheduling:** Bar chart, line of balance technique, resource constraints and conflicts, resource aggregation, allocation, smoothening and leveling	05
5	**Project Costing and Budgeting** Classification of costs, time cost trade-off in construction projects, Compression and decompression. Preparing budgets, master networks. At least one assignment shall be done using any project planning and scheduling software as part of term work. Introduction of Rivet software in estimation	06
6	**Estimating methods and Appraisal criteria**: parameter, cost capacity factor, cost indices, detailed estimates, provision for escalation, inflation and contingencies Financial appraisal criteria : NPV, BCR, IRR, Urgency, payback period, ARR, Scheme of evaluation of various criteria, investment appraisal in practice	05
7	**Advancement in Project Management** Advance/latest developments in Project Management: Construction digitization, Introduction of Internet of Things in construction industry, Augmented reality (AV), Virtual reality (RV), Scenario Analysis.	05

Term Work

Term work shall comprise of

1. Report on assignments including problems based on the above syllabus shall be submitted as term work.
2. One assignment on each module is to be submitted.
3. Reports of assignments : 25 points

Text / Reference Books

1. Prasanna Chandra (1986); “Projects preparation, appraisal, budgeting & implementation”, Tata McGraw Hill. ISBN-13: 978-0074516287. 543p.
2. Gregory T. Haugan (2002); “Project Planning and scheduling” Management Concepts Inc. ISBN 13: 9781567261363. 102p.
3. Saleh A. Mubarak (2012); “Construction project scheduling and control” John Wiley & Sons. ISBN 13: 9780470919958. 480p.
4. James Lewis (2005); “Project Planning, Scheduling & Control, 4E: A Hands-On Guide to Bringing Projects in on Time and on Budget” McGraw-Hill Companies, Incorporated. . ISBN 13: 9780071460378. 510p.
5.Eric S. Norman, Shelly A. Brotherton, Robert T. Fried (2010); “Work Breakdown Structures: The Foundation for Project Management Excellence” John Wiley & Sons. ISBN 13: 9781118000267. 304p.
6. Project Management Institute (2006); “Practice Standard for Work Breakdown Structures”’ Project Management Institute, ISBN 13: 9781933890135. 111p.
7. Robert B. Harris (1978); “Precedence & arrow networking techniques for construction” Wiley. ISBN 13: 9780471041238. 448p.
8. Antill&Woodhead (1990); “Critical path methods in construction practice”, John Wiley & sons. ISBN-13: 978-0471620570. 440p.
9. Chitkara K K (1998); “Construction Project Management”, Tata McGraw Hill, ISBN 13: 9780074620625, 558p.
10. Barrie D.S. & Paulson B C (1992); “Professional Construction Management” , McGraw Hill., ISBN :13 9780070038899. 577p.
11. Harold R. Kerzner (2013); “Project management: A system approach to planning, scheduling and controlling” John Wiley & Sons. ISBN 13:9781118415856. 1296 p.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-MTCM255 Mini Project

Course Code	Course Name
PC-MTCM255	Mini Project
Course Objectives	
Students should be able to 1. Educate the student to understand the field problems in civil engineering. 2. To apply the principles of management and suggest remedial measures.	
Course Outcomes	
Upon successful completion of the course, students should be able to 1. Students will be able to identify the research areas and formulate research objectives for dissertation wok in the area of construction management field 2. Students will be able to prepare reports and present their work in the form of seminars.	

Module No.	*Details*
1	**Report on mini Project** The mini project work extends through the third and fourth semester. It is aimed at identifying the research area and formulates research objectives. Students are expected to carry out independent research work on the chosen topic and submit a report of same for evaluation? The work at this stage may involve extensive review of literature, laboratory experimental work, development of software, development of model, case study, field data collection and analysis etc. On completion of the work the student shall prepare a report and will give a Seminar on the report.

PE-MTCM201 Risk and Value Management

Course Code	Course Name
PE-MTCM201	Elective – IV: Risk and Value Management

Course pre-requisites	

Course Objectives
1. To discuss the basics of risk and value management. 2. To explain various mathematical tools used in risk assessment process. 3. To describe value engineering job, plan. 4. To outline the process of life cycle costing.
Course Outcomes
1. To carry out risk analysis and development of mitigation measures. 2. To implement value management process. 3. To execute the life cycle cost analysis
Course Content

Module No.	***Details***	***Hrs.***
1	Risk analysis and Management for projects (RAMP) – Identifying risk events. Probability distribution. Stages in Investment life-cycle; Determination of NPV and its standard deviation for perfectly co-related, moderately co-related and un-correlated cash flows. Sensitivity analysis	07
2	scenario analysis simulation, decision tree analysis, risk profile method, certainly equivalent method; risk adjusted discount rate method, certainty index method, 3 point estimated method; use of risk prompts, use of Risk Assessment tables, details of RAMP process, utility of Grading of construction entities for reliable risk assessment.	06
3	Risk Mitigation – by elimination, reducing, transferring, avoiding, absorbing or pooling. Residual risk, mitigation of unquatified risk. Coverage of risk through CIDC's MOU with the Actuarial Society of India through risk premium such as (BIP) – Bidding Indemnity Policy (DIMO) – Delay in meeting obligation by client policy, (SOC) – Settlement of claims policy (LOP)- Loss of profit policy (TI).	04
4	Transit Insurance policy (LOPCE) Loss of performance of construction equipment policy. Insurance from construction point of view – CAR Policy, EAR Policy, 3rd party risk cover, Professional Liability Insurance policy, Contractor's Plant & machinery policy, and IT risk policy	04
5	Value : Meaning of value, basic and secondary functions, factor contributing to value such as aesthetic, ergonomic, technical,	06

	economic : identifying reasons or unnecessary costs	
6	Value Analysis: value analysis team; principles of value analysis, elements of a job plan viz. orientation, Information, presentation. Implementation, follow up action, benefits of value analysis, various applications; assessing effectiveness of value analysis.	05
7	Value management : Energy resources, consumption patterns, energy cost escalation and its impact, key factors affecting energy consumption in the building and other construction works.	04

Text / Reference Books

1. Faculty of Actuaries (Great Britain), Institute of Actuaries (Great Britain) (2005); "RAMP - Risk Analysis and Management for Projects: A Strategic Framework for Managing Project Risk and Its Financial Implications". Thomas Telford. ISBN 13: 9780727733900. 147p.
2. Seetharaman (2000);" Construction Engineering and Management", ISBN: 9788188114061.487p.
3. Prasanna Chandra (1986); "Projects preparation, appraisal, budgeting & implementation", Tata McGraw Hill. ISBN-13: 978-0074516287. 543p.
4. Dr.Surendra Kumar "Industrial Engineering and Management of manufacturing systems" .Satya Prakashan.
5. Zimmerman & Hart (1982);" Value engineering - a practical approach for owners, designers &contractors", CBS Publishers. ISBN:9780442295875.279p.
6. S C Rangwala ,Estimating Costing and valuation, Charotar Publishing House.
7. Del Younke, Value Engineering: Analysis And Methodology.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM202 International Construction Business

Course Code	Course Name
PE-MTCM202	Elective – IV : International Construction Business

Course pre-requisites	Construction Management

Course Objectives		
student will be able to 1. Explain basic concept of international economy with theories of trade. 2. Describe culture of international business. 3. Summarize legal frame in contest of international business. Discuss about multi project management and regulatory committees		
Course Outcomes		
1. Distinguish the theories of international trade. 2. Execute multi projects management. 3. Basic of legal frame and regulatory committees.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**International economy** International political system, economic system, Globalizations, multinationals, features of international trade & investment, national interest in international trade. Impact of EU, SAARC, BRICS, ASEAN on global economy	05
2	**Theories of international trade** OHLINS'S international trade Developing countries in the world economy, international differences in technology, policy implications for host countries International monetary system, balance of international payments, transfer of international payments, foreign exchange rates and their determination. Role of IMF (International Monetary fund), World Bank, IBRD (International Bank for Reconstruction and development), Asian Development Bank	08
3	**Cultural environment of international business:** Elements of culture, culture role, Effect of culture, language, education, religion, value systems on business, impact on management styles in selected countries, cross-cultural differences.	05
4	**Legal Framework and International Trade** Restriction on Import-Export, International Dispute Settlement.	07

	Role of WTO and its Function. International arbitration & case studies.	
5	**Multi project management & control:** International project planning, resource management, document management, Consortium and collaboration, controlling tools, use of ERP for international business, introduction to CVC.	06
6	Introduction to international regulatory committees, GCC/MENA/FU.	03
7	Case studies on international project	02

Text / Reference Books
Published books in the relevant areas to be supplemented by latest journal articles and papers, seminar and conference proceedings, in-house publications, monographs etc.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM 203** Infrastructure Planning and Managements (Online Course)

Course Code	Course Name
PE-MTCM 203**	Elective IV: Infrastructure Planning and Managements (Online Course)

Course pre-requisites	

Course Objectives
1) To introduce students to 'real world' risks and challenges in managing infrastructure 2) To explain the infrastructure planning process as well as the state of infrastructure across sectors in India 3) To understand various risks that plague infrastructure projects
Course Outcomes
students will be able to 1. Aware of current risks in infrastructure sector 2. Provide solutions that can help to execute infrastructure projects better 3. Carry out strategic management techniques

Course Content

Module No.	*Details*	*Hrs.*
1	Class Introduction, Introduction to Infrastructure and to the Transportation, power and telecom sectors	04
2	Rural and Urban Infrastructure Sectors, Players and Phases in an Infrastructure Project	03
3	Project Finance and Public Private Partnerships	05
4	Construction and Economic Risks, Political and Social Risks	03
5	Stakeholder Management, Design Thinking and Negotiations, Socio-Economic Analysis and Good Governance for Infrastructure	06
6	Guest Lectures from Infrastructure Practitioner, Modeling Flexible Project Arrangements	05
7	Case Studies, Incomplete Design	06

Text / Reference Books		
1. 'Infrastructure Planning Handbook' by Prof Makarand Hastak, ASCE Press 2. 'Strategic Management of Large Engineering Projects' by Miller and Lessard		
Sr. No.	**Examination**	**Module**
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM211 Management of Construction Resources

Course Code	Course Name
PE-MTCM211	Elective V : Management of Construction Resources

Course pre-requisites	Construction Management

Course Objectives
1. To Describe the concept of human Resources Management 2. To explain concept of equipment Management 3. To summarize concept of material management
Course Outcomes
students will be able to 1. Carry out human Resources Management 2. Execute equipment Management 3. Apply materials management technique in construction

Course Content

Module No.	*Details*	*Hrs.*
1	**Human Resources Management** Need of HRD in the context of globalization Staffing, recruiting, orientation and training, performance evaluating, merit rating Labour Management: Strikes and lockouts, collective bargaining, grievances and grievance settling procedure, labour welfare.	05
2	**Manpower planning** Techniques of manpower planning. Estimation of manpower for company project. Manpower planning at various stages considering a risk due to lead time. Remuneration of a person. Various methods of deciding remuneration, Techniques to decide actual manpower resources	05
3	**Equipment Management** Mechanization on construction projects, selection of major and minor equipment, production estimating, sizing and matching of equipment Sources of construction equipment: purchase, rent and lease, old and new equipment	06
4	**Economics of Equipment** Economics of equipment, useful / economic life of equipment, equipment operation and service, maintenance, depreciation,	06

	obsolescence and replacement Equipment management systems, organizations, record keeping, training to operators, life cycle costing of equipment,	
5	**Materials Management** Importance and role in construction industry. Objectives and functions. Estimation of materials, Classification and codification, Material Requirement Planning. Vendor analysis, Purchase function: legal aspects of purchase, Requisition forms, Quality assurance	06
6	**Inventory Management** Stores Management; Planning layout of stores, Plant & machinery, Digitalization in effective control of stores; Inventory control techniques concept of EOQ , Advantages and limitations of use of EOQ, ABC analysis, Stores management, minimizing wastage, Precautions to be taken during storage and transport Material management systems, Organizations, record keeping.	04
7	Introduction of various software's for construction resource management such as Microsoft Project , Prima Vera, Building Information and Modelling, ERP	04

Text / Reference Books
1. Varma Mahesh (1975); "Construction Equipment, Its Planning & Application", Metropolitan & Co. 539p. 2. Gopalkrishnan (1977); "Materials Management: An Integrated Approach" PHI Learning Pvt. Ltd. ISBN 13: 9788120300279. 280p. 3. Nunnally (2000); "Managing Construction Equipment", Prentice Hall. ISBN 13: 9780139012167. 399p.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM212 Total Quality Management in Construction

Course Code	Course Name
PE-MTCM212	Elective – V : Total Quality Management in Construction

Course pre-requisites	Construction Management

Course Objectives
The main objectives of the course are to 1. To study the concept of quality in construction. 2. To describe the need of MIS in Construction. 3. To explain the need of TQM, ISO and SIX Sigma in Construction.
Course Outcomes
At the end of the course the students shall be able to 1. To carry out quality control in construction. 2. To develop Total quality management system and Management Information System

Course Content

Module No.	*Details*	*Hrs.*
1	Quality: Necessity for improving Quality in the context of Global Challenges.	05
2	Concept of Quality Control, Quality Assurance, Quality Management and Total Quality Management (TQM)	05
3	Study of various Quality Standards in Construction: Related to building materials and other inputs for construction processes, methods and techniques for construction outputs, products and services, such as BIS, BS, Indian standard, British, American, German & Japanese standards, Managing Quality in various projects stages from concept to completion by building quality into design of structures, Inspection of incoming material and machinery In process quality inspections and tests.	06
4	Designing of quality manuals, checklists and inspection reports, installing the quality	06
5	Assurance system, monitoring and control.	05
6	Quality Assurance Department and quality control responsibilities of the line organization. Quality in foundations and piling work, structural work. Concreting, electrical system building facilities, waste recycling and maintenance.	05
7	Developing quality culture in the organization: Training of people, Bench – marking quality. Quality circles.	04

Text / Reference Books
1. Rumane, Abdul Razzak (2011);" Quality management in construction projects", ISBN:

9781439838723 464p.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM213 International Contracting

Course Code	Course Name
PE-MTCM213	Elective – V : International Contracting

Course pre-requisites	

Course Objectives		
1. The significance & role of contracts 2. contracts professionals in the world of business		
Course Outcomes		
1. Describe the fundamental elements of a contract, including basic terms and conditions 2. Develop appropriate selection criteria for vendor selection 3. Be able to choose the right contract type for a given situation		
Course Content		
Module No.	***Details***	***Hrs.***
1	International contracting – meaning, scope, nature, present status of the International construction market, role of Asia- Pacific region countries in the present construction development. Impact of WTO/GATS on the Indian Construction Sector as regards domestic market and export sector.	04
2	Study and application of various conditions of contract under the FIDIC document development of regulatory framework. Project exports from India. Overview of EC, ICC, ENNA, IChemE & AIA , Emerging contract model – Integrated Project Delivery, Guaranteed Maximum Price contract	05
3	International financing: Various institutions such as WB, IMF, ADB. African bank etc. and their role, rules – regulations in funding various projects, forming alliance, bilateral and multilateral funding, trade practices etc.	06
4	International Projects – Types of BOT systems such as BOT, BOOT, BOO, DBO, BOR, BLT, BRT, BTO & DBGO, MOOT, ROO, ROT, BOLT – Contractual procedures, special features, methods of handling.	08
5	Selection of personnel to suit socio-economic-environmental culture in other countries, suitable organisational structure.	05
6	Disputes Resolving – International Courts, formation of DRB's (Dispute resolving boards) functioning and experiences in India and abroad, Advantages of DRB's	05
7	CASE studies of any 2 major project executed/functioning under International contracting.	05

Text / Reference Books
1. FIDIC documents 2. Simon M.S. McGraw Hill (2007);" Construction Contracts & Claims", New York.

ISBN:9780070574335. 278 p.
3. Unified Contract Documents by CIDC
4. ReboertMatays and Mathews (1995);" Dispute Review Board Manual", ISBN-13: 978-0070410602.
5. K.N.Vaid (1991);" International Construction Contracting", NICMAR Publication. ISBN: 9788185448169

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PE-MTCM214** Modern Construction Materials (Online course)

Course Code	Course Name
PE-MTCM214**	Elective V: Modern Construction Materials (Online course)

Course pre-requisites	

Course Objectives

1. To discuss the modern construction materials used in construction industry
2. To provide the scientific basis for the understanding and development of construction materials
3. To understand the properties and application of construction materials

Course Outcomes

students will be able to
1. Understand the science and design of construction materials.
2. To Carry out research related to construction materials
3. Practice marketing, decision making, innovation and specification related to construction materials.

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to the course, Science Engineering and Technology of Materials- 1&2, Atomic Bonding-1, Atomic Bonding-2, Structure of Solids-1, Structure of Solids-2&3	05
2	Movement of Atoms, Development of Microstructure-1, Development of Microstructure-2	04
3	Surface Properties, Response to Stress-1, Response to Stress-2&3, Failure Theories, Fracture Mechanics-1, Fracture Mechanics-2	06
4	Rheology & Thermal properties, Review of Const. Materials & Criteria for Selection, Wood and Wood Products-1	06
5	Wood and Wood Products-2, Wood and Wood Products-3, Polymers, Fiber Reinforced Polymers-1&2, Metals-1, Metals-2, Metals-3	04
6	Bituminous Materials-1, Bituminous Materials-2, Concrete-1, Concrete-2, Concrete-3	05
7	Concrete-4, Concrete-5, Glass, Waterproofing Materials, Polymer Floor Finishes, Anchors	06

Text / Reference Books

1. Building Materials, P.C. Varghese, Prentice-Hall India, 2555.
2. Materials Science and Engineering: An introduction, W.D. Callister, John Wiley, 1994.
3. Materials Science and Engineering, V. Raghavan, Prentice Hall, 1990.

4. Properties of Engineering Materials, R.A. Higgins, Industrial Press, 1994.
5. Construction materials: Their nature and behaviour, Eds. J.M. Illston and P.L.J. Domone, 3rd ed., Spon Press, 2551.
6. The Science and Technology of Civil Engineering Materials, J.F. Young, S. Mindess, R.J. Gray & A. Bentur, Prentice Hall, 1998.
7. Engineering Materials 1: An introduction to their properties & applications, M.F. Ashby and D.R.H. Jones, Butterworth Heinemann, 2553.
8. The Science and Design of Engineering Materials, J.P. Schaffer, A. Saxena, S.D. Antolovich, T.H. Sanders and S.B. Warner, Irwin, 1995.
9. Concrete: Microstructure, properties and materials, P.K. Mehta and P.J.M. Monteiro, McGraw Hill, 2556.
10. Properties of concrete, A.M. Neville, Pearson, 2554.

OE-MTCM201 Operational Research

Course Code	Course Name
OE-MTCM201	Operational Research

Course pre-requisites	

Course Objectives
1. To impart knowledge in concepts and tools of Operations Research. 2. To understand mathematical models
Course Outcomes
1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables. 2. Students should able to apply the concept of non-linear programming 3. Students should able to carry out sensitivity analysis 4. Student should able to model the real world problem and simulate it.

Course Content

Module No.	*Details*	*Hrs.*
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	05
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method	07
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	06
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models	07
5	- Probabilistic inventory control models - Geometric Programming.	05
6	-Sensitivity analysis - parametric programming	03
7	Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	03

Text / Reference Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010

6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

OE-MTCM202 Legal Aspects in Construction

Course Code	Course Name
OE-MTCM202	Elective IV : Legal Aspects in Construction

Course pre-requisites	

Course Objectives		
1. To describe fundamentals of common law and understand bid cycle 2. To explain Indian contract act and demonstrate the concept contract administration 3. To summarize students with Laws applicable to construction activity 4. To interpret various acts in connection with construction activities		
Course Outcomes		
1. Use of law in general and Practice tendering process 2. Utilize Indian contract act and its provision with respect to construction 3. Implement contract administration and Use International contract provisions 4. Use labor laws and other Acts applicable to construction site		
Course Content		
Module No.	***Details***	***Hrs.***
1	Law and common man	04
2	Construction through contracts ;Types, critical comparison, bid cycle, tender and contract documents, contract conditions, study of contract documents of State PWD and CPWD	06
3	Indian Contract Act; Need, provisions, scope for modifications / improvement	06
4	Contract administration Deviations and extras, claims and their management, disputes and dispute resolution methods, Arbitration and Conciliation Act.	06
5	Laws applicable to construction activity need and broad provisions of : Industrial Disputes Act, Workmen's Compensation Act ,	05
6	Employer's Liability Act, Payment of wages Act, Contract Labour Act, Minimum Wages Act, Inter-state Migrant workmen act, BOCW Act and other acts introduced from time to time	05
7	FIDIC contracts; Contract administration;	04

Text / Reference Books
1. Bajirao Shankarrao Patil (1986); "Legal Aspects of Building & Engineering Contracts" S.B. Patil. 471p. 2. G. T. Gajria, Kishore Gajria (2000); "Law Relating To Building & Engineering Contracts In India", Lexisnexis Butterworths India. ISBN 13: 9788187162162. 538p. 3. P. C. Markanda, Naresh Markanda (2013); "Law Related To Arbitration and Conciliation" Lexisnexis Butterworths India. ISBN 13: 9788180388132. 1570p. 4. Edward R. Fisk, Wayne D. Reynolds (2013); "Construction Project Administration" Pearson Education. ISBN 13: 9780133149258. 432p. 5. Indian Contract Act 1872 6. Arbitration Conciliation Act 1996.4. All Referred Bare Acts 7. CPWD Manual Volume I & II, A Handbook For Government Officials And Contractors

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

Sardar Patel College of Engineering, Andheri (West), Mumbai 400058
Year: 2023-24

OE-MTCM203 Business Analytics

Course Code	Course Name
OE-MTCM203	Elective – VI : Business Analytics

Course pre-requisites	

Course Objectives

student will be able to

1. The main objective of this course is to give the student a comprehensive understanding of business analytics methods.
2. Understand and critically apply the concepts and methods of **business analytics**. Identify, model and solve decision problems in different settings.

Course Outcomes

1. Students shall be able to have knowledge of various business analysis techniques.
2. Interpret results/solutions and identify appropriate courses of action for a given managerial situation whether a problem or an opportunity

Course Content

Module No.	***Details***	***Hrs.***
1	Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst. Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.	06
2	Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.	06
3	Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.	07
4	Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling	05
5	Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools	05
6	Recent Trands in: Embedded and colleborative business intelligence,	05

7	Visual data recovery, Data Storytelling and Data Journalism.	02

Text / Reference Books
1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press. 2. Business Analytics by James Evans, persons Education.

Sr. No.	**Examination**	**Module**
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

OE-MTCM204 Industrial Safety Engineering (*Online Course)

Course Code	Course Name
OE-MTCM204	Industrial Safety Engineering (*Online Course)

Course pre-requisites	

Course Objectives

1. To impart knowledge on different facets and aspects of engineering systems safety
2. To study tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings

Course Outcomes

students will be able to

1. Understand concepts of engineering systems safety and dimensions of engineering systems safety,
2. Carry out safety design and analysis mathematics,
3. Design for engineering systems safety and control for safety,
4. Integrate safety with other operational goals such as quality and reliability

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction, key concepts, terminologies, and safety quantification	04
2	Safety by design, Hazard identification techniques (e.g., HAZOP, FMEA, etc.)	06
3	Fault tree and event tree analysis (qualitative & quantitative), Bow-tie and quantitative risk assessment (QRA)	05
4	Safety function deployment, Safety vs reliability – quantification of basic events (repair to failure, repair-failure-repair, and combined processes)	04
5	Systems safety quantification (e.g., truth tables, structure functions, minimal cut sets)	05
6	Human error analysis and safety, Accident investigation and analysis	07
7	Application of virtual reality, OSHAS 18001 and OSHMS	06

Text / Reference Books

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OE-MTCM205 Cost Management of Engineering Projects

Course Code	Course Name
OE-MTCM205	Cost Management of Engineering Projects

Course pre-requisites	

Course Objectives		
1. Cost management is to reduce the Project cost expended by Direct Costs and indirect costs 2. Establish systems to help streamline the transactions between corporate support departments and the operating units.		
Course Outcomes		
1. Devise transfer pricing systems to coordinate the buyer-supplier interactions between decentralized organizational operating units. 2. Use pseudo profit centers to create profit maximizing behavior in what were formerly cost centers		
Course Content		
Module No.	***Details***	***Hrs.***
1	Introduction and Overview of the Strategic Cost Management Process	06
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	06
3	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents	07
4	**Cost Estimations** Methods of cost estimation – Analogous estimates – Parametric estimates & cost aggregation method – Contingency reserve and management reserve in project cost estimations - Cost baseline & cost budgeting, Developing Project Control Budget. Understanding the cost estimates from Engineering, Procurement and Construction point of view.	05
5	**Financial Statements** Understanding Financial Statements, EBITDA, PBIT, PAT, Financial Ratios for understanding Profitability and healthy Cash	05

	Flow management	
6	**Working Capital Management** Working Capital Basics - Working Capital Issues in Projects - Estimating Working Capital - Working Capital ratios - Inventory Ordering Cost - Economic Order Quantity (EOQ) - Work In Progress (WIP).	05
7	**Project Cash flow Management** Project Cash flow, Components of Cash flow - Impact of Cash flow on Project Performance - Construction cumulative cost curves - Earned Value Management concept, Direct & Indirect Cost in Projects, Project overheads, Understanding the aspects of GST, Project Insurance.	02

Text / Reference Books
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi 2. Charles T. Horngren and George Foster, Advanced Management Accounting 3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting 4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher 5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd 6. Prasanna Chandra (2011); "Financial Management", Tata McGraw-Hill Education. ISBN 13: 9780071078405. 1026p.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

SE-MTCM201 Lab Course-Building Information modeling (BIM)

Course Code	Course Name
SE-MTCM201	Building Information modeling (BIM)

Course pre-requisites	

Course Objectives
1. To educate the student on 3D design of Civil / Commercial Buildings 2. To develop model using Navisworks 3. To monitor progress of work
Course Outcomes
Students will be able to 1. Explain the modeling concept of building information , 2. Illustrate planning, design and construction by using BIM software

Course Content

Module No.	*Details*	*Hrs.*
1	Exploring the User Interface, Working with Revit elements, Creating a basic Floor Plan.	02
2	Working with grids and Structural Columns, adding and Modifying Walls, Loading Additional Building Components, importing and Exporting using External Files and Linking Files	02
3	Creating Advanced Components, Creating and Modifying Parametric Families.	02
4	Viewing the Building Model, Controlling Object Visibility, Creating and Modifying Section And Elevation Views.	02
5	Developing the Building Model, Creating and Modifying Floors, Ceilings, Roofs and Curtain Wall.	02
6	Detailing and Drafting, Duplicating Views, Creating Elevations, Creating Section structural Works, Floor Framing, Working with Roofs, Working with Structural Steel Frames.	02
7	Working with Sloped Beams, Working with Floor Decks, Working with Foundation Slabs and Slabs, Footings and Grade Beams, Managing Revisions, User Interface & File Organization.	02
8	Viewing the Building Model, Controlling Object Visibility, Creating and Modifying Section And Elevation Views	02
9	**NevisWorks :** (Model Development User Interface & File Organization, Overriding transparency, color, and object/model location.	02
10	Importing 3D Files, How to import and append 3D model File, Understanding NavisWorks file formats, Object enablers	02

11	Navigation, Zooming, panning, walking around Sectioning, Moving objects, Hiding layers and objects, Establishing Selection Sets.	02
12	Viewpoints, Establishing and organizing custom, Viewpoints, Publishing the model file and Viewpoints, Internal/in-house clash detection, 4D simulation	02

Lab Work

Lab work shall comprise of

1. Report on assignments including problems based on the above syllabus shall be submitted as term work.
2. One assignment on each module is to be submitted.
3. Reports of assignments : 50 points

PC-MTCM202 Lab Course- Project Management Lab

Course Code	Course Name
PC-MTCM202	Project Management Lab

Course pre-requisites	

Course Objectives
1. To educate the student about modern construction management software 2. To apply the knowledge of planning and scheduling technique for a construction project
Course Outcomes
Students will be able to 1. determine the list of activities and their dependencies 2. prepare bids for works, plans and schedules for construction activity using software 3. demonstrate use of general purpose software to develop applications for cash flow generation, resource planning etc.
Course Content

Laboratory work to include;

FUNDAMENTALS OF PROJECT MANAGEMENT using M.S .Project

Structuring of Projects and Organizations. Applications of Network Techniques using software, Resource profiles, tables, and resource/cost curves; Setting Up a Project, Creating Calendars, Defining Task and Relationship, Creating WBS, Scheduling and Progress of Project, Resource organization in Project Plans,

Monitoring & Control

- Updating and Reporting on Project Performance Monitoring, Controlling and Report Generation.

Project structuring, task organizations, scheduling, resources, costs etc. various features and functions available in Primavera.

Creating Project, sub-project, activities planning and scheduling calendars

Resource definitions: Task types, resource types, resource planning, allocations of cost etc.; Various Structures i.e. WBS, OBS, EPS, etc. Activity codes, Project progress, progress updating: setting baseline, status updating, tracking formatting for printing etc.

Tilus

TILOS Interface Overview; Overview of Capabilities and Benefits Time Distance View layout, settings, and properties; Time Scale Distance Scale, Elevation Profiles, Grid Lines, Inserting tasks (activities) Linking tasks (logic/relationships), Calendars, Holidays, and shift patterns Text Fields, Layers, Filters, Task Templates, Resources like Labor, Machines, and Material , Costs and expenditures, Histograms; E**nvironmental Constraints,** Task Groups (Fragnets), Splitting Tasks Adding project milestones, Creating a baseline, Reporting progress Detecting task clashes/conflicts, Reschedule, Adding a Legend, Logo, and images, Hints, Tips, and shortcuts.	
Lab Work	
Lab work shall comprise of 1. Report on assignments including problems based on the above syllabus shall be submitted as term work. 2. One assignment on each module is to be submitted. 3. Reports of assignments : 50 points	

AE-MTCM201 English For Research Paper Writing

Course Code	Course Name
AE-MTCM201	English For Research Paper Writing

Course pre-requisites	

Course Objectives

Students will be able to:
1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title

Course Outcomes

Upon successful completion of the course, students should be able to

1. Demonstrate appropriate English language usage to disseminate scientific findings to the research community.
2. Writing Research Papers Across the Curriculum
3. Conduct appropriate research and synthesize outside sources into writing.

Course Content

Module No.	*Details*	*Hrs.*
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	04
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.	04
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	05
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	05
5	Skills needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be The first- time submission.	06

Text Books

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht

Heidelberg London, 2011
Reference Books
1. William Strunk Jr., and Richard De A'Morelli (2018), The Elements of Style: Classic Edition, USA.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 5

AE-MTCM202 Project Planning and Management

Course Code	Course Name
AE-MTCM202	Project Planning and Management

Course pre-requisites	Construction Management

Course Objectives

1. Understand the roles and responsibilities of civil and structural engineer in practice.
2. Understand the important activities and the sequence in which they are to be carried out
3. Learn the importance of accuracy and correctness in work and how this is achieved.
4. Understand the skills required by a civil and structural engineer

Course Outcomes

1. Have a clear understanding of the stages and activities in project execution
2. Draw upon the academic knowledge gained in college to achieve efficiency in actual practice.
3. Appreciate the developments in Civil and Structural engineering and the continuous upgradation of knowledge and skills.
4. To approach industry with enthusiasm, motivation, confidence and a strong pride in the profession

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction and Early work** • Roles and challenges of the Civil and structural engineer • Planning and scheduling for a project • Budget and Cost control • Surveying activity for a project • Geotechnical Investigation for a project	05
2	**Basic Design of a Project** • Plot Layout Planning, • Construction strategy • Tendering and Contract strategy for a project • Design basis for the project • Important codes, specifications and standards • Site Development	05
3	**Global design** • Important engineering principles and concepts • Preliminary structural analysis and design • Quantity and cost estimation and monitoring • Piling in a project • Material Estimation for ordering	05

	• Construction strategy for a project	
4	**Detailed Design** • Detailed computer analysis and design of structures, • Statutory approvals and permits • 3D computer modelling and interaction with other engineering disciplines. • Design reviews and Change management • 2D Detailed construction drawings for Reinforced concrete, Steel and Architecture	05
5	**Construction Stage** • Steel fabrication drawings and concrete bar bending schedules • Construction management • Safety and Quality Control • Present and future trends in Civil and Structural engineering • Essential skills required by a Civil and Structural engineer	04

Text Books
1. Koontz, O’Donnell &Weihrich (2010); “Management”, Mcgraw Hill. ISBN-13: 9780070144958. 464p. 2. Chinowsky, Paul S. & Songer, Anthony D. (2011) “Organization Management in Construction”. Routledge. ISBN-13: 978-0415572613. 216p. 3. Sears, Keoki S, (2008) “Construction Project Management: A Practical Guide to Field Construction Management”. Wiley. ASIN: B00HQ1CNE2. 4. Frank Harris (2013); “Modern Construction Management”, Ronald Mccaffer Wiley Blackwell Publications. ISBN-13: 978-0470672174. 572p. 5. Wagner.Harvey M (1975) “Principles of Management Science” Prentice Hall College Div. ISBN-13: 978-0137095353. 612p. 6. Snell, Scott & Bohlander George (2009) “Managing Human Resources” South-Western Cengage Learning; ISBN-13: 978-0324593310. 864p. 7. Dessler, Gary (2008) “Human Resource Management” Prentice Hall. ISBN-13: 978-0131746176. 801p. 8. Dharwadkar P. P (1992); “Management In Construction Industry” Oxford & IBH Luthans. 9. V. J. Davies, K. Tomasin (1996); “Construction Safety Handbook”, Thomas Telford, London. Isbn-13: 9780727725196. 303p. 10. PSG Design Data Book, PSG College, Coimbatore (2012)
Reference Books

1. Construction Safety Manual Published By National Safety Commission of India.
2. "Safety Management in Construction Industry" – A Manual for Project Managers. Nicmar Mumbai.
3. "IS For Safety In Construction – Bureau Of Indian Standards.
4. Girimaldi and Simonds (1989); "Safety management", AITBS, New Delhi. ISBN: 9780939874989.651p.
5. Stranks, Jeremy (2010) "Health and Safety at Work: An Essential Guide for Managers", Kogan Page Publishers. ISBN 13: 9780749461201. 352p.

Sr. No.	Examination	Module
1	T-I	1 and 2
2	T-II	3 and 4
3	End Sem	1 to 5

M.Tech. in Civil Engineering with

Construction Management

SEMESTER III

VE-MTCM301 Disaster Management

Course Code	Course Name
VE-MTCM301	Disaster Management

Course pre-requisites	

Course Objectives
Students will be able to: 1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response. 2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. 4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.
Course Outcomes
On completion of the course, the student will develop competencies in 1. Applying concepts of disaster to management 2. Analysing relationship between development and disasters 3. Ability to understand categories of disasters 4. Realization of the responsibilities to society

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	04
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	04
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.	04
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data	04

	From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	
5	**Risk UIdentification** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation.	02
6	**Risk Assessment** Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	02
7	**Disaster Mitigation** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	04

Text / Reference Books

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

DS-MTCM 301 Dissertation Phase-I

Course Code	Course Name
DS-MTCM 301	Dissertation Phase-I

Course pre-requisites	

Course Objectives
Students will be able to: 1. To enrich the knowledge of construction management and their application in the construction project. 2. To identify the potential research gap and propose research methodology.
Course Outcomes
Students will be able to: 1. Students will be able to do detailed literature review and formulate problem statements related to their research area. 2. Students will be able to carry experimental work, data collection, and development of models.

Module No.	***Details***
1	**Seminar on Literature Review** The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a thesis for Scheme of evaluation? The work at this stage may involve review of literature, laboratory experimental work, development of software, development of model, case study, field data collection and analysis etc. On completion of the work the student shall prepare a report and will give a Seminar on the report. Also, Student shall finalize a theme, related to construction engineering and/or management area for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.
2	**Stage-I Seminar** Topic Selection ; Literature Review; Knowledge integration to formulate problem statement; Plan of problem solving Methodology (tools and technique); Presentation skills

<u>M.Tech.</u> in Civil Engineering with Construction Management

SEMESTER IV

CC-MTCM401 Stress Management By Yoga

Course Code	Course Name
CC-MTCM401	Stress Management By Yoga

Course pre-requisites	

Course Objectives
1. To achieve overall health of body and mind 2. To overcome stress
Course Outcomes
Students will be able to: 1. Develop healthy mind in a healthy body thus improving social health also 2. Improve efficiency
Course Content

Module No.	***Details***	***Hrs.***
1	Definitions of Eight parts of yog. (Ashtanga)	04
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha	08
3	ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	04
4	Asan and Pranayam i) Various yog poses and their benefits for mind & body	04
5	ii)Regularization of breathing techniques and its effects-Types of pranayam	04

Text / Reference Books
1) 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur 2) "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

Sr. No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

DS-MTCM401 Dissertation Phase-II

Course Code	Course Name
DS-MTCM401	Dissertation Phase-II

Course pre-requisites	

Course Objectives
Students will be able to: 1. To enrich the knowledge of construction management and their application in the construction project. 2. To identify the potential research gap and propose research methodology.

Course Outcomes
Students will be able to: 1. Students will be able to analyze their research problem statement and derive inferences/results. 2. Students will be able to prepare a final dissertation report and present the same.

Module No.	*Details*
1	**Seminar (Pre –Synopsis)** Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inference the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis to the University
2	**Dissertation and Viva Voce** On finalization of the dissertation student shall submit the dissertation report to the University. The student shall have to appear for a Viva-voce examination for the dissertation.

M. Tech. in Civil Engineering with Structural Engineering Courses

Course Contents
Academic Year 2023-24
Regulation 23

Contents

SEMESTER -I

PC-MTSE101- Structural Dynamics

Course Code	Course Name
PC-MTSE101	Structural Dynamics

Course pre-requisites	

Course Objectives
The objectives of this course are 1. Dynamic load, difference between static load and dynamic load and different types of dynamic load. 2. Free vibration analysis of SDOF systems, concept of damping and dynamic analysis of SDOF system to different dynamic loads including ground motion. 3. Frequency domain analysis. 4. Dynamic degrees of freedom, Calculation of frequencies and mode shapes for lumped mass MDOF systems, analysis of MDOF systems subject to dynamic loads using modal analysis. 5. Analysis of system with distributed mass.

Course Outcomes
At the end of the course the students shall be able to, 1. Distinguish between static and dynamic loads; understand different types of dynamic loads 2. Understand the elements of single degrees of freedom, concept of damping and free and forced vibrations; able to find the frequency and free vibration response of single degree of freedom (including generalized single degree of freedom) system for different types of dynamic loads including ground motion in time domain. 3. Find the frequencies and mode shape for various types of multiple degrees of freedom lumped mass structures and carry out the dynamic (Damped and un-damped) for different types of dynamic loads including ground motion in time domain. 4. Carry out the dynamic analysis of systems with distributed mass. 5. Able to apply Fourier series in analysis of systems subjected to periodic loads and will understand the frequency domain analysis.

Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction** Introduction to structural dynamics, definition of basic problem in Dynamics, static v/s dynamic loads, different types of dynamic loads	02

2	**Single degree of Freedom (SDOF) systems** Un-damped free vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, computation of damping. Forced vibration, response to harmonic forces, periodic loading, dynamic load factors, and response of structure subjected to general dynamic load, Duhamel's integral, numerical evaluation of dynamic response of SDOF systems subjected to different types of dynamic loads. Numerical methods of evaluation of dynamic response of structures. Distributed mass system idealized as SDOF system, use of Rayleigh's method, response of SDOF system subjected to ground motion.	10
3	Use of Fourier Series for periodic forces, introduction to vibration isolation, and transmissibility. **Introduction to frequency domain analysis**, response of structure in frequency domain subjected to general periodic and non-periodic /impulsive forces of short duration, use of complex frequency response function, Fourier Response Integral, Discrete Fourier Transforms, Fast Fourier Transforms.	03
4	**Generalized Single-Degree of Freedom System:** Generalized properties, assemblages of rigid bodies, systems with distributed mass and elasticity, expressions for generalized system Properties.	07
5	**Free vibration of Lumped mass multi degree of freedom (MDOF) system:** Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods, energy methods and use of Lagrange's method in writing equations of motion	04
6	**Forced vibration of Lumped mass multi degree of freedom (MDOF) system:** Decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, and application to beams and multi storey frames with rigid girders subjected to lateral dynamic loads.	07
7	**Structure with distributed mass system:** Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads	03
TOTAL		36

Text Books
1. Dynamics of Structures by Clough & Penzien, McGraw-Hill, Computers & Structures, CBS Publishers, 2015 2. Dynamics of Structures: Theory & Applications to Earthquake Engineering by Anil K Chopra, Prentice Hall of India
Reference Books
1. Structural Dynamics by Mario Paz, Springer India, CBS Publishers, 2004 1. Introduction to Structural Dynamics by John M Biggs, CBS Publishers,2014 2. Basic Structural Dynamics by James C Anderson &FarzadNaeim, John Wiley & Sons 3. Fundamentals of Structural Dynamics by Roy R Craig & Andrew J Kurdia, Wiley 4. Mechanical Vibrations by Den P Hartog, McGraw-Hill 5. Dynamics of Structures by Jagmohan L Humar, 3rd Edition, CRC Press, 6. Passive Energy Dissipation Systems in Structural Engineering by Soong T T&Dargush G F, Wiley 7. Introduction to Structural Motion Control by Connor J J, Prentice Hall, NJ 8. Active Structural Control by Soong T T, Wiley, NY & Longman Scientific & Technical, England 9. Random Vibrations by N.C.Nigam 10. Structural Dynamics by Meriowich 11. Structural Damping: Applications in Seismic Response Modification by Zach Liang, George C Lee, Gary F Dargush&Jianwei Song, CRC Press 12. MATLAB: An Introduction with Applications by Amos Gilat, Wiley India

PC-MTSE102-Advanced Theory of structures

Course Code	Course Name
PC-MTSE102	Advanced Structural Analysis

Course pre-requisites	

Course Objectives
The objectives of this course are 1. To learn the force method of analysis of indeterminate structures 2. To understand displacement method of analysis of indeterminate structures 3. To understand the behaviour of curved beams 4. To understand the concept of beams on elastic foundations
Course Outcomes
Upon successful completion of the course, students should be able to 1. Use the force method for analysis of indeterminate structures 2. Use the displacement method for analysis of indeterminate structures 3. To determine stresses developed in curved beams 4. To analyze beams resting on elastic foundations

Course Content

Module No.	***Details***	***Hrs.***
1	**Matrix method of analysis of structures – Stiffness approach:** Introduction, Stiffness coefficients, member stiffness matrix, energy concept, transformation of system forces and displacements to element forces and displacements, transformation of element stiffness matrix to system stiffness matrix, effect of support settlement and temperature changes, spring supports.	05
2	**Matrix method of analysis of structures – Stiffness approach:** Consideration of Shear effects, Consideration of torsional effects for thin-walled member including torsional bending. Static condensation.Symmetry considerations in structures.	06
3	**Application of stiffness matrix method:** Application to beams, pin jointed plane frames, rigid jointed plane frames and grid structures. Basic concepts associated with computer implementation of stiffness method	06
4	**Matrix method of analysis of structures – flexibility approach:** Introduction, flexibility coefficients, member flexibility matrix, transformation of element flexibility matrix to system flexibility matrix, effect of support settlement and temperature changes, application to beams, pin jointed plane frames, rigid jointed plane frames and grid structures.	06
5	**Analysis of curved beams loaded perpendicular to their plane:**	06

	Introduction, force developed at a section in a curved beam, sign conventions, torsion factor, analysis of beams curved in plan, circular arc cantilever, semi-circular beam fixed at two ends and subjected to central concentrated load, semi-circular beam subjected to udl and simply supported by three columns spaced equally, circular ring beam. Torsional analysis- Calculation of moments and forces	
6	**Curved beams with loading in their plane:** Circumferential and radial stresses, neutral axis, analysis of crane hooks of different cross sections and chain links.	06
7	**Beams on elastic foundations:** Infinite beam subjected to concentrated load, beam supported on equally spaced discrete elastic supports, Infinite beam subjected to distributed load, semi-infinite beam subjected to concentrated load at its end and near its end, short beams.	04

Text Books

1. Aslam Kassimali (2012), “Matrix Analysis of Structures”, Cenage Learning
2. C. S. Reddy (2009), “Basic Structural Analysis”, Tata McGraw, 779 pages
3. Pandit Gupta (2001), “Matrix structural Analysis”, Tata McGraw-Hill Education, ISBN 0070667358, 602 pages
4. Arthur P. Boresi, Richard J. Smith, “Advanced Mechanics of Materials”, Willey, 681 pages
5. Meghre A.S, Deshmukh S.K (2016), “Matrix Method Of Structural Analysis ”, Charotar Publishing House, 552 pages

Reference Books

1. Gere Weaver(1980), “Matrix Structural Analysis”, Van Nostrand Reinhold Company, ISBN 0442257732, 492 pages

Sr.No.	Examination	Module
1	T-I	1, 2
2	T-II	3, 4
3	End Sem	1 to 7

PC-MTSE103-Research Methodology & IPR

Course Code	Course Name
PC-MTSE103	Research Methodology & IPR

Course pre-requisites	

Course Objectives
The objectives of this course are 1. Understand research problem formulation 2. Analyze research related information 3. Follow research ethics

Course Outcomes
Upon successful completion of the course, students should be able to 1. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity 2. Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. 3. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course Content

Module No.	*Details*	*Hrs.*
1	**Meaning of research problem**. Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	03
2	**Effective literature studies approaches, analysis** Plagiarism, Research ethics	03
3	**Effective technical writing, how to write report, Paper** Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	03
4	**Nature of Intellectual Property** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	03

5	**Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	03
6	**New Developments in IPR** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	03

Text Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

PE-MTSE111-Analysis of Composite Structures

Course Code	Course Name
PE-MTSE111	Analysis of Composite Structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To introduce the general set of composite materials
2. To show the advantages of composites over metals
3. To explain the fabrication processes
4. To analyze the structural mechanics of composite materials.
5. To explain the deformation and failure of composite materials under the influence of different loads.
6. To know the effect of hygro-thermal environment on composite materials.

Course Outcomes

Upon successful completion of the course, students should be able

1. The use of composite materials in real structures.
2. Composite material: classification, characterization, fabrication techniques.
3. Structural mechanics of composite materials: Calculation of strength and stresses.
4. De lamination, knowledge about inters laminar stresses.
5. Environmental effect on composite materials.

Course Content

Module No.	*Details*	*Hrs.*
1	Polymer matrix composites in structures. Fibre sand polymeric matrix materials. Fabrication processes.	06
2	Introduction to anisotropic elasticity. Unidirectional composites.	05
3	Micromechanics Interfaces and inter phases in polymer composites. Laminates and lamination theory.	06
4	De lamination in composites. Inter laminar stresses and free edge effects. Stress and failure analysis of laminated composites.	06
5	Hygro thermal and environmental effects.	04
6	Experimental characterization of composites.	04
7	Introduction to metal matrix, ceramic matrix and carbon-carbon composites. Intelligent composites, design approach.	05

Text Books

1. Jones R. M. (1975), "Mechanics of Composite Materials", McGraw Hill Kogakusha, Tokyo, ISBN 0070853479, 355 pages
2. Agarwal B. D. and Broutman L. J. (1990), "Analysis and Performance of Fibre composites", John Wiley & Sons, New York., ISBN 0471625728, 741 pages

3. Kaw A. K, “Mechanics of Composite Materials”, CRC Press
4. Mukhopadhyay M (2005), “Mechanics of Composite Materials & Structures”, Universities Press

Reference Books

1. Christensen R. M. (1991), “Mechanics of Composite Materials” Krieger Publishing Company, ISBN 0894645013, 348 pages
2. Calcote L. R. (1969), “The analysis of Laminated Composite Structures”, Van Nostrand Reinhold Co., New York, ISBN 0442156286, 222 pages
3. Holmes M. and Just D. J. (1985), “GRP in structural Engineering”, Applied Science Publishers, London. ISBN 0853342326, 298 pages
4. Gibson R. F. (17-Oct-2011), “Principles of Composite Material Mechanics”, CRC Press, ISBN 1439850054, 683 pages
5. Reddy J. N., “Analysis of Composite Laminated Plates”, McGraw Hill.

PE-MTSE112- Advanced Foundation Engineering

Course Code	Course Name
PE-MTSE112	Advanced Foundation Engineering

Course pre-requisites	

Course Objectives

The objectives of this course are

1. The design of foundation requires the consideration of many essential factors with regard to soil data, geology of the site, land use patterns, ground conditions and the type of structure to be built.
2. A detailed understanding of the field situation is also very important apart from theoretical knowledge of the course. This course seeks to provide an overview of the essential features of foundation design.
3. The different aspects of foundation engineering ranging from soil exploration to the design of different types of foundation, including the ground improvement measures to be taken for poor soil conditions have been covered in this course.

Course Outcomes

Upon successful completion of the course, students should have

1. An ability to apply knowledge of mathematics, science and engineering
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to identify, formulate and solve engineering problems
4. An ability to use the techniques, skills and modern engineering tools

Course Content

Module No.	*Details*	*Hrs.*
1	**Review of fundamentals of soil mechanics:** Soil, soil formation , soil profiles , weight volume relationship, soil classification, Indian standard method of soil classification, concept of total stress, effective stress and pore water pressure. One dimensional consolidation, Terzaghi's theory, derivation of equation. Determination of a_v, m_v, c_c, c_v from laboratory test , determination of p_c by various methods, field consolidation curve, secondary consolidation, quassi- pre consolidation , three-dimensional consolidation, practical applications.	07
2	**Shear strength** Coulomb's law of shear strength , Mohr's Coulomb's criteria of failure, shear strength and shear strain behavior of sandy and clayey soils under undrained , drained and consolidated drained conditions, concept of progressive failure , critical void ratio, practical applications. Estimation of stresses in soils, Boussinesque and Westergard theories, Newmark Chart, practical applications	06

3	**Sub-surface ground geotechnical investigations** Direct methods of explorations, influence of type of soils, type of foundations, etc. on the programme of exploration, lateral extent and depth of exploration, bore log details, profiles of soil in various directions, indirect methods, and practical applications.	05
4	**Bearing capacity of shallow foundations**: Type of shallow foundations, gross load and net load , gross and net ultimate bearing capacity, safe bearing capacity, and allowable bearing pressure, modes of failure, criteria of failure , Terzhagi, Meyerhof, bearing capacity in shear, compressibility (including critical rigidity index) criteria, factor of safety. Bearing capacity of clay and sand in settlement, settlement analysis for clay, normally and over consolidated soils, settlement analysis of sand, Schemertmann method, and practical applications.	06
5	**Pile foundations**: Axially loaded piles, necessity of piles, types of piles, static and dynamic resistance of piles, pile load carrying capacity using dynamic pile formulae and their limitations, pile load carrying capacity using Terzhaghi, Meyerhof, Berznatsv, Vesic, Indian standard 2911 (part -1 & part-2) method, settlement of pile in clay, group of piles, load carrying capacity for sand and clay soils, group efficiency, group settlements, practical applications.	06
6	**Ground improvements**: Various methods, sand drains, stone columns, stabilization, grouting, reinforced earth, geotextiles, diaphragm walls,	04
7	**Caissons & cofferdams.**	02

Reference Books

1. Taylor D.W. (2013), “Fundamentals of Soil Mechanics”, Asia publications Bombay, ISBN 1258768925, 714 pages
2. Karl terzaghi, (1996),” Soil Mechanics in Engineering Practice”, John Wiley & Sons, ISBN 0471086584, 549 Pages
3. Joseph E Bowles, (1997),” Foundation Analysis and Design”, McGraw-Hill, ISBN 0071188444, 1175 Pages
4. Dr. Alam Singh, “Soil Mechanics and Foundation Engineering Vol. 1, & 2”, Standard Book House
5. Dr.Alam Singh, “Geotechnical Application”, Standard Book House.
6. Reddy J. N., “Analysis of Composite Laminated Plates”, McGraw Hill.

PE-MTSE113 Design of Pre-Stressed Concrete Structures

Course Code	Course Name
PE-MTSE113	Design of Pre-Stressed Concrete Structures

Course pre-requisites	Design of RCC structures

Course Objectives

The objectives of this course are

1. To understand prestress force and its effect in structural members, prestressing systems and industrial applications.
2. To understand the materials which can be used for prestressed structure. To understand the concept of deflections due to prestressing force along with other forces
3. To understand the concept of composite structures and concordancy of cables.
4. To understand the design concept using prestressing force and familiarize with IS-1343.

Course Outcomes

Upon successful completion of the course, students should be able to

1. To apply the concept of pre stressing, its types and methods.
2. To analyse the losses in pre stressed sections.
3. To analyse and design simple pre stressed flexural members and their end zones.
4. To analyse and understand the behaviour of prestressed composite sections and indeterminate members.
5. To appropriately use IS code provisions for analysis and design of prestressed structures.

Course Content

Module No.	***Details***	***Hrs.***
1	Introduction to basic concepts and general principles of pre-stressed concrete, materials used in prestressed concrete and methods and techniques of prestressing, prestressing systems.	02
2	Analysis of prestressed concrete sections for flexure considering loading stages, computational of sectional properties, critical sections under working loads for pretensioned and post tensioned members, load balancing method of analysis of prestressed concrete beams, losses in prestress, application to simply supported beams and slabs, concept of debonding of cables in pre tensioned units.	08
3	Design philosophy of prestressed concrete sections, permissible stresses in concrete and steel, design approaches using working stress method as per IS 1343 – 2012, limit state of collapse – flexure and shear as applied to prestressed concrete beams, kern points, choice and efficiency of sections, cable profile and layouts, cable zone, deflection of prestressed concrete sections.	08

4	End zone stresses in prestresses concrete members, pretension transfer bond, transmission length, end block of post tensioned members.	05
5	Design of simply supported pre-tensioned and post tensioned slabs and beams.	05
6	Analysis and design of composite prestressed concrete structures, concept and behavior of long term creep and relaxation of prestressed members.	04
7	Introduction to application of prestressing to continuous beams, linear transformation and concordancy of cables.	04

Text Books

1. T. Y. Lin, "Design of Prestressed Concrete Structures", John Wiley Publishers
2. N. Krishna Raju, "Prestressed Concrete", Tata McGraw Hill
3. Y. Guyon, "Prestressed Concrete", Contractors Record Ltd.
4. R. H. Evans & E. W. Bennette, "Prestressed Concrete", McGraw Hill Book Co.

PE-MTSE114-Advanced Concrete Technology

Course Code	Course Name
PE-MTSE114	Advanced Concrete Technology

Course pre-requisites	

Course Objectives
The objectives of this course are 1. To expose the students to advancement in concrete technology.
Course Outcomes
Upon successful completion of the course, students should be able to 1. Test materials used in concrete per IS code 2. Design the concrete mix using IS code method 3. Determine the properties of fresh and hardened concrete, ensure quality control and acceptance criteria 4. Decide suitability of special concretes for specific applications and to decide suitability of recycling & re-use of industrial waste material. 5. Select and use suitable repair techniques

Course Content

Module No.	*Details*	*Hrs.*
1	Review of properties of cement, their physical and chemical properties, special purpose cements, Classification and properties of aggregates, soundness of aggregates, alkali aggregate reaction, thermal properties of aggregates, Importance of shape and Surface area and grading, gap graded and aggregates.	02
2	Admixtures & construction chemicals, Use of Fly Ash, Silica Fumes, Metakaolin& GGBS in concrete Rheological behavior of concrete, requirements of workability of concrete, Durability & Effect of environmental conditions, Strength & maturity of hardened concrete, Impact, Dynamic and fatigue behaviour of concrete, shrinkage and creep of concrete, behaviour of concrete under fire.	07
3	Permeability and Durability of concrete, Parameters of durability of concrete, chemical attack on concrete, Production of concrete; batching mixing, transportation, placing, compaction of concrete. Special methods of concreting and curing, Hot weather and cold weather concreting, Guniting (Shotcreting).	07
4	Concrete mix design, Basic considerations and choice a mix proportions, various methods of mix designs including IS Code method.	05
5	Quality control and quality assurance of concrete, Acceptance	05

	criteria, Quality management in concrete construction, Inspection and testing of concrete. Non-destructive testing of concrete, core test and load test.	
6	Special concrete such as high strength, Lightweight, heavy weight, vacuum processed concrete, Mass concrete, high performance concrete, Pumpable concrete, Self-Compacting concrete, Air entrained concrete, Ferro cement, fiber reinforced concrete, Polymer impregnated concrete. Jet concrete.	04
7	Recycling & re-use of industrial waste material. Deterioration and repair technology of concrete, Distress and type of repairs, crack sealing techniques.	06

Text Books

1. Gambhir M.L., “Concrete Technology”, Tata McGraw Hill, 2nd Edition, 1995.

2. M.S.Shetty, “M.S.Shetty”, S.Chand& Company New Delhi, 2005.

3. P.KumarMehata, Paulo & J.M. Monteiro, “Concrete microstructure, properties & materials”, Prentice Hall INC &Mcgraw Hill USA.

4. Short &Kenniburg, “Light Weight Concrete”, Asia Publishing House, Bombay, 1963.

5. Orchard D.F, “Concrete Technology -Vol I. & II”, Applied Science Publishers, 4th Edition, 1979.

6. Neville A.M., J.J.Brook, “Properties of Concrete”, Addison Wesley, 1999.

PE-MTSE121-Non Linear Analysis

Course Code	Course Name
PE-MTSE121	Non Linear Analysis

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To introduce the students to the concepts of plastic analysis of steel structures including continuous beams, single/multiple span rigid jointed portal frames and single bay gable frames.
2. To introduce the students to the concepts of elastic stability of structures.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Find the shape factor, determine the collapse load of single and multiple span beams, pin jointed frames, single/multiple span rigid jointed portal frames and single bay gable frames.
2. Find the fully plastic moment of a section under the effect of axial force and shear force.
3. Determine buckling loads of prismatic, non-prismatic members, beam-columns, single bay single storey portal frames.
4. Analyse thin walled open cross sections for torsional buckling, combined buckling due to torsion and flexure and analyse the beams for lateral buckling.

Course Content

Module No.	***Details***	***Hrs.***
1	Plastic Analysis: Concepts of plastic analysis of steel structures, stress strain relations. Shape factor- Plastic modulus, plastic hinge, fully plastic moment, moment curvature relations. Use of statistical and mechanism methods for calculation of collapse load, Lower and upper bound theorems, various types of failure mechanisms.	05
2	Collapse load analysis of pin jointed frames, Determination of collapse load – Single and multiple span beams carrying various types of loads, single/multiple span rigid jointed portal frames and single bay gable frames.	07
3	Effect of axial force and shear force on the fully plastic moment of a section. Design of beams and single span rigid jointed frames subjected to a system of proportionate loading as per Indian code provisions.	07
4	Elastic stability: Geometric Non linearity –Basic Concepts. Elastic buckling of bars with various end conditions, Euler's formula, buckling of non-prismatic members, use of energy method and finite difference method for evaluation of critical load analysis of single storey members.	07
5	Analysis of beam-columns, buckling of continuous beams. Buckling of single bay single storey portal frames. P-delta Analysis.	05
6	Torsional buckling: Pure torsion of thin walled open cross section, warping and warping rigidity, Torsional buckling of columns, combined buckling of	05

	members under torsion and flexure.	
7	Lateral buckling of beams, lateral buckling of beams in pure bending, lateral torsional buckling of cantilever and S.S. beams.	03
Term Work		
There is no Term Work for this Course		

Text Books
1. Lord Baker & Jacques Heyman (1980), "Plastic Design of Steel frames", Cambridge University Press, ISBN-0521297788, 238 pages. 2. Michael. R, Horne & B. G. Neal (2014), "Plastic Theory of Structures", Elsevier, ISBN9781483188454, 188 pages. 3. Alexander Chajes (1974), "Principles of Structural Stability Theory", Prentice Hall, ISBN-9780137099641, 336 pages. 4. NGR Iyengar (2007), "Elastic Stability of Structural Elements", Macmillan, 440 pages. 5. M. L. Gambhir (2004), "Stability Analysis & Design of Structures", Springer Science & Business Media, 535 pages.
Reference Books
1. Lynn. S. Beedle (1997), "Plastic Design of Steel Frames", John Wiley & Sons, Australia Limited, ISBN-978047109862, 406 pages. 2. Stephen Timoshenko & James. M. Gere, "Theory of Elastic Stability", Tata McGraw Hill 3. Chai H Yoo & Subg Lee (2011), "Stability of Structures: Principles & Applications", Elsevier, 536 pages. 4. George Simites & Dewey H Hodges (2006), "Fundamentals of Structural Stability", Butterworth-Heineman, 480 pages.

PE-MTSE122-Numerical Methods

Course Code	Course Name
PE-MTSE122	Numerical Methods

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To master basic Programming fundamentals, Fundamentals of numerical methods
2. Determine errors present in numerical solutions to engineering problems.
3. Utilize programming logic, structure and syntax to develop multifunctional algorithms to solve engineering problems
4. Identify and classify the numerical problem to be solved.
5. Choose the most appropriate numerical method for its solution based on characteristics of the problem
6. Understand the characteristics of the method to correctly interpret the results.

Course Outcomes

Upon successful completion of the course, students should have an ability of

1. Root finding; solutions for nonlinear algebraic equations
2. Solving sets of linear equations
3. Interpolation and curve fitting models
4. Numerical Differentiation and Integration
5. Understand fundamentals of numerical methods.

Course Content

Module No.	***Details***	***Hrs.***
1	Programming fundamentals, Fundamentals of numerical methods, Error analysis;	06
2	Curve fitting, Interpolation and extrapolation	04
3	Differentiation and integration	05
4	Solution of nonlinear algebraic and transcendental equations	06
5	Elements of matrix algebra	05
6	Solution of systems of linear equations, Eigen value problems, differential equations.	06
7	Computer oriented algorithms; Numerical solution of different problems.	04

Reference Books

1. J.H. Wilkinson (1965), “The Algebraic Eigenvalue Problem”, Oxford University Press, ISBN 0198534183,608 pages
2. K.E. Atkinson (1989), “An Introduction to Numerical Analysis”, J. Wiley and Sons, ISBN0471624896, 712 pages

3. G.E. Golub and C.F. Van Loan (1989), “Matrix Computations”, Johns Hopkins University Press, ISBN 1421407949, 756 pages.

PE-MTSE123-Structural Optimization

Course Code	Course Name
PE-MTSE123	Structural Optimization

Course pre-requisites	

Course Objectives
The objectives of this course are 1. The objective of this course is to introduce the concepts of design optimization and review major conventional and modern optimization methods used in structural optimization applications.

Course Outcomes
Upon successful completion of the course, students should be able 1. To find the best solutions from which a designer or a decision maker can derive a maximum benefit from the available resources.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction to optimization:** Historical development, engineering applications of optimizations	03
2	**Classical optimization technique:** Single variable optimization. Multivariable optimization with no constraints, multivariable optimization with equality and quality constraints	04
3	**Linear programming:** Simple method- simplex algorithm **Non-linear programming:** One dimensional methods-elimination methods- unrestricted search- exoustive search- Fibonacci method-golden section method –interpolation method –quadratic & cubic interpolation method-direct root method	09
4	**Non-linear programming:** Unconstrained optimization technique –direct search methods – random search, univariable and pattern search methods-descent methods-gradient of a function-steepost descent method –fletcher –reeves conjugate gradient method, quasi newton methods, dividon Fletcher powells variable metric method **Non-linear programming:** Constrained optimization techniques –direct method – method of physible direction- indirect method- transformation techniques – basic approach in the penalty function method – interior and exterior penalty function methods	10

5	Introduction to dynamic programming	03
6	Introduction to CPM and PERT	03
7	Applications of the above methods to some structural problems	04

Reference Books

1. Rao S. S. (2009), "Optimization – Theory and Applications", John Wiley & Sons, ISBN 0470183527, 813 pages
2. Gass S.I (2003), "Linear Programming", McGraw Hill Book.Co, ISBN 0486432847, 532 pages
3. SrinathL.S(2001),"PERT and CPM - Principles and Applications", Affiliated East-West Press (Pvt.) Ltd, ISBN 8185336202.
4. Wagner H.M, (1975), "Principles of Operation Research", Prentice Hall of India, ISBN 0137095929, 1039 pages

PE-MTSE124 - Advanced Design of Steel Structures

Course Code	Course Name
PE-MTSE124	Advanced Design of Steel Structures

Course pre-requisites	Design of steel structures

Course Objectives		
The objectives of this course are 1. To develop clear understanding of concepts, and practical knowledge of modern Civil Engineering techniques for design of steel structures. 2. Use of various relevant IS codes for designing steel structures. 3. To encourage students and faculty to interact with industry, alumni and other reputed institutes for purpose of better understanding of industry requirements 4. To deal with social, environmental and economic issues		
Course Outcomes		
Upon successful completion of the course, students should be able 1. To understand the design concept of different types of moment resistant connections 2. To understand the analysis and design concept of round tubular structures 3. To understand the design concept of different type of steel water tank 4. To understand the design concept of lattice tower and steel chimney 5. To understand the design concept of gantry girder 6. Use of various relevant IS codes for designing steel structures		
Course Content		
Module No.	***Details***	***Hrs.***
1	Moment Resistant Beam End Connections: Design of moment resistant bolted and welded beam end connections.	04
2	Round Tubular Structural Members Properties of steel tubes, design of tension and compression members, design of welded connections, design of flexural members, analysis and design of tubular trusses including purlins	06

	and supports.	
3	Elevated Steel Tanks: Loads acting on tanks including wind and earthquake, design of circular tanks with conical bottom, supporting ring beam, staging for circular tanks including design of columns and base plate.	06
4	Design of rectangular steel tanks including design of staging, columns and base plate	04
5	Gantry Girder: Loads acting on gantry girder. Analysis and design of gantry girder.	06
6	Lattice Tower: Different configurations of lattice towers, loads acting on lattice towers, analysis and design of lattice tower including welded or bolted connections for members.	04
7	Steel Chimney: Forces acting on chimney, design of self-supporting welded chimney and its components including design of base.	06

Text Books

1. Design of steel structures: Subramanian, Oxford Press.
2. Design of steel structures: Negi L.S., Tata McGraw Hill
3. Design of steel structures: Kazimi S.M. A. & Jindal R.S., Prentice Hall of India.
4. Design of steel structures: Krishnamachar B.S, &Ajitha Sinha D.
5. Design of steel structures: Arya and Ajmani, New Chand & Bros.
6. Design of steel structures, Vol I & II: Ramchandran, Standard Book House, New Delhi.
7. Design of steel structures: Dayaratnam, Wheeler Publication, New Delhi
8. Comprehensive design of steel structures: Punamia, A.K. Jain &Arun Kumar Jain, LaxmiPublicalions Pvt. Ltd.
9. Design of steel structures: I C Sayal&Salinder Singh, Standard Publishers & Distributors.

Reference Books

1. Steel structures, Controlling behaviour through design: R. Englekirk, Wiley
2. Design of steel structures: Breslar, Lin and Scalzi, John Willey, New York.
3. Design of steel structures: Mac. Ginely T.
4. Structural steel work: Reynolds TJ., Kent L.E. &Lazenby, D.W., English University Press.

PE-MTSE131- Advanced Solid Mechanics

Course Code	Course Name
PE-MTSE131	Advanced Solid Mechanics

Course pre-requisites	

Course Objectives

The objectives of this course are

1. This course will expand on the basic principles established in Solid Mechanics.
2. Methods of three-dimensional stress and strain analysis will be extended to allow the student to obtain solutions using analytical and/or numerical methods. These will include the analyses of principal stresses and strains, three dimensional Mohr's circles, strain gauge experimentation and failure criteria.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Define stress/strain correlations for an engineering problem
2. Derive governing differential equations to solve engineering problem
3. Establish links between theoretical and practical applications; identify problems and formulate solution strategies

Course Content

Module No.	*Details*	*Hrs.*
1	**Revision:** Stress transformation and strain transformation at a point in an elastic body, 3-D Problems, rigid body translation and rotation of an element in space. Generalized Hook's law, separation of elastic strain rigid body displacement for a general displacement field u,v,w. Principal stresses and strains.	07
2	**Two dimensional problems in elasticity:** Plain stress and Plain strain problems. Differential equations of equilibrium and compatibility equations. Boundary conditions, stress functions.	04
3	**Problems in rectangular coordinates:** Polynomial solutions, cantilever loaded at the end, simply supported beam under uniformly distributed load, linear loading.	03
4	**Two dimensional problems in polar coordinates:** Stress distribution symmetrical about an axis, pure bending of curved bars, displacement for symmetrically loaded cases, bending of curved bars by forces at end. Effect of a circular hole in a plate under in-plane loading. Concentrated load at a point of a straight boundary. Stresses in circular disk. Forces acting on the end of	07

	wedge.and friction plate selection	
5	**Three dimensional problems in elasticity:** Differential equation of equilibrium in 3D, condition of compatibility determination of displacement, principle of superposition, uniqueness theorem, problems of rods under axial stress bar under its own weight pure bending of prismatic rods, torsion of prismatic bars of elliptical rectangular triangular and other sections. Membrane analogy-torsion of narrow rectangular bars .torsion of hollow shafts and thin tube.	07
6	**Bending of prismatic bars as a problem of elasticity in 3D:** Bending of cantilever stress functions circular and rectangular section non-symmetrical cross section shear centre for different cross section of bars calculation of deflection.	04
7	**Energy theorems**: Application of complimentary energy theorems to the problems of elasticity. **Failure theories:** Types of theories of failure and their application Maximum principle stress theory Maximum shear stress theory Maximum principle strain theory Maximum total strain energy theory Distortion energy theory	04

Text Books

1. C.K.Wang (December 1963) , "Applied Elasticity", MCGRAW-HILL INC.,US, ISBN 0070681252, 537 pages
2. Timoshenko (1970), "Theory of Elasticity", McGraw-Hill Publishing Company, ISBN 0070858055,608 pages
3. Shames I. H (1964), "Mechanics of Deformable Solids", Prentice Hall India
4. Srinath L. S (2009)," Advanced mechanics of solids", Tata McGraw-Hill Education, ISBN 0070139881, 504 pages
5. Mohammad Ameen (January 2008), "Computational Elasticity: Theory of Elasticity, Finite and Boundary Element Methods" Alpha Science International Ltd, ISBN: 978-1842654491,532 pages

Reference Books

1. J. Chakrabarti (2006), "Theory of plasticity", Elsevier/Butterworth-Heinemann, ISBN 0750666382, 882 pages
2. Timoshenko S (2004), "Strength of Materials Vol – I & II", CBS Publishers & Distributors, ISBN 8123910304 ,298 pages
3. Boresi A. P (2002)," Advanced mechanics of materials", John Wiley & Sons, ISBN 0471438812,681 pages

PC-MTSE151-Advanced Concrete Lab

Course Code	Course Name
PC-MTSE151	Advanced Concrete Lab

Course pre-requisites	

Course Outcomes

Upon successful completion of the course, students should be able to
1. Design high grade concrete and study the parameters affecting its performance.
2. Conduct Non Destructive Tests on existing concrete structures.
3. Apply engineering principles to understand behaviour of structural/ elements

Course Content

Practical No.	***Details***
1	Mix design of high strength concrete
2	Stress-Strain curve of high strength concrete
3	Cube compressive strength, cylindrical comp. strength of concrete and relation between them.
4	Split tensile strength and Modulus of rupture
5	A. Flexural strength of beam. B. Shear strength of beam
6	Non-Destructive Tests A. Study of Rebound Hammer test on concrete B. Ultrasonic Pulse Velocity test on Concrete C. Study of half-cell Potentiometer and measurement of corrosion in RCC. D. Core removal from concrete structure and compression testing E. Carbonation Test on concrete

Report on experiments performed as detailed above shall be submitted as laboratory work

SE-MTSE152- Numerical Analysis Lab

Course Code	Course Name
SE-MTSE152	Numerical Analysis Lab

Course pre-requisites	

Course Outcomes

Upon successful completion of the course, students should be able to

1. Find Roots of non-linear equations by Bisection method and Newton's method.
2. Do curve fitting by least square approximations
3. Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss - Jorden Method
4. Integrate Numerically Using Trapezoidal and Simpson's Rules
5. Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge- Kutta Method.

Course Content

Practical No.	***Details (Atleast 8 to be performed)***
1	Find the Roots of Non-Linear Equation Using Bisection Method
2	Find the Roots of Non-Linear Equation Using Newton's Method
3	Curve Fitting by Least Square Approximations.
4	Solve the System of Linear Equations Using Gauss - Elimination Method
5	Solve the System of Linear Equations Using Gauss - Seidal Iteration Method
6	Solve the System of Linear Equations Using Gauss - Jorden Method.
7	Integrate numerically using Trapezoidal Rule.
8	Integrate numerically using Simpson's Rules.
9	Numerical Solution of Ordinary Differential Equations By Euler's Method
10	Numerical Solution of Ordinary Differential Equations By Range- Kutta Method

Report on experiments performed as detailed above shall be submitted as laboratory work

IK-MTMD101: Constitution of India (Indian Knowledge System Course)

Course Code	Course Name
IK-MTMD101	**Constitution of India**

Course pre-requisites	

Course Objectives
Students will be able to: 1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. 2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. 3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution
Course Outcomes
Students will be able to: 1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. 2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. 3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. 4. Discuss the passage of the Hindu Code Bill of 1956

Course Content

Module No.	***Details***	***Hrs.***
1	➢ History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	5
2	➢ Philosophy of the Indian Constitution: Preamble Salient Features	5
3	➢ Contours of Constitutional Rights & Duties: ➢ Fundamental Rights ➢ Right to Equality ➢ Right to Freedom ➢ Right against Exploitation ➢ Right to Freedom of Religion ➢ Cultural and Educational Rights ➢ Right to Constitutional Remedies ➢ Directive Principles of State Policy ➢ Fundamental Duties.	5
4	➢ Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume -II][194] ➢ Parliament	5

	➢ Composition ➢ Qualifications and Disqualifications ➢ Powers and Functions ➢ Executive ➢ President ➢ Governor ➢ Council of Ministers ➢ Judiciary, Appointment and Transfer of Judges, Qualifications ➢ Powers and Functions	
5	➢ Local Administration: ➢ District's Administration head: Role and Importance, ➢ Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. ➢ Pachayati raj: Introduction, PRI: Zila Pachayat.	5
6	➢ Elected officials and their roles, CEO Zila Pachayat: Position and role. ➢ Block level: Organizational Hierarchy (Different departments), ➢ Village level: Role of Elected and Appointed officials, ➢ Importance of grass root democracy	5
7	➢ Election Commission:Role and Functioning. ➢ Chief Election Commissioner and Election Commissioners. ➢ State Election Commission: Role and Functioning. ➢ Institute and Bodies for the welfare of SC/ST/OBC and women	6

Reference Books
1. The Constitution of India, 1950 (Bare Act), Government Publication. 2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015. 3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

SEMESTER II

PC-MTSE201 Finite Element Analysis

Course Code	Course Name
PC-MTSE201	Finite Element Analysis

Course pre-requisites	Advanced Solid Mechanics

Course Objectives

The objectives of this course are
1. To understand mathematical modelling and numerical formulation of engineering problems.
2. To learn about concepts of elements and their properties.
3. To understand finite element methods and its application for solution of structural mechanics problems.
4. To understand finite element methods and its application for solution of non-linear and dynamics problems

Course Outcomes

Upon successful completion of the course, students should be able to
1. Use Method of Weighted Residuals, Rayleigh-Ritz Method.
2. Formulate Interpolation function for 1-d, 2-d & 3-d elements.
3. Solve 1-d & 2-d problems using finite element approach.
4. Solve non-linear and dynamics problems using finite element approach

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction** Mathematical Modeling of Engineering Problems, Types of governing equations, Solution methodologies, numerical modeling, approximate method of analysis – method of point collocation, method of collocation by sub region, method of least squares, Galerkin's method, Rayleigh-Ritz method	05
2	**Finite Element Method:** General Steps in FEM, Direct approach, variational approach, energy approach and weighted residual approach.	06
3	**Finite Elements and Interpolation Functions:** Interpolation functions, one two and three dimensional elements – linear, quadratic, Cubic and Lagrangian Interpolation function, Isoparametric elements, Serendipity elements Shape Functions, Sub-Parametric and super parametric elements, Infinite elements	06
4	**One Dimensional Finite Elements:** Linear spring, Truss element, Space truss, Beam Element.	03

5	**One Dimensional Finite Elements:** Application of elements for analysis of beams, trusses, plane frames and grids Multilinear springs, compression and tension only springs.	07
6	**Two Dimensional Finite Elements:** Two dimensional stress analysis, CST element for plane stress and plane strain, triangular elements for axi-symmetric analysis, rectangular elements, isoparametric formulation	05
7	**Introduction to Non-Linear Analysis:** Geometric Non-Linearity-Geometric Stiffness of an Axial Element. Stability of Bar- Spring System. General Formulation of Geometrically Non Linear Problem. Geometric Stiffness of Beam-Column and Triangular Elements. Non-Linear Material Behavior.	04
TOTAL		36

Text Books

1. Desai Y.M, Eldho T.I, Shah A.H (2011) ,"Finite Element Method With Applications in Engineering ", Pearson Education India , ISBN 8131724646 , 492 pages
2. Krishnamoorthy C.S, (1994), "Finite Element Analysis", Tata McGraw Hill, ISBN 0074622102, 710pages
3. William B. Bickford, (1990),"First Course in The Finite Element Method", ISBN 0256079730, 649 pages
4. Rajshekaran S. (2008), "Finite Element Analysis", Wheeler publishing, ISBN 8121923149, 630 pages

Reference Books

1. O. C. Zienkiewicz,K. Morgan (2000), "Finite Elements and Approximation", Dover publications, ISBN 0486453014, 352 Pages
2. J.N. Reddy, (2008), "Non linear Finite Element Analysis", Oxford University Press, ISBN 0195692039,
3. Cook R.D., Malkus D.S. and Plesha,(2001), "Concepts and Applications of Finite Element Analysis", John Wiley & Sons (Asia) PvtLtd.ISBN0471356050, 736 pages.
4. Weaver W and Johnston P.R., "Finite Element for Structural Analysis", Prentice Hall

PC-MTSE202 Earthquake Engineering

Course Code	Course Name
PC-MTSE202	Earthquake Engineering

Course pre-requisites	Structural Dynamics

Course Objectives

The objectives of this course are

1. The importance of the earthquake engineering.
2. Basics of earthquake engineering : causes of earthquake, types of earthquakes, seismic waves, structure of earth, and measurement of earthquake.
3. Concept of Response Spectrum: ground motion parameters, response spectrum, characteristics of response spectrum, and methods of construction of response spectrum.
4. Analysis of the structure subjected to earthquake ground motion. Provisions of IS 1893-2016 and calculation of earthquake loads
5. Importance of ductility in earthquake resistant design of structures and provisions of IS 13920 (2016)
6. Practical knowledge by conducting some basic experiments in structural dynamics.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Describe earthquake phenomenon, their causes and effects on structures
2. Apply knowledge of structural dynamics in evaluation of structural response to earthquake ground motion
3. Characterize the ground motion in the form of response spectra and construct response spectra and evaluate the structural response to earthquake ground motion using response spectra
4. Carry out Seismic analysis of structure, incorporating the provision of IS -1893-2016; and IS 13920- 2016

Course Content

Module No.	*Details*	*Hrs.*
1	**Review of Structural dynamics:** Review of dynamic analysis of SDOF and MDOF systems subjected to various types of dynamic loads including earthquake ground motion.	02

2	**Seismological background:** Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, intensity and magnitude of earthquake, measurement of ground motion, seismogram, earthquake frequency, local site effects, seismo-tectonics and Seismicity of India. Effect of near-field and far-field earthquake ground motions	04
3	**Characterization of ground motion:** Earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra. peak structural response from the response spectrum, response spectrum characteristics, construction of site-specific response spectra.	05
4	**Deterministic earthquake response:** Types of earthquake excitation, lumped SDOF elastic systems. translational excitation, lumped MDOF elastic systems, systems with distributed mass and elasticity, translational excitation, time history analysis, multi storied buildings with symmetric plans, multi storied buildings with unsymmetric plans, torsional response of unsymmetric plan building, distributed - parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQC combination of modal responses. **Earthquake response of inelastic buildings:** Allowable ductility and ductility demand, building with weak or soft storey.	07
5	**I. S. code method of seismic analysis:** Equivalent static method and its limitation, response spectrum method, IS 1893-2016 provisions for seismic analysis of buildings and water towers, seismic evaluation and retrofitting, types of structural system used in building to resist earthquake loads.	07
6	**Seismic Design Considerations for RC Buildings:** Choice of earthquake resisting systems for low-rise, medium-rise and high-rise buildings, Principles of member design, ductile detailing, Earthquake Resistant Design of beams and columns, Design of Beam-Column Joints, Design of Shear Walls with ductile detailing, Drift and lateral stability criteria.	06
7	**Seismic Design Considerations for Steel Structures:** Performance of steel structures in the past earthquakes, Design philosophy for steel structures, Capacity design concept, Ductility of steel buildings, Seismic design and detailing of Moment Resistant Frames (MRFs); Beams and columns, Panel Zones and Connections, Seismic design and detailing of Concentric Brace Frames (CBFs)	05

Text Books
1. Dynamics of Structures by Anil K Chopra, Prentice Hall of India 2. Structural Dynamics of Earthquake Engineering: Theory & Application using MATHEMATICA & MATLAB by S Rajasekaran, Woodhead Publishing Ltd. 3. Earthquake Resistance Design & Risk Reduction by David Dowrick, Wiley India 4. Seismic Analysis of Structures by T K Dutta, John Wiley & Sons (Asia) Pvt.Ltd 5. Seismic design of RC buildings : Theory and Practice by S.N.Manohar, S.N.Madhekar ,Springer (2015) 6. Earthquake Resistant Design of Structures by Manish Shrikhande, Pankaj Agrawal 7. I.S. Codes No. 1893, 4326, 13920 (All latest codes)
Reference Books
1. Fundamentals of Earthquake Engineering by N M Newmarks& E Rosenblueth, Prentice Hall 2. Earthquake Spectra & Design by N M Newmarks& W J Hall, Earthquake Engineering Research Institute, Berkeley, California 3. Dynamics of Structures by Clough &Penzien, McGraw-Hill, Computers & Structures 4. Fundamentals of Earthquake Engineering by Amr S Elnashai& Luigi Di Sarno, Wiley India 5. Fundamentals of Earthquake Resistant Construction by Ellis L Krinitzsky, James P Gould & Peter H Edinger, Wiley India 6. Elementary Seismology by C R Richter, W.H. Freeman & Company, San Francisco

PE-MTSE211 Bridge Engineering

Course Code	Course Name
PE-MTSE211	Bridge Engineering

Course pre-requisites	Design of Prestressed Concrete Structure

Course Objectives

The objectives of this course are

1. To learn IRC Loading criteria
2. To understand fundamentals of Bridge design
3. To understand the principles of long span bridge design

Course Outcomes

Upon successful completion of the course, students should be able to

1. Understand the different loadings on Bridges & the components of different types of Bridges.
2. Understand the behaviour and suitability of various bridge types
3. Analyse the different types of bridges and design their various components.
4. Understand the different construction methods for bridge construction and their impact on bridge design.
5. Apply the Indian code provisions for analysis and design of bridge components.

Course Content

Module No.	*Details*	*Hrs.*
1	Classification and components of bridges, historical perspective, layout and planning, investigations for bridges, choice of type of the bridges, conceptual bridge design, bridge aesthetics. Bridge appurtenances.	05
2	Loading standards for highway and railway bridges (IRC, IRS)	05
3	Analysis and design of RC and PSC bridge decks: Slab culvert bridges, slab-and-beam bridges, load distribution in slabs and beams, behavior of skew bridge decks, box girder bridges	07
4	Behavior, analysis and design of steel bridge decks: girder bridges, truss bridges, arch bridges.	05
5	Design of bearings, substructure and foundations – piers and abutments of different types, shallow and deep foundations –design and constructional aspects	06
6	Modern methods of construction of concrete, steel and composite bridges, their impact on analysis and design, construction stage analysis.Introduction to analysis and design of long span bridges: suspension and cable stayed bridges, balanced cantilever construction, segmental construction.	06
7	Introduction to seismic design of bridges	02

Text Books
1. Raju N. K (1988), "Design of Bridges", Oxford and IBH Publishing, ISBN 8120417410. 2. Victor D. J (2007), "Essentials of Bridge Engineering" , Oxford & IDH, ISBN 8120417178, 495 pages. 3. T.R Jagdeesh& M.A Jayaram,(2009), " Design of Bridge Structures", Prentice Hall India Private Ltd. New Delhi, 360 pages
Reference Books
1. Ponnuswamy S (2008), "Bridge engineering", Tata McGraw-Hill Education, ISBN 0070656959, 747 pages 2. Raina V.K(1994), " ConcreteBridge Practice", Tata McGraw Hill, ISBN 0074623621, 756 pages 3. Tomlinson M.J (2001), "Foundation Design And Construction " , Prentice Hall , ISBN 0130311801, 584 pages 4. FIB recommendations.

PE-MTSE212 Analysis of Offshore Structures

Course Code	Course Name
PE-MTSE212	Analysis of Offshore Structures

Course pre-requisites	

Course Objectives
The objectives of this course are to understand wave and ocean structure interaction under various types of Hydrodynamic and aerodynamic loading
Course Outcomes
Upon successful completion of the course, students should be able 1. Wave generation process 2. Design aspects of ocean and coastal structure. 3. Short and long term statistics of wind, wave 4. Different types of offshore structures 5. Codes of Practices for design of ocean structures

Course Content

Module No.	*Details*	*Hrs.*
1	Wave Mechanics: Wave generation process, small and finite amplitude wave theories.	05
2	Types of offshore structures, planning and design aspects, Loads and structural forms of different types of offshore structures.	05
3	Wave loads regular and random, loads due to wind, tides and currents. Operational environment. Wind forces: Wave forces on vertical, inclined cylinders, structures – current forces and use of Morison equation.	05
4	Short and long term statistics of wind; static wind load; effect of size, shape and frequency; Aerodynamic admittance function and gust factor, spectral response due to wind for various types of structures;	05
5	Static and dynamic analysis of fixed structures.	06
6	Different types of offshore structures, foundation modeling, structural modeling, Static method of analysis, Foundation analysis, Dynamics analysis of offshore structures, Design of platforms, Jacket tower and mooring cables and pipe lines	05
7	Codes of Practices (latest versions) such as API R-2A, bureau Veritas	05
TOTAL		36

Reference Books

1. Brebbia C.A. and Walker (1978): Dynamic Analysis of offshore structures", Newness butterworth, London, 1978.
2. Sarpakaya T. and Isaacson M.(1981): Mechanics of Wave Forces on Offshore Structures", Van NostrandRainhold, NewYork, 1981.
3. Hallam M.G., Heaf N.J. and Wootton, L.R. (1978): "Dynamics of Marine Structures", CIRIA Publicartions, Underwater Engg. Group, London, 1978.
4. Graff W.J. (1981): "Introduction to Offshore Structures", Gulf Publishing Co., Houston, Texas, 1981.
5. Clough R.W. and Penzien J. (1992): "Dynamics of Structures", IInd Edition, McGraw hill, 1992.
6. Simiu E. and Scanlan R.H. (1978): wind effects on Structures", Wiley,New York, 1978.
7. Codes of Practices (latest versions) such as API R-2A, bureau Veritas etc.

PE-MTSE213 Deterioration, Instrumentation and Rehabilitation of Structures

Course Code	Course Name
PE-MTSE213	Deterioration, Instrumentation and Rehabilitation of Structures

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To impart knowledge on laboratory / field testing of Civil Engineering Structures.
2. To expose students to state-of-the-art Instrumentation for Structural analysis results and techniques for Rehabilitation of RC, Steel and Masonry structures.
3. To inculcate aptitude for quality control and strengthening of civil structures.

Course Outcomes

Upon successful completion of the course, students shall be able to

1. Present methods of laboratory / field testing of Civil Engineering Structures.
2. Identify cracks in buildings: causes and remedial measures.
3. Identify and apply the techniques for rehabilitation / strengthening of RC, Steel and Masonry structures.

Course Content

Module No.	***Details***	***Hrs.***
1	Study of various transducers, Principle of their working, displacement, velocity, acceleration etc, strain gauge & piezoelectric type of transducers.	10
2	Strain measurements, strain gauges (static and dynamic), calculation of stresses and loads from measurements of strains and deflections.	04
3	Special concrete constructions: fibre reinforced concrete; fibre wrapping, Special concrete like lightweight concrete, ferro cement, fly ash concrete, High performance concrete, concrete admixtures.	05
4	Corrosion of steel and concrete: Theory and prevention	05
5	Cracks in buildings: causes and remedial measures.	05
6	Techniques for Rehabilitation of RC, Steel and Masonry structures	05
7	Non-destructive testing of concrete, steel structures, Various NDT tests, codal provisions, Proof Load testing.	06
TOTAL		36

Reference Books
1. Singh, Sadhu; Experimental Stress Analysis, Khanna Publishers. 2. Soisson, H.E.; Instrumentation in Industry; John Willey & Sons; NY; 1975 3. Boomfield, J.P.; Corrosion of Steel in Concrete; E& FN SPON; 1997 4. Ganesan, T.P.; Model Analysis of Structures; University Press; 2000 5. IS: 13935; Repair and Seismic Strengthening of Bulidings- Guidelines; Bureau of Indian Standard; New Delhi; 1993 6. SP: 25; Causes and Prevention of Cracks in Buildings; Bureau of Indian Standard; New Delhi; 1984

PE-MTSE221 Advanced Design of Concrete Structures

Course Code	Course Name
PE-MTSE221	Advanced Design of Concrete Structures

Course pre-requisites	

Course Objectives
The objectives of this course are 1. To introduce the students to different design philosophies applied to reinforced concrete structures. 2. To introduce the students to the design of special reinforced concrete structures.
Course Outcomes
Upon successful completion of the course, students should be able to 1. Analyse the structure using the concept of limit design, analyse slabs using yield line analysis and design various RCC elements using ultimate load method and limit state method. 2. Design special reinforced concrete structures such as silos and bunkers, folded plate roofs, circular cylindrical shell roofs etc.

Course Content

Module No.	***Details***	***Hrs.***
1	**Ultimate Load analysis of concrete structures:** Stress strain characteristics of concrete and reinforcing steel, review of elastic theory and ultimate strength theory, Whitney's rectangular stress block, analysis and design of singly and doubly rectangular and tee sections.	04
2	**Concept of limit design:** Introduction to the concept of limit design. Moment curvature relationship of reinforced concrete sections, rotation capacity of sections, ultimate load analysis by Cambridge and Baker's method. Application to continuous beams and simple rectangular portal frames.	06
3	**Yield line analysis:** Yield line analysis of slabs, virtual work and equilibrium method. Application to orthotropically reinforced rectangular slabs with various boundary conditions under uniformly distributed loads.	05
4	**Reinforced concrete design by limit state method:** Review of limit state method as per IS 456:2000. Limit state collapse in flexure, direct compression, compression with bending, shear and torsion, limit state of serviceability for deflection and cracking, applications to beam-slab system of typical residential, office, industrial floors and rectangular portal frames and gable ended frames.	05
5	**Design of different slab systems:** Analysis and Design of Two-way Slab System without Beams (Flat Plate and Flat Slabs), Two-way Slabs with Beams.	05
6	**Silos and bunkers:** Lateral pressure as per Janssen's and Airy's theories, design consideration for square, rectangular and circular shapes, design of hoppers and supporting structures.	05
7	**Large span roofs:** Analysis of Folded plate roofs- Whitney's method,	06

	Simpson's method. Circular cylindrical shell roofs- beam theory of cylindrical shells.	

Text Books

6. G. S. Ramaswamy, (2005), "Design and Construction of Concrete Shell Roofs ", CBS Publishers & Distributors, ISBN 8123909905.
7. Karve S.R. and Shah V. C (1994), "Design of Reinforced Cement Concrete Structures using Limit State Approach", Structures Publishers, ASIN B007I29ARC.
8. Krishna Raju (2016), Advanced Reinforced Concrete Design (IS : 456-2000) , CBS Publishers & Distributors, ISBN: 9788123929606, 8123929609, 488 Pages.

Reference Books

5. V. Ramkrishnan & P. D. Arthur (1964), "Ultimate Strength Design for Structural Concrete", Wheeler Publishing Co, Pitman, 264 pages.
6. P. C. Verghese, (2005), "Advanced Reinforced Concrete Design", PHI Publishers, ISBN-10: 812032787X, 560 pages.

PE-MTSE222 Theory of Plates

Course Code	Course Name
PE-MTSE222	Theory of Plates

Course pre-requisites	

Course Objectives

The objective of this course is to enable students to acquire the analytical and numerical methods needed for the solution of different types of plates and thin slabs.

Course Outcomes

Upon successful completion of the course, students should be able to

1. Express various types of loadings on a plate in terms of Fourier series.
2. Apply the Navier and Levy solutions for rectangular plates with different boundary conditions and loading.
3. Obtain solutions for circular plates.
4. Use finite difference methods to obtain plate deflections and moments, and also apply available finite-element programs to plate problems.

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction**: Introduction to theory of plates with small and large deflections, distinction between plate and shell action.	03
2	**Pure bending of thin plates**: Curvature at a point, circle of curvature, moment curvature relationships, relationship between twisting moment and twist of surface.	05
3	**Classical plate theory**: Classical Small-Deflection Theory of Thin Plates, Plate Equation in Cartesian Coordinate System, Boundary Conditions of Kirchhoff's Plate Theory	05
4	**Symmetrical bending of thin circular plates with small deflections under axi-symmetrical transverse loads:** Differential Equation of Circular Plates, Circular plates different support conditions, plates with overhangs, plates with coaxial circular opening. Circular plates subjected to different loads.	06
5	**Small deflection theory for laterally loaded thin rectangular plates**: Rigorous Solution of Plate Equation, Rectangular plates subjected to transverse load, Transverse shears and bending moments, corner effects	06
6	**Series solutions of governing differential equation:** Various	05

	support conditions, Navier's and Levi's solution for uniformly distributed , uniformly varying load and concentrated loads	
7	**Numerical technique for solution of plate equations:** Use of numerical techniques for the solution of plates, concept of influence surface; study of simply supported plate with continuous edge moments,	06
TOTAL		36

Text Books
1. D Timoshenko, (1989), ‘‘Theory of Plates and Shells”, McGraw-Hill, 580 pages 2. Varadan T.K and Bhaskar K, “Analysis of Plates Theory and Problems”, Narosa Publishing House, ISBN 8173192561, 198 pages 3. N.K. Bairagi(1984),” Plate Analysis”, Khanna Publishers, 310 pages 4. Bhavikatti (2015), “Thoery of Plates & Shells”, New Age International
Reference Books
1. R.Szilard(1974), “Theory and Analysis of Plates, “John Wiley & Sons, ISBN 0471429899,1024 pages

PE-MTSE223 Reliability Based Civil Engineering Design

Course Code	Course Name
PE-MTSE223	Reliability Based Civil Engineering Design

Course pre-requisites	

Course Objectives

The objectives of this course are

1. Random variables, probability and statistics, Monte Carlo simulation, Variation reduction techniques
2. Concept of failure of a structure
3. Reliability based design , Application of reliability analysis to structural members and structural systems

Course Outcomes

Upon successful completion of the course, students should be able

1. Determine probability distributions, correlation between random variables
2. Use Monte Carlo simulation, variation reduction techniques and find different reliability indices
3. Perform Reliability based design and Apply reliability based analysis to structural members and structural systems

Course Content

Module No.	*Details*	*Hrs.*
1	**Revision:** General introduction to structural safety and reliability and reliability. Concept of uncertainty in reliability-based analysis and design. Course outline.	10
2	• Random variables. • Probability axioms and probability functions. • Conditional probability. • Common probability distributions. • Correlation between random variables. • Random vectors and functions of random variables	04
3	• . Monte Carlo simulation, Variation reduction techniques.	05
4	• Concept of failure of a structure. • Reduced variable space and basic definition of reliability index. • First order second moment index. • Hasofer-Lind reliability index.	06

	• Rackwitz-Fiessler reliability index.	
5	• Reliability-based design code and its development. • Load and resistance factor design format. • Calibration of partial safety factors. • Uncertainty models for load and resistance.	05
6	• Second order reliability method. • Bayesian approach. • Response surface approach. • Time-varying reliability. • Summary.	06
7	Application of reliability analysis to structural members and structural systems	06
TOTAL		36

Text Books
1. Srinath L., Raghavan. M., Ingaiah K., Gargesha G, Pant B. and Ramachandra K., Experimental Stress Analysis, Tata McGraw Hill Company, New Delhi, 1984. 2. Dally J. W. and Riley W. F., Experimental Stress Analysis, McGraw Hill Book Co. 1977.
Reference Books
1. Ang, A.H.S. & Tang, W.H. (1975), “Probability Concepts in Engineering Planning and Design: Volume 1 - Basic Principles”, Wiley, New York, ISBN 3857480939 2. Benjamin, J.R. & Cornel, C.A. (1970), “Probability, Statistics and Decision for Civil Engineers”, McGraw-Hill, New York, 684 pages 3. Ellingwood, B. et al.(1980), “Development of a Probability Based Load Criterion for American National Standard A58”, US Department of Commerce, Special Publication NBS-577. 4. Ranganathan R. (1990), “Reliability Analysis and Design of Structures”, McGraw-Hill, New Delhi, ISBN 0074603140, 354 pages

PE-MTSE224 Theory of Shells

Course Code	Course Name
PE-MTSE224	Theory of Shells

Course pre-requisites	

Course Objectives
The objective of this course is to enable students to acquire the analytical and numerical methods needed for the solution of different types of shells

Course Outcomes
Upon successful completion of the course, students should be able to 1. Understand the force flow in shell structures and be able to manually calculate stresses, deformations and buckling loads of elementary shell shapes. 2. Understand the scientific approach to deriving and solving the governing differential equations and will be able to make, interpret and check analyses of shell structures.

Course Content

Module No.	*Details*	*Hrs.*
1	Introduction to structural behavior of thin shells, membrane and bending actions.	04
2	**Mathematical representation of a shell surface:** Principal curvatures, Gauss curvature. Classification of Shells	05
3	**Membrane theory of thin shells:** Stress resultants, application to cylindrical shell under symmetric loads and surfaces of revolution under axi-symmetric loads	05
4	**Bending theory of open circular cylindrical shells:** With special emphasis to approximate theories of Finsterwalder and Schorer theories: Introduction to DKJ Flugge and other exact theories: Different boundary conditions for single and multiple shells.	05
5	**Bending theory of closed cylindrical shell:** Stiffness coefficients at free edges along radial and rotational directions; Bending theory of spherical shells. Geckeler's approximations, Stiffness coefficients	05
6	**Moment theory of shells of revolution:** Introduction, Governing equations, Shells of revolutions under axisymmetrical loads, Approximate method for solutions of governing equations.	06
7	**Approximate theories of shell analysis and their application:** Introduction, the semi membrane theory of cylindrical shells, The	06

	Donnel-Mushtari Vlasov theory of thin shells, Theory of shallow shells, Edge effects.	
TOTAL		36

Reference Books
1. Stephen Timoshenko, S. Woinowsky-Krieger (2003), "Theory of Plates and Shells", Textbook Publishers, ISBN 0758184093, 580 Pages 2. R. Chandrashekara, (1987), "Analysis of Thin Concrete Shells", McGraw Hill Book Co, ISBN 0074515683, 288 Pages 3. Ramaswamy G.S., (1984), "Design and Construction of Concrete Shell Roofs", Krieger Pub Co; ISBN 0898740010, 745 Pages 4. N.K. Bairagi, (1990), "Shell Analysis", Khanna Publishers, Delhi , 5. V.V. Novozhilov, (1970), "Thin Shells", Kluwer Academic Publisher, ISBN 900164550X, 429 Pages 6. Bhavikatti (2015), "Theory of Plates & Shells", New Age International

OE-MTSE201 Operational Research

Course Code	Course Name
OE-MTSE201	Operational Research

Course pre-requisites	

Course Objectives

1. To impart knowledge in concepts and tools of Operations Research.
2. To understand mathematical models

Course Outcomes

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Course Content

Module No.	*Details*	*Hrs.*
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	05
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method	07
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	06
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models	07
5	- Probabilistic inventory control models - Geometric Programming.	05
6	-Sensitivity analysis - parametric programming	03
7	Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	03

Text / Reference Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

OE-MTSE202 Legal Aspects in Construction

Course Code	Course Name
OE-MTSE202	Legal Aspects in Construction

Course pre-requisites	

Course Objectives
1. To describe fundamentals of common law and understand bid cycle
2. To explain Indian contract act and demonstrate the concept contract administration
3. To summarize students with Laws applicable to construction activity
4. To interpret various acts in connection with construction activities

Course Outcomes
1. Use of law in general and Practice tendering process
2. Utilize Indian contract act and its provision with respect to construction
3. Implement contract administration and Use International contract provisions
4. Use labor laws and other Acts applicable to construction site

Course Content

Module No.	*Details*	*Hrs.*
1	Law and common man	04
2	Construction through contracts ;Types, critical comparison, bid cycle, tender and contract documents, contract conditions, study of contract documents of State PWD and CPWD	06
3	Indian Contract Act; Need, provisions, scope for modifications / improvement	06
4	Contract administration Deviations and extras, claims and their management, disputes and dispute resolution methods, Arbitration and Conciliation Act.	06
5	Laws applicable to construction activity need and broad provisions of : Industrial Disputes Act, Workmen's Compensation Act ,	05
6	Employer's Liability Act, Payment of wages Act, Contract Labour Act, Minimum Wages Act, Inter-state Migrant workmen act, BOCW Act and other acts introduced from time to time	05
7	FIDIC contracts; Contract administration;	04

Text / Reference Books
1. Bajirao Shankarrao Patil (1986); “Legal Aspects of Building & Engineering Contracts” S.B. Patil. 471p. 2. G. T. Gajria, Kishore Gajria (2000); “Law Relating To Building & Engineering Contracts In India”, Lexisnexis Butterworths India. ISBN 13: 9788187162162. 538p. 3. P. C. Markanda, Naresh Markanda (2013); “Law Related To Arbitration and Conciliation” Lexisnexis Butterworths India. ISBN 13: 9788180388132. 1570p. 4. Edward R. Fisk, Wayne D. Reynolds (2013); “Construction Project Administration” Pearson Education. ISBN 13: 9780133149258. 432p. 5. Indian Contract Act 1872 6. Arbitration Conciliation Act 1996.4. All Referred Bare Acts 7. CPWD Manual Volume I & II, A Handbook For Government Officials And Contractors

SE-MTSE201 Earthquake Engineering and Model Testing Lab

Course Code	Course Name
SE-MTSE201	Earthquake Engineering and Model Testing Lab

Course Outcomes

Upon successful completion of the course, students should be able to

1. understand the different philosophies and concepts of performance based seismic engineering and analyse the non-linear properties of structural elements
2. understand the concept of and perform non-linear static and dynamic analysis for seismic performance
3. Understand and apply techniques for testing model under free and forced vibration.

Contents

1.	Concepts of Earthquake Resistant Design: Force based vs. displacement-based design, performance-based design, seismic input characteristics and their effect on seismic design, study of ASCE 41
2.	Modelling for Performance Based Design: Back-bone curve, Idealized component models, estimation and modelling of stiffness, strength and ductility of RC, and steel structures
3.	Methods for non-linear seismic analysis of Structures Nonlinear static and dynamic analysis methods : NLSPA, NLTH (selection and scaling of time histories –ASCE-41, PEER database)
4.	Direct Displacement-Based Design: Structure performance objectives, performance levels (structural and NSE) and limit states; P-Delta effects; Torsion; Capacity design for directdisplacement-based design.
5.	Performance-Based Design: Structural and non-structural performance, quantification of performance
6.	Free vibration analysis on model : Natural frequency and Damping of frames –(Time domain)
7.	Forced vibration analysis on shake table : Response Analysis of Frames subjected to ground motion

PC-MTSE202 Structural Engineering LAB

Course Code	Course Name
PC-MTSE202	Structural Engineering Lab

Course pre-requisites	

Course Outcomes
Upon successful completion of this course, students will be able to : 1. Design structure using Latest relevant IS codes. 2. Design structure using latest relevant software.
Practicals
1. Design and Detailed drawing of complete structure by student using relevant Software as well as Latest IS codes.

AE-MTSE201 English for Research Paper Writing

Course Code	Course Name
AE-MTSE201	English For Research Paper Writing

Course pre-requisites	

Course Objectives
Upon successful completion of the course, students should be able to 1. Understand that how to improve your writing skills and level of readability. 2. Learn about what to write in each section. 3. Understand the skills needed when writing a Title

Course Content

Module No.	*Details*	*Hrs.*
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	03
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts	03
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	03
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an introduction, skills needed when writing a Review of the Literature	03
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	03
6	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.	03

Text Books

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

AE-MTSE202 Project Planning and Management

Course Code	Course Name
AE-MTSE202	Project Planning and Management

Course pre-requisites	Construction Management

Course Objectives

1. Understand the roles and responsibilities of civil and structural engineer in practice.
2. Understand the important activities and the sequence in which they are to be carried out
3. Learn the importance of accuracy and correctness in work and how this is achieved.
4. Understand the skills required by a civil and structural engineer

Course Outcomes

1. Have a clear understanding of the stages and activities in project execution
2. Draw upon the academic knowledge gained in college to achieve efficiency in actual practice.
3. Appreciate the developments in Civil and Structural engineering and the continuous upgradation of knowledge and skills.
4. To approach industry with enthusiasm, motivation, confidence and a strong pride in the profession

Course Content

Module No.	*Details*	*Hrs.*
1	**Introduction and Early work** • Roles and challenges of the Civil and structural engineer • Planning and scheduling for a project • Budget and Cost control • Surveying activity for a project • Geotechnical Investigation for a project	05
2	**Basic Design of a Project** • Plot Layout Planning, • Construction strategy • Tendering and Contract strategy for a project • Design basis for the project • Important codes, specifications and standards • Site Development	05
3	**Global design** • Important engineering principles and concepts • Preliminary structural analysis and design • Quantity and cost estimation and monitoring • Piling in a project • Material Estimation for ordering	05

	• Construction strategy for a project	
4	**Detailed Design** • Detailed computer analysis and design of structures, • Statutory approvals and permits • 3D computer modelling and interaction with other engineering disciplines. • Design reviews and Change management • 2D Detailed construction drawings for Reinforced concrete, Steel and Architecture	05
5	**Construction Stage** • Steel fabrication drawings and concrete bar bending schedules • Construction management • Safety and Quality Control • Present and future trends in Civil and Structural engineering • Essential skills required by a Civil and Structural engineer	04

Text Books

1. Koontz, O'Donnell &Weihrich (2010); "Management", Mcgraw Hill. ISBN-13: 9780070144958. 464p.
2. Chinowsky, Paul S. & Songer, Anthony D. (2011) "Organization Management in Construction". Routledge. ISBN-13: 978-0415572613. 216p.
3. Sears, Keoki S, (2008) "Construction Project Management: A Practical Guide to Field Construction Management". Wiley. ASIN: B00HQ1CNE2.
4. Frank Harris (2013); "Modern Construction Management", Ronald Mccaffer Wiley Blackwell Publications. ISBN-13: 978-0470672174. 572p.
5. Wagner.Harvey M (1975) "Principles of Management Science" Prentice Hall College Div. ISBN-13: 978-0137095353. 612p.
6. Snell, Scott & Bohlander George (2009) "Managing Human Resources" South-Western Cengage Learning; ISBN-13: 978-0324593310. 864p.
7. Dessler, Gary (2008) "Human Resource Management" Prentice Hall. ISBN-13: 978-0131746176. 801p.
8. Dharwadkar P. P (1992); "Management In Construction Industry" Oxford & IBH Luthans.
9. V. J. Davies, K. Tomasin (1996); "Construction Safety Handbook", Thomas Telford, London. Isbn-13: 9780727725196. 303p.
10. PSG Design Data Book, PSG College, Coimbatore (2012)

Reference Books

1. Construction Safety Manual Published By National Safety Commission of India.
2. "Safety Management in Construction Industry" – A Manual for Project Managers. Nicmar Mumbai.
3. "IS For Safety In Construction – Bureau Of Indian Standards.
4. Girimaldi and Simonds (1989); "Safety management", AITBS, New Delhi. ISBN: 9780939874989.651p.
5. Stranks, Jeremy (2010) "Health and Safety at Work: An Essential Guide for Managers", Kogan Page Publishers. ISBN 13: 9780749461201. 352p.

SEM-III

VE-MTSE301 Disaster Management

Course Code	Course Name
VE-MTSE301	Disaster Management

Course pre-requisites	

Course Objectives		
The objectives of this course are 1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response. 2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. 3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. 4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.		
Course Content		
Module No.	***Details***	***Hrs.***
1	**Introduction** Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	04
2	**Repercussions of Disasters and Hazards** Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	04
3	**Disaster Prone Areas in India** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.	04
4	**Disaster Preparedness and Management** Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.	04
5	**Risk Assessment** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk	04

	Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.	
6	**Disaster Mitigation** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.	04

Reference Books

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

DS-MTSE 301 Dissertation phase -I

Seminar on Literature Review

The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a thesis for evaluation. The work at this stage may involve review of literature, laboratory experimental work, development of software, development of model, case study, field data collection and analysis etc. On completion of the work the student shall prepare a report and will give a Seminar on the report.

Dissertation Seminars Stage I

Student shall finalize a theme, related to construction engineering and/or management area for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.

SEM IV

CC-MTSE401 Stress Management by Yoga

Course Code	Course Name
CC-MTSE401	Stress Management By Yoga

Course pre-requisites	

Course Objectives

The objectives of this course are

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes

Upon successful completion of the course, students should be able

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Course Content

Module No.	*Details*	*Hrs.*
1	Definitions of Eight parts of yog. (Ashtanga)	08
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	08
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayama	08

Reference Books

1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama
3. (Publication Department), Kolkata

DS-MTSE401 Dissertation Phase -II

Seminar (Pre –Synopsis)

Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inferencing the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis to the University.

Dissertation and Viva Voce

On finalization of the dissertation student shall submit the dissertation report to the University. The student shall have to appear for a Viva-voce examination for the dissertation.

Research Methodology Subject in Ph.D

AC – 30/09/2016

Item No. 4.17

UNIVERSITY OF MUMBAI

Revised Syllabus for PhdCourse Work

(As per Credit Based Semester and Grading System with effect from the academic year 2017–2018)

Course Work Structure for Phd Program in Faculty of Technology
Mumbai University
(With effect from Academic Year 2017-18)

CODE	NAME OF COURSE	CONTACT HOURS	CREDITS	EXAMINATION SCHEME				
				MID TERM TEST	END SEMES TER EXAM	TERM WORK	SEMINAR PRESENT ATION	TOTAL
Phd101	Research Methodology	6	6	20	80	--	--	100
Phd102	Course suggested by Guide*	6	6	20	80	--	--	100
Phd103	Seminar	-	4	-	-	50	50	100
Total		12	16	40	160	50	50	300

Grading of Research Candidates Performance

Awarding of gradesto research candidates based on their performance shall be done as per the applicable ordinances and regulations for undergraduate and Post graduate programs of Engineering under the Faculty of Technology. Semester Grade Point Index (SGPI) shall be also calculated based on the ordinances and regulations applicable for engineering programs under Faculty of Technology. Approved and recognized Research Centers shall prepare Phd course work grade card after successful completion of course work and issue to candidates and one copy to University concerned section for record.

Course Code	Course Name	Credits
PhdC101	**Research Methodology**	**06**

Module	Detailed content	Hrs.
1	**Definition and Characteristics of Research:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.	8
2	**Types of Research:** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches. Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design, Sample size.	10
3	**Outcome of Research:** Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis, Preparation of the Report on conclusions reached, Testing validity of research outcomes, Suggestions and recommendations, identifying future scope.	10
4	**Probability Distribution and Hypothesis Testing:** Theoretical: binomial, poisson, normal, exponential, hyper geometric, uniform distributions. Type I and II error, testing of mean, proportion, tests for equality of mean and variances of two populations, confidence interval, Z test and χ^2 test for goodness of fit, ANOVA (one way classification), Non parametric tests: sign test, U test.	14
5	**Correlation and Regression Analysis**: Karl Pearson's and Rank Correlation coefficient, simple linear regression: least squares method, Linear Programming:Graphical solution, simplex method, dual, sensitivity analysis, transportation and assignment problems.	10
6	**Management Decision Making & Computer Applications:** System approach, decision making under uncertainty and risk: decision tables and decision tree. Statistical data analysis: generating charts/ graph and other features. Introduction to tools: Tools used may be Microsoft Excel, Open office, Microsoft Power Point or similar tools.	8

References:

1. Dawson, Catherine, 2002, *Practical Research Methods,* New Delhi, UBS Publishers' Distributors.
2. Kothari, C.R.,1985, *Research Methodology-Methods and Techniques,* New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners,* (2nd.ed), Singapore, Pearson Education.
4. *Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions, Wiley*
5. Goode W J &Hatt P K, Methods in social research, McGraw Hill
6. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH)

Course Code	Course Name	Credits
PhdC102	**Course suggested by Guide***	**06**

This courseis to be suggested by guide/supervisor in specific domain area of research undertaken by the research candidate.

Research candidates can undertake this course in consultation with guide/supervisor as per guidelines given below;

1. Relevant course shall be successfully completed in IITBombay which has 6 credits.

OR

1. Relevant PG course in the research domain area of research candidate at any PG center affiliated to University of Mumbai.
   In this case, PG course as per University of Mumbai syllabus is of 4 credits. Thus additional work needs to be done for remaining 2 credits. (Any relevant PG course suggested by guide 4 credits + additional work suggested by guide for 2 credits).

   Additional work may be in line with any of the following guidelines:

   i. Minimum four assignment problemsfrom same domain area

   OR

   ii. Any relevant PG Laboratory course, as per University of Mumbai PG syllabus, suggested by guide

   OR

   iii. One course project from same domain area

   OR

   iv. One simulation based project in the domain area using relevant software tool.

Course Code	Course Name	Credits
PhdS103	**Seminar**	**04**

Following guidelines for credit seminar shall be followed:

1. Seminar should be based on thrust areas in specific research domain.
2. Research scholar should do literature survey, identify the topic for seminar and finalize the same in consultation with Guide/Supervisor.
3. Research scholar is expected to use multiple literatures and understand the topic.
4. Report should be compiled in the standard format as per University Guidelines for report writing and present in front of pair of Examiners appointed by the Head of the Department/Institute of respective Program.

Seminar should be assessed jointly by the pair of Internal and External Examiners

Following points must be assessed during the presentation of Credit Seminar

i. Quality of Literature survey and Novelty in the topic
ii. Relevance to the specialization
iii. Understanding of the topic
iv. Quality of Written and Oral Presentation

Appendix-
II and III

Office Order and Minutes of Meetings of Committees related to research are available at-

https://www.spce.ac.in/rnd_1.php

Appendix-IV

अमृतं तु विद्या

BHARATIYA VIDYA BHAVAN'S

Sardar Patel College of Engineering

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri-West, Mumbai-400058

Code of Conduct: Plagiarism

Preamble:

College is using Turnitin Plagiarism software for checking the Intellectual creation of the faculty and students

Ethics and honesty are the two most important components of the academic activities (be it teaching or research). Teaching & research is a novel profession based on extremely high moral values. There cannot be any room for claiming the credit for the work he/she has not undertaken. Many times it is observed that some of the "academicians" knowingly or unknowingly publish or present other's work as their own. Such acts will affect healthy academic atmosphere in the institute which will also harm the reputation of the institute as well as the individual. It is therefore important for an academic institute like Sardar Patel College of Engineering to have in place a policy on plagiarism to avoid such type of acts.

1. Definition of Plagiarism:

Plagiarism is defined as presenting another person's work as one's own work. Presentation includes copying or reproducing it without the acknowledgement of the source. Plagiarism involves copying of phrases, clauses, sentences, paragraphs or longer extracts from published or unpublished work (including from the Internet) that exceeds the boundaries of the legitimate cooperation without acknowledgement of the source. Plagiarism could be intentional (dishonest plagiarism) or non-intentional (negligent plagiarism).

2. Objective

A. To create academic awareness about responsible conduct of research, study, project, assignment, thesis, dissertation, promotion of academic integrity- and prevention of misconduct including plagiarism in academic writing among students, researchers, faculty and other members of academic staff as well as any employee of the institute.

B. To establish institutional mechanism through education and training to facilitate responsible conduct of research, study, project work, assignment, thesis, dissertation, promotion of academic integrity and deterrence from plagiarism.

C. To develop systems to detect plagiarism and to set up mechanisms to prevent plagiarism and punish a student, faculty or staff committing the act of plagiarism.

3. Detection of Plagiarism

It is the prime responsibility of an institute or individual to distinguish original content from plagiarized work. The detection of plagiarism is a judgment to be made by a person who understands the subject and who is also aware of the definition of plagiarism. Such person should also be aware of the tools available to detect the plagiarism. Our Institute will use the best tools / software to detect plagiarism. It is of an at-most important for an academic institute to educate its student and teaching community about what constitutes plagiarism, how it is detected and of course the action that is going to follow if plagiarism is proved.

4. Procedure for handling alleged Plagiarism

a. Procedural Fairness:

The Institution is committed to deal with alleged plagiarism in accordance with the principles of procedural fairness, including the right to:

- Be informed of the allegations against them in sufficient detail to enable them to understand the precise nature of the allegations and to properly consider and respond.
- Have a reasonable period of time within which to respond to the allegations against them.
- Have the matter resolved in a timely manner
- Impartiality in any investigation process.
- An absence of bias in any decision making.

b. Identification and Assessment of Alleged Plagiarism:

Where an examiner detects or is made aware of alleged plagiarism by any person, the examiner must report the alleged plagiarism to an empowered body which confirms first if there is a plagiarism or not; if it is, then whether it is negligent or dishonest type and what is the degree of plagiarism. This empowered body will then submit its report along with its recommendation to statutory bodies which are empowered to take disciplinary actions. The severity of plagiarism can be of categorised as Plagiarism would be quantified into following levels in ascending order of severity for the purpose of its definition:

Similarities up to 10% - excluded
Level 1: Similarities above 10 to 40% Level
2: Similarities above 40 to 60 % Level
3: Similarities above 60%
c. Counselling: As the detection of plagiarism and steps to prevent it are important, equally important is to educate students about the dangers of plagiarism. Institution needs to take steps to strengthen the moral of students so that they do not take support of the unfair-means.

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