Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

END-SEMESTER EXAMINATION - DECEMBER 2022

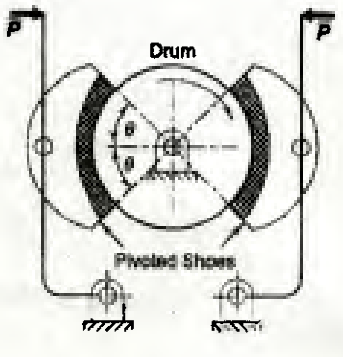
Program: B.Tech. in Mechanical Engineering **Duration: 3 Hours**

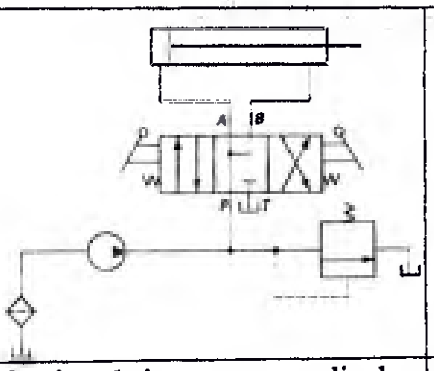
Course Code: PC-BTM711 **Max. Points: 100**

Course Name: Design of Machines & Mechanical Systems **Semester: VII**

Notes:

1. Use of the design data book is allowed. Assume suitable data if necessary.
2. 'x' is the single last digit (0 to 9) of the student's registration number.
3. Question no. 1 is **compulsory**. Attempt any 4 questions out of the remaining 6 questions.

Q. No.	Questions	Points	CO	BL	Mod. No.
Q1 COMPULSORY	A) A pair of parallel helical gears consists of an $(20+x)$ teeth pinion (right-handed) meshing with a $(40+x)$ teeth gear. The pinion rotates in **clockwise** direction when seen from left side of the figure. The pinion is supplied with a power of $(5 + 0.5 \times x)$ kW at 1000 rpm. The normal module is 4 mm, while the normal pressure angle is 20 deg. The helix angle is 23 deg. Determine the magnitudes and directions of tangential, radial, and axial components of the tooth **forces acting on the pinion**. 	(5)	1	3	1
	B) Draw a flowchart depicting the different steps and iterations involved in the selection of a rolling element bearing from the manufacturer's catalog. Briefly discuss the procedure for selecting a bearing which has a probability of survival different from that specified by the manufacturer.	(5)	1	2	2
	C) A pivoted double-block brake as shown in the figure, has two shoes, which subtend an angle $2\theta=100°$. The diameter of the brake drum is $(300 + 10 \times x)$ mm, and the width of the friction lining is 50 mm. The brake drum is cast iron, and the brake lining is made of wood. The pivot of each shoe is located such that the moment of frictional forces about the pivot is zero. Calculate: (i) distance of pivot from drum axis, (ii) the torque capacity of each shoe, (iii) reactions at pivot. 	(5)	1	3	4

	D) Figure shows a hydraulic circuit for a simple drilling machine. Describe the operation of the drilling machine will the help of this circuit. List down the factors that will influence the determination of the power and flow capacity of the pump. 	(5)	2	3	5
Q2	A) A pair of straight bevel gears are having their axes perpendicular to each other. The number of teeth on the pinion and gear are $(20 + x)$ and $(30 + x)$ respectively. The pressure angle is 20 degrees. The pinion shaft is connected to an electric motor developing 5 kW rated power at 1000 rpm. The service factor can be taken as 1.25. The pinion and gear are made of steel with UTS $= (600 + 10 \times x)$ MPa. The module and face width of the gears are 5 mm and 45 mm respectively. Calculate the **bending strength** of the gear tooth.	(5)	1	3	1
	B) Design a full hydrodynamic bearing with the following specification for a heavy duty transmission shaft bearing. Journal diameter = (50+x) mm Radial load = $(2 + 0.1 \times x)$ kN Journal speed = 1000 rpm Min. oil film thickness = 20 μm Inlet temperature = 25 deg.C Bearing matl. = Babbitts Determine length of bearing and select a suitable oil for this application.	(10)	1	3	3
	C) With the help of neat sketch, explain the design of bumper springs for the trolley of an EOT crane.	(5)	3	3	6
Q3	A) A single row deep groove ball bearing with outer race rotating is subjected to 90 second work cycle that consists of following three parts.	(10)	1	3	2

	Part I	Part II	Part III
Duration (s)	20	30	40
Radial load (kN)	20+x	30+x	10+x
Axial load (kN)	10	2.8	5.2
Speed (rpm)	1000	800	600

The static and dynamic load capacities of ball bearing are respectively 40 kN and 80 kN, from manufacturer's catalogue.

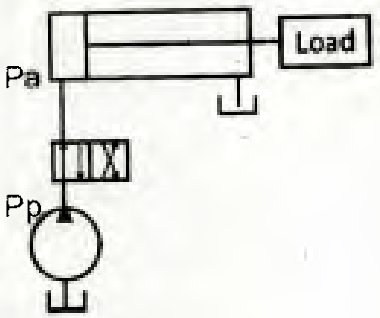
- Calculate the expected life of bearing in hours.
- Calculate the expected life with 98% reliability.

B) A multidisc clutch consists of steel and leather lined plates. It transmits $(10 + 0.5 \times x)$ kW power at 1000 rpm from petrol engine to a screw pump for viscous fluid. The inner and outer diameters of the contacting surfaces are 100 and 200 mm respectively. Assuming uniform wear theory, calculate the number of steel and leather lined plates.	(10)	1	3	4

Consider the following additional data for the clutch.

	Input shaft	Output shaft
Equivalent mass	8 kg	15 kg
Radius of gyration	60 mm	80 mm

Calculate the time required to bring the output shaft to the rated speed from rest. Also, compute the heat generated during the clutching operation.

Q4	A) It is required to design a worm gear speed reducer unit composed of worm wheel made of centrifugally cast phosphor bronze and worm made of normalized carbon steel 55C8. The center distance is approximately 200 mm and the transmission ratio is to be around 20. The worm speed is $(600 + 100 \times x)$ rpm. Find out the power transmitting capacity of the drive based on **only the bending failure.**	**(10)**	1	4	1
	B) Figure shows a hydraulic circuit which is used to push a load connected to the rod end of cylinder. Briefly **explain the construction of DCV** and calculate the following. • Pressure at Point 'a' (Pa). • Calculate pump flow rate in LPM. • Cylinder Extending speed. • A load that can be pushed if the cylinder pressure at the rod end outlet is zero.  The data related to the circuit is as follows.	**(10)**	2	3	5
	Gear Pump pressure (Pp) — (30+x) barg Tube size (ID) — 6 mm No. of elbows used, (pump to Cylinder inlet) — 5 Length of tubing (Pump to cylinder point 'a') — (3+x) m Resistance coefficient K_1 for elbow — 0.8 Resistance coefficient K_2 for DCV — 6 Oil Viscosity — 40 cSt Velocity of Oil in tubing — $(4 + 0.1 \times x)$ m/s Oil Specific Gravity — 0.85 Cylinder Diameter — 30mm				
Q5	A) A pair of spur gears with 20° full-depth involute teeth consists of a (20+x) teeth pinion meshing with an 81 teeth gear. The module and face width of the gears are 5 mm and 50 mm respectively. The pinion as well as gear is made of steel with UTS = 500 MPa. The gears are machined to meet the specifications of Grade-5. The pinion is connected to an electric motor and receives power of $(3 + 0.1 \times x)$ kW at 1200 rpm. The driven shaft is connected to the main drive of a machine tool. Using Buckingham's equation, calculate the factor of safety against the **bending failure.**	**(10)**	1	3	1

	B) Briefly explain the various types of static and dynamic seals used in machines and state their main features.	(5)	1	2	3
	C) List down different types of pumps used in industry. Compare the centrifugal and positive displacement pumps.	(5)	3	3	7
Q6	A) What is the self-locking condition for a block brake with a fixed shoe? Derive the expression for the self-locking condition.	(5)	1	4	4
	B) It is required to design a centrifugal pump to generate total head of $(25 + x)$ meters; the medium is water and discharge rate is 200 m^3/hr. The pump is directly coupled to an electric motor. Determine power requirement and select suitable motor for the pump. Calculate the suction pipe diameter and impeller dimensions. **Do not calculate the number of vanes.** What are the ways to **balance the axial thrust** in centrifugal pumps? Briefly describe the significance of integrating the **Industry 4.0** technologies into the modern pump systems.	(15)	3	4	7
Q7	A) Give a comparison between the rolling contact and sliding contact bearings. Also explain any two failure mechanisms in sliding contact bearings.	(5)	1	2	3
	B) A 4-fall EOT crane has following specifications: • Safe Working Load in kN = (80+2×x) kN • Height to which load is raised = 15 m • 2500 hours of service/year • Dead weight of hoisting system = 4 kN • Hoisting velocity = 10 m/min • Braking distance for hoist = 80 mm • Hook shank diameter = 90 mm • Hook nut outside diameter = 200 mm • Distance between side plates of snatch block = 400 mm (i) Select suitable size of rope of 6x37 type. Calculate (ii) thickness of cross-plate, (iii) diameter, length, and wall thickness of rope drum, (iv) Motor power for hoisting assuming overall mechanical efficiency of pully-gearbox as 0.9. Briefly describe the significance of integrating the **Industry 4.0** technologies into the modern EOT crane systems.	(15)	3	4	6

Annexure 1

(All symbols indicate their conventional meaning)

EOT Crane Design

- Rope area, $A = \frac{F}{\frac{\sigma_u}{n} - \frac{d}{D_{min}} \frac{d_{wire}}{d} E'}$
  - $n = (FOS\ from\ DDB) \times Impact\ factor$
  - $\frac{d_{wire}}{d} = \frac{1}{1.5\sqrt{i}}$; i = total number of wires
  - E' = corrected Young's modulus of wire = 76,000 MPa for 6x37 rope

- D_{min}/D as a function of number of bends in system

No. of bends	1	2	3	4	5	6
D_{min}/d	16	20	23	25	26.5	28

- Factors for permissible stress calculations
  - C_{df} = duty/impact factor from DDB
  - C_{bf} = basic stress factor = 3.15 for normal loading
  - C_{sf} = safety factor = 1.12 for mild steel
- Rope drum
  - Length of rope drum = $\left(\frac{2H\times i}{\pi D}+12\right)s+l_1$
  - Crushing stress below rope groove of drum = $\frac{F_T'}{w\times s}$
  - Standard diameters of rope drum at the bottom of groove: 200, 250, 315, 400, 500, 630, 710, 800, 900, 1000, 1250 mm.
- Wheel Design
  - $p=\frac{P}{c_1c_2DK_0}$; c_1= speed factor, interpolate between (rpm=100, c_1=0.82) and (rpm=25, c_1=1.03); c_2= life factor; K_0= useful width of rail head

Relative operating period of travel, %	Up to 16	16 to 25	25 to 40	40 to 63	Over 63
c_2	1.25	1.12	1.00	0.90	0.80

Some useful relationships for design of centrifugal pump:

$n_q=\frac{n\sqrt{Q}}{H^{3/4}}$; Suction pipe diameter, $D_s=\sqrt{\frac{4Q'}{\pi V_s}+{d_n}^2}$

where Q' = (leakage factor) $\times Q$, $V_s=V_0=V\epsilon$, $V=\sqrt{2gH}$, $\epsilon=0.023\sqrt{n_q}$

Inlet vane width, $b_1=\frac{Q'}{\pi D_1V_0}$

Outlet vane width, $b_2=\frac{Q'}{\pi D_2V_{m3}}$ where $V_{m3}=(0.8\ to\ 0.9)\times V_0$

Number of vanes, $z=13\frac{r_m}{e}\sin\beta_m$

$$\tan\beta_1=\frac{1.25V_0}{u_1},\quad u_1=\frac{\pi nD_1}{60}$$

Radius of curvature of vane profile (approx.) = $\frac{R_2^2-R_1^2}{2(R_2\cos\beta_2-R_1\cos\beta_1)}$

Volute radius $\rho_\theta=\frac{\theta^o}{C}+\sqrt{2r_3\frac{\theta^o}{C}}$, $C=\frac{2\times360^\circ\times\pi gH_{th}}{wQ'}$

Deflection of shaft, $Y=\frac{L^3}{EI}\left(\frac{P_1}{3}+\frac{P_2}{8}\right)$; Whirling speed = $\omega_{cr}=\sqrt{\frac{3EI}{mL^2L_1}}$

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END SEM EXAM DEC 2022, Date-07-12-2022

Programme : B.Tech.in Mechanical Engineering Sem VII	Semester : VII
Course Name & Code: IEPM , PC-BTM 714	Session: Afternoon
Points :100 Industry Engg & Project mgt.	Time 3Hrs

Que 1 is compulsory.
Solve any four questions from remaining
Use of ND table permitted

Questions		Points	CO	Module
Q1	Write short notes on the followings. Draw the necessary sketches. 1.Draw the Ishikawa diagram to depict the Risk in Project Procurement Management 2.State and Explain Project Life Cycle with neat sketch 3.Explain the concept of Earned Value management with neat sketch 4 Illustrate Pareto Chart with necessary example. Draw the chart.	20	1,2,3	M5
Q2A	Refer the time estimates (in weeks) of PERT network of a Project	10	1,2	M6

Activity	Optimistic Time - to	Most likely time- tm	Pessimistic- tp
1-2	4	9	15
1-3	2	5	10
2-4	2	4	10
2-5	3	7	12
2-6	4	7	12
3-6	3	6	16
3-7	3	5	9
4-9	3	5	12
5-9	4	7	15
6-8	0	0	0
6-9	5	6	10
7-8	3	8	12
8-9	3	8	11

Draw the project network and Find

- Effective time for each activity
- Variance for each activity
- Duration for all paths
- Project duration
- Critical Path
- Probability of completion of project in 2 weeks earlier than expected
- Find Earliest Occurrence and Latest occurrence for each event.
- Find the Earliest start, latest start, Earliest Finish latest finish and float/slack for each activity
- Comment on selection of human resource for various activities.

Q2B	Numerical on Project Crashing. Please refer the project data	10	1,2,3	M6, M7

Activity	Dependence	Normal Duration (days)	Crash Duration (days)	Normal Cost Rs.	Crash cost Rs.
A	-	10	8	800	1200
B	A	7	4	700	1000
C	A	8	7	800	700
D	A	9	6	1100	1400
E	B,C	10	6	1000	1400
F	C,D	8	4	1100	1600
G	E,F	9	6	1100	1700

- Find the normal duration and minimal duration
- What is percentage increase in cost to complete the project in 4 days less than normal duration?
- State the rules of crashing

Q3A	Refer the Project data. 1. Find maximum number of men required without project resource smoothing. 2. Find maximum number of men required after project resource smoothing. 3. Draw the diagram to illustrate.	10	1,2,3	M6, M7

Activity	Duration	Men (M)
1-2	2	1
2-3	3	2
2-4	4	3
2-5	2	1
3-10	4	2
4-6	2	3
4-7	4	3
5-9	4	5
6-8	2	1
7-9	5	1
8-9	3	-
9-11	2	1
10-11	3	1
11-12	2	1

Q3B	A project has following schedule. Construct project network. Find project duration and critical path. Compute float for each activity. Find minimum number of cranes needed for its activities 2-5, 3-7, 8-9 without delaying the project. Is there any change required, please suggest.	10	CO2, CO3	M6, M7

Activity	Duration
1-2	2
1-3	2
1-4	1
2-5	4
3-6	8
3-7	5
4-6	3
5-8	1
6-9	5
7-8	4
8-9	3

Q4A	The elemental timings are given below alongwith the respective ratings. Assuming rest and personal allowance as 12% and contingency allowance of 2 % Calculate the standard time for the operation.	10	CO1, CO2, CO3	M2

Elemental Time	Observed Time in min.	Rating	Remark
A	0.22	95	
B	0.03	85	
C	0.05	100	
D	0.78	100	
E	0.05	100	
F	0.06	100	
G	0.04	85	Once in 5pieces
H	0.05	90	
I	0.12	85	
J	0.05	95	Once in 20 pieces

Q4B	Refer following case study and complete a cash flow forecast from the following information for Timmy's Toy Shop: · Sales per month are forecast to be £24,000 except in the run up to Christmas when October sales are forecast at £26,000 and November and December salesare anticipated to be £32,000. · Timmy's Toy Shop receives £600 per month interest on an investment it has inanother business · Rent on the shop unit is £6,800 per month although the landlord has advised the Timmy that the rent will increase to £7,000 in December. · Bills are paid quarterly in January, April, July and October. Timmy pays £5,500 each quarter. · Salaries usually cost Timmy £12,000 per month however in the last three months of the year he will take on temporary staff during the busy Christmas period and this will cost him an extra £2,500 per month. · Between January and August Timmy expects to pay £5,200 per month for stock. In September that will rise to £8,100 and in October and Noveinber it will be £11,000. In December stock costs will fall to £8,000. · Theft has been a problem at Timmy's Toy Shop so additional security equipment is going to be installed in May. This will cost £50,000 and Timmy is hoping to get a loan in month of May to pay for this for which repayments will be started from immediate next month. · The opening balance for Timmy's Toy Shop in January is £200. Explain the strategies for better cash flow management.	10	CO2, CO3	M7
Q5A	A company that makes shopping carts for supermarkets recently purchased some new equipment that reduced the labor content of the jobs needed to produce shopping carts. The information regarding the old system (before adding the new equipment) and after adding the new equipment are given below.	10	CO1, CO2, CO3	M1

Subject	Current System	New Equipment Added
Output/hr	84	90
Workers	5	4
Wage/hr	$14	$20
Machine/hr	$50	$60

	a) Compute labor productivity for both the Old System and the New System b) Compute AFP productivity for both the Old System and the New System c) Suppose production with old equipment was 40 units of cart A at price of $120 per cart, and 60 units of cart B at price of $140. Also suppose that production with new equipment is 80 units of cart A, at price of $130 per cart, and 50 units of cart B at price of $135. Compare all factor productivity for old and new systems.			
Q5B	Businessman wants to sale the product. There are two markets domestic market and Export Market. Both markets with their typical information are given the table. Prepare a Decision tree referring data and advise businessman to take decision with respect to new product launch.	10	CO2, CO3	M6, M7

Items	Export Market	Domestic Market
Probability of sale	0.6	1
Probability of meeting schedule	0.8	0.9
Penalty for delay	Rs. 60000	Rs. 10000
Sale price	Rs. 1000000	Rs. 800000
Third party inspection cost	Rs. 40000	NIL
Probability of collection of sale amount	0.8	0.9

Q6A	Explore the reasons for failure of a project. Draw Ishikawa diagram considering failure of project as an effect and show causes under various cause categories. Illustrate how Blockchain and IOT can help in reduction of failure cases.	10	CO2, CO3, CO4	M5, M6, M7
Q6B	Illustrate the labour productivity improvement using Workstudy tool. Draw the process flow chart for before and after improvement cases for a manufacturing plant. Explore how Blockchain and IOT can help in improvement of productivity.	10	CO1, CO2, CO3	M1, M2
Q7A	List down 20 examples of Bad Ergonomic Designs.	10	CO1, CO2	M3
Q7B	***Attempt any one*** • Draw and Explain organisational culture maturity model (TMKC) for the business excellence success. • Explore and explain HR Barriers to project risk management in internationalprojects. • Explain the DMAIC approach for process improvement. List the tools (with their purposes) useful in each phases	10	CO2, CO3, CO4	M1, M5, M6, M7

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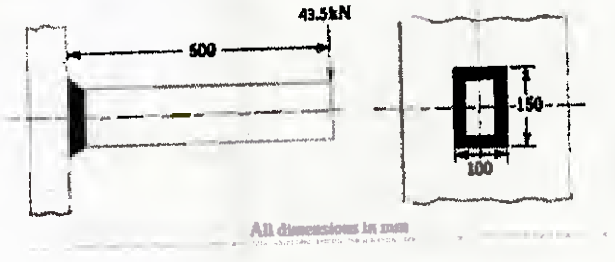
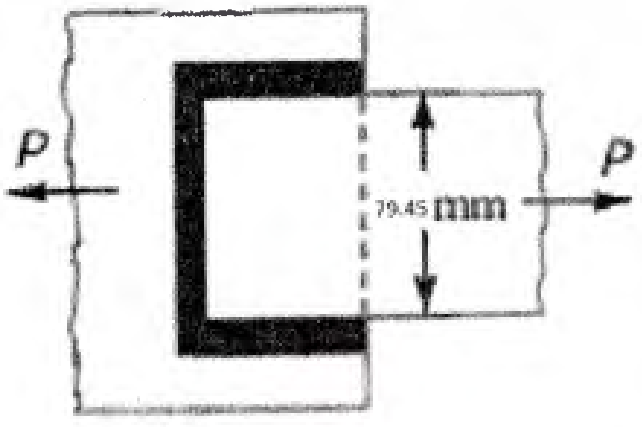
END SEMESTER EXAMINATION
December 2022

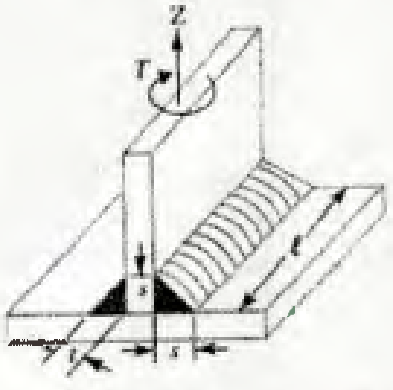
Max. Marks:100 Duration: 3HR
Class: B.Tech Mechanical Sem VII 9/12/22 Semester:VII
Program: MECHANICAL ENGINEERING
Name of the Course: WELDING PROCESS AND WELDING TECHNOLOGY
Course Code : PE-BTM735

Instructions:

1. **Question No 1 is compulsory.**
2. **Attempt any four questions out of remaining six.**
3. **Draw neat diagrams**
4. **Assume suitable data if necessary**

Question No		Maximum Marks	CO	BL	PI
1.	A. Write types of weld defects in welding. Explain the causes and remedies of at least five weld defects with a schematic diagram. Justify remedies properly. (**NOTE:** minimum three reasons required for each defect)	10	1,2,4	3	3.1.4
	B. The rectangular cross-section bar is welded to a support by means of fillet welds, as shown in Fig. Determine the size of the welds if the permissible shear stress in the weld is limited to 75 MPa. 	10	2	3	2.4.1

2	A. Explain welding arc characteristic with schematic diagram	05	1,2	5	2.2.1
	B. Explain working principle and construction of electron beam welding.	05	4	6	1.3.2
	C. A plate 79.45 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Fig. 10.15. The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading. 	10	1,4	2	1.3.1
3	A. Explain the necessity of shielding gas in GTAW. What are the different types of shielding gases for GTAW; discuss the characteristic of each shielding gas.	08	4,1	2,4	1.3.3
	B. Explain the cooling curve of the nugget zone and how the rate will decide the properties of the nugget zone and HAZ.	06	3	4	2.1.3
	C. Explain the modes of metal transfer in MIG welding considering welding parameters using appropriate graphs.	06	3,4	4	2.4.2
4	A. Explain the Laser generation process in the laser welding machine with a schematic diagram. Discuss different types of modes of it.	08	1,3	2	2.1.4

	B. A plate 1 m long, 60 mm thick is welded to another plate at right angles to each other by 15 mm fillet weld, as shown in Fig. Find the maximum torque that the welded joint can sustain if the permissible shear stress intensity in the weld material is not to exceed 80 MPa. 	06	2	6	2.4.1
	C. Name the welding process which required molten slag during welding and mostly it is used for vertical joints. Explain working principle of it and main part of this machine using schematic diagram.	06	1,4	4	2.4.1
5	A. An arc welding DC power source has a linear power source characteristic with open circuit voltage V_0=85 Volts and I_s=1100amps.The voltage length characteristic of the arc has given by V=30+5L Volt where L is the arc length in mm. Calculate the optimum length of arc for obtaining max. arc power at welding. What voltage and current setting should be done on the power source for max.arc power. Also calculate net heat input for process if the arc heat transfer efficiency is 0.83 and welding speed is 7mm/sec.	10	2	4	2.4.1
	B. Explain following NDT of welded joints with schematic diagram. I. Magnetic particle test II. Ultrasonic reflection approaching testing.	10	4	2	2.4.3
6	A. Writes the properties of welding electrode ingredients for following types. I. Cellulose-sodium II. Rutile-sodium	08	4	3	2.2.2

	III. Low hydrogen-sodium IV. Rutile-iron powder				
	B. Explain the process of transferred and non-transferred plasma with a suitable schematic diagram. Also, explain the variant of the process where above mention phenomenon is used.	06	1,4	3	1.3.1
	C. Explain autogenous and heterogeneous welding with suitable examples; write the welding process name based on it.	06	1	3	1.3.1
7	A. Why Is Damascus Steel Popular For Knives? Explain the manufacturing process considering welding for Damascus steel knife.	08	1,4	6	2.1.2
	B. DC power source for arc welding has the characteristic 3V+I=240, V=voltage and I= current in amps. Determine the voltage that should be set for maximum power at the electrode.	06	2	5	2.4.1
	C. Explain electrode identification system for the steel arc welding process.	06	4	3	3.2.1

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End Semester Examination, DECEMBER 2022

B.Tech. (Mechanical Engineering), Semester-VII Max. Marks: 100

BTM 708: COMPUTATIONAL FLUID DYNAMICS Duration: 3 Hours

9/12/22

Instructions:

- Answer any **FIVE** questions.
- Answers to all sub questions of a particular question must be grouped together for their evaluation.
- Make suitable assumption if needed with proper reasoning
- Figures on right in square bracket shows maximum marks for a particular sub-question.
- Figure on the extreme right shows **course outcome number** and **module number** respectively as per the syllabus of the course.

1.	A.	What is up-winding? Discuss about its need in numerical computation? Explain different techniques of up-winding with suitable sketch of cells.	[10]	3,2
	B.	A 5cm long straight fin of circular cross section (dia. 1mm) of insulated tip is used for dissipating heat from a base body maintained at constant temperature 400°C. If the fin is suddenly exposed to an ambient temperature: 25°C and h: 50 W/m^{2}K. i) Write governing equation and BCs, ii) Using FVM discretize the equation, iii) Calculate temperature at equally spaced 6 points along the fin at 4 different time step level for a good convergence iv) Plot temperature variation at all-time steps. (Take thermal diffusivity α for the material as 10^{-5} m^2/s).	[10]	3,4
2.	A.	Discuss different approach of numerical modeling of transient heat transfer. Identify stability issues for one-dimension transient heat conduction with convection using FVM scheme.	[10]	1,4
	B.	Discuss and explain following terms: i) Diagonal dominance ii) Over and under relaxation iii) Role Eigen values in solution of linear algebraic equations iv) Time step size in transient analysis	[10]	2,2
3.	A.	What are the different approach to investigate a thermo-fluid problem? Discuss merits and demerits associated with each approach.	[10]	1,4
	B.	Solve following set of equation using Gauss elimination method & LU method and compare the result. $5y_1 + 2y_2 + y_3 = 8$ $y_1 + 2y_2 + y_3 = 4$ $y_1 + y_2 + 3x_3 = 5$	[10]	3,4
4.	A.	Write the fundamental thermal and flow boundary conditions and explain them with examples. Discuss image point and polynomial fitting method of treating convective boundary condition.	[10]	2,4
	B.	A large steel plate (k = 50 W/mK) with a thickness of 0.05 m. One side of it is maintained at a constant temperature of 900°C and other side is covered by ceramic	[10]	2,5

plate (k = 0.5 W/mK) with a thickness of 0.08m. The ceramic plate exposed to an ambient temperature 25 °C with a convective heat transfer coefficient 50 W/m²K. The internal heat transfer coefficient at the steel ceramic plate interface is 500 W/m²K. Develop finite difference equation and calculate temperature distribution in the steel and ceramic plate.

4. **A.** (i) With suitable examples, explain following terms **[10]** 1,1
a) Physical Model, b) Mathematical Model and c) Numerical Model.
(ii) What is model validation? State its significance in numerical computation.

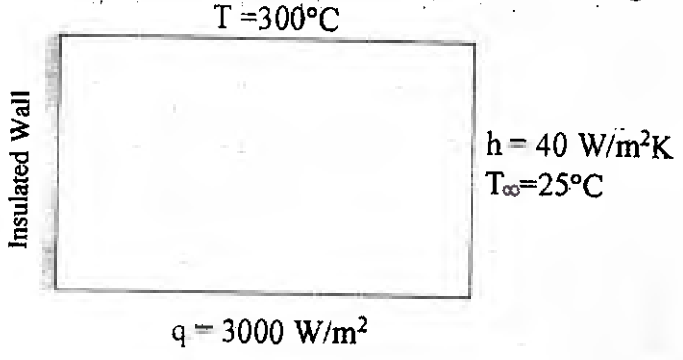
B. Discuss the fundamental conservation law required for the analysis of a thermo-fluid system. Listing all assumptions, derive general form of momentum conservation equation. **[10]** 2,1

6. **A.** Discuss different approach of modeling transient heat transfer. **[10]** 1,4
Identify stability issues for one-dimension transient heat conduction with convection using FVM.

B. What is alternating direction implicit scheme (ADI)? Where it can be used? **[10]** 2,2
Mathematically represent ADI scheme applying it to a 2D transient conduction.
How does it differ from explicit and implicit scheme?
Where are the advantages of ADI scheme?

7. **A.** Discuss about the application and scope of the computational fluid dynamics in thermal engineering. **[05]** 1,2

B. The rectangular plate (thermal conductivity = 25 W/mK) has dimensions 24cm by 40cm and is 1cm thick. Boundary conditions are as shown in figure. Neglecting the heat flow in the direction normal to the plane assuming steady state condition, **[15]** 4,5
(i) Develop a mathematical model in integral form.
(ii) Assuming 4 horizontal and 3 vertical mesh, write descretized equation for all cells based FVM.
Obtain steady state solution using point by point method with proper initial guess. Tabulate the result.



7. **A.** Mention different flow solvers and explain the procedure of SIMPLE algorithm? For a 2D incompressible flow derive pressure correction equation? **[10]** 3, (4,3)

B. Solve $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, subjected to initial condition u = sinπx at t = 0 for $0 \le x \le 1$ and **[10]**
boundary condition u = 0 at x=0 and x=1 for t>0.
Consider 6 grind points in the computational domain; calculate values of variable at 6 time levels using explicit method. Show results in tabular form.

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END SEMESTER EXAMINATION, DECEMBER-2022

Program: **B. Tech. in Mechanical Engineering** Sem VII
Class: **Final Year B. Tech. (Mechanical)**
Course code: **PEC-BTM 753**
Name of the Course: **Introduction to Cryogenics**

Date: **09 /12/2022**
Duration: **3 Hr.**
Max.Points:**100**
Semester: **VII**

Instructions:

- Solve **ANY 05** questions.
- Assume suitable data wherever necessary and state the same.
- Draw **neat** and labelled system diagram **and/or** process diagram **wherver necessary.**
- proper figures and tidy work carry weightage.
- Use of **Reference Data** for **T-s Diagrams, Material Property Charts and Tables for Cryogens** approved by Examiner is permitted for solving numerical examples.
- Answers to theory questions should be specific and in **Legible hand writing.**

Q. No.	Question	Points	CO	BL	PI	Module
Q.1	**a) Define:** Cryogenics and **State:** its Domain of Scope. **Distinguish:** Between Refrigeration and Cryogenics.	(6)	1	I, IV	1.4.1	1
	b) List: Applications of cryogenic engineering in various fields. **Discuss:** Applications in field of space sciences and rocket propulsion.	(7)	2	II, V	1.4.1	1
	c) Explain: i) Meissner Effect ii) Type-I and Type-II Superconductors. **Evaluate:** Threshold current for a ***1.3 mm*** Indium wire at ***3K***, assuming that parabolic rule holds true.	(7)	4	IV, V	1.4.1	2
Q.2	**a) Explain:** Ortho and Para Hydrogen. **Describe:** Necessity of catalysts and its arrangements in Hydrogen Liquefaction system. **Draw:** Neat system diagrams.	(10)	2,4	I, II	1.4.1	2,4
	b) Explain: Criterion for determination of specific heat of solids for cryogenic applications with Formulae used. **Evaluate:** Percentage of electronic contribution to specific heat ($c_{v,e}$) in the total specific heat for Aluminum at i) ***200 K*** and ii) ***20 K***. Universal Gas Constant $\bar{R} = 8.31434\ kJ/kmol$ and Atomic Wt. of Aluminum = $27\ g/mol$. **Summarize:** About variation of specific heat of metals at cryogenic temperatures.	(10)	2	II, V	1.4.1	2
Q.3	**a) Explain:** Working of Precooled Linde-Hampson system. **Draw:** Neat system diagram and T-s diagram. **Derive:** Expressions for i) Yield and ii) Compressor work required per unit mass of gas compressed for	(10)	4	I, II, III	1.4.1	3

	the system. **b)** A Linde-Dual pressure system is to liquefy Argon gas which enters the low pressure compressor at ***285 K*** and ***2 atm***. The gas is compressed reversibly and isothermally to ***50 atm*** in low pressure compressor and further to ***160 atm*** in the high pressure compressor. The intermeidate pressure flow rate ratio ***i = 0.65***. **Draw :** Neat system diagram and T-s diagram. **Evaluate:** i) Liquid yield ii) Compressor work per unit mass of gas compressed. **Draw:** Neat system diagram and T-s diagram.	**(10)**	4	I, V	1.4.1	3
Q.4	**a) Explain:** Working of Claude system. **Draw:** Neat system diagram and T-s diagram. **Derive:** Expressions for i) Yield and ii) Net Work requirement per unit mass of the gas compressed, considering expander work.	**(10)**	4	I, II, V	1.4.1	3
	a) Explain: Significance of Maximum Inversion Temperature for liquefaction of gas. **Compare:** Advantages and disadvantages of i) Isenthalpic expansion and ii) Isentropic expansion of a gas during liquefaction. Nitrogen gas expands from ***200 K*** and ***100 atm*** to ***50 atm.*** **Evaluate:** i) Joule- Thomson Coefficient μ_{JT} and ii) Isentropic Expansion Coefficient μ_S. **Draw:** Neat T-s Diagram.	**(10)**	4	I, II, V	1.4.1	3
Q.5	**a) State:** Various systems for liquefaction of Neon, Hydrogen and Helium. **Explain:** Working of LN2 Precooled Linde-Hampson system for liquefcation of Neon / Hydrogen. **Derive:** Expression of yield. **Draw:** Neat system diagram.	**(10)**	4	I, II	1.4.1	4
	b) Discuss: Effect of heat exchanger effectiveness on performance of simple Linde-Hampson liquefaction system. In a Simple Linde Hampson system for Nitrogen, the compressor inlet pressure is ***101.3 kPa*** and compressor exit conditions are ***200 atm*** and ***300 K***. Heat Exchanger effectiveness is ***0.965***. **Evaluate:** i) Liquid yield ii) Work requirement per unit mass of gas compressed iii) Figure of Merit.	**(10)**	4	V	1.4.1	4
Q.6	**a) Explain:** Classification of cryogenic insulations with example and significance of each. **Justify:** Preferred use of Multilayer Insulation (MLI) in cryogenic systems as compared to other types.	**(10)**	3	II, V	1.4.1	5
	b) Justify: Necessity of vacuum in Cryogenics with an illustrative example. **Explain:** Working of diffusion pump with neat sketch.	**(10)**	3	II, V	I.4.I	6
Q.7	**a) Explain:** With **criteria,** Types of Flow regimes and Types of vacuum with range in vacuum systems.	**(05)**	3	II	1.4.1	6
	b) Explain: Various modes of heat in-leak in a cryogenic system and concept of apparent thermal conductivity for cryogenic insulations.	**(05)**	3	II	1.4.1	5
	c) Discuss: Various Health hazards associated with cryogenic systems and measures for personal safety in cryogenic plants.	**(10)**	3	V	1.4.1	7

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End Semester Examination - DECEMBER 2022 Examinations

Program: BTECH (MECH.ENGG.) Sem VII **Duration:** 3 hrs.

Course Code: OE-BTM617 **Maximum Points:** 100

Course Name: Digital Twin

Semester: **VII**

- All questions are compulsory
- Figures to the right indicate full marks
- Draw neat sketches & figures wherever required

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	Explain INDUSTRY4.0 with neat figure? Also explain the basic concepts of digital twin with neat figures?	[10]	1,2,3	2	3.2.1
(b)	Explain enabling technologies of Digital twin with neat sketches	[10]	1,2,3	2	3.2.1
Q.2 (a)	Explain the following with respect to Digital Twin • Digital Twin Prototype (DTP) • Digital Twin Instance (DTI) • Digital Twin Aggregate (DTA) • Partial Digital Twin • Clone Digital Twin • Augmented Digital Twin along with neat figures	[12]	1,2,3	2	5.4.1
(b)	Explain the evolution of Digital Twin with neat figure?	[08]	1,2	2	5.4.1
Q.3 (a)	Explain the integration benefits of various enabling technologies with digital twin along with neat figures?	[20]	2,3	3	5.5.1
Q.4 (a)	Explain the New business & Revenue models in Digital twins? Also explain the challenges of Digital Twin?	[10]	2,3	3	5.5.1
(b)	Explain BIM with neat sketch? Also explain advantages of BIM & Machine Learning integration	[10]	1,2,3	2	5.5.1

Q.5 (a)	Explain Smart Cities in detail along with neat sketch?	[15]	3,4	3	5.5.1
(b)	Explain the steps in building a digital twin along with neat sketch?	[05]	2,3	3	5.1.2
Q.6	What are enterprise software's? Explain the benefits of Digital Twin integration with any two enterprise software's along with neat figures?	[20]	3,4	3	5.5.1
Q.7	Write Short notes on (any three)	[20]	2,3,4	3	5.4.1, 5.5.1
	• BIM Interoperability • Scan to BIM • DT in Product Development • Predictive Maintenance • DT in construction industry • Digital twin driven power transformer • DT in Asset Maintenance				

********** All the Best **********

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END SEMESTER - December 2022 Examinations

Program: ~~B. Tech.~~ Mech Sem VII **Duration: 03 Hrs**

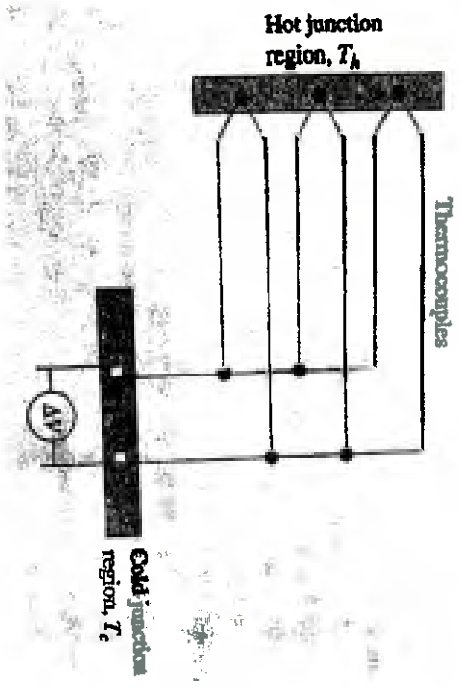
Course Code: OE-BTM714 **Maximum Points: 100**

Course Name: Introduction to MEMS **Semester: VII**

Notes:

1. **Questions 1 to 3 are compulsory**
2. **Solve any two questions from Q. 4 to Q. 7**
2. **If necessary assume suitable data with justification**
3. **Draw neat labeled sketches wherever required.**

Q. No.	Questions	Points	CO	BL	M. No.
1	Only draw labelled sketches depicting working principle of (i) Electrophoresis systems (ii) Chemical Vapor Deposition Technique (iii) Micro pressure sensor (iv) Atomic Force Microscope	20	1 to 4	5	1 to 7
2 (A)	A thin piezoelectric crystal film, PZT is used to transduce the signal in a micro accelerometer involving a cantilever beam made of silicon. The accelerometer is design for maximum acceleration/deceleration of 10 g. The PZT transducer is located at the support of the cantilever beam where the maximum strain exists (near the support) during the bending of the beam as illustrated below in Figure 1. Determine the electrical voltage output from the PZT film at a maximum acceleration/deceleration of 10 g. Take E for silicon beam as 1.9×10^{11} Pa. Piezoelectric coefficient d = 480×10^{-12} m/V  Figure 1: Silicon cantilever beam for micro-accelerator	10	2 to 4	6	4,5

2 (B)	Estimate the voltage output for thermopile shown in Figure 2 if copper wires are use for the thermocouples with hot junction temperature at 120 degree centigrade while cold junction is maintained at 20 degree centigrade. Consider Seebeck coefficient for copper being 38.74 microvolts per degree centigrade.  Figure 2: Thermocouples in parallel arrangements with voltage output in series.	10	3,4	6	2,3
3 (A)	In parallel plate capacitor, the two plates have identical dimensions of L=W=1000 microns with a gap of d= 2 microns. Air is the dielectric medium between the two plates. Consider permittivity of free space (vacuum) being 8.85 pF/m Farad and relative permittivity of dielectric material (air) being unity. Determine the voltage ratio (Vo/Vi) for variation of the gap between two flat plate electrodes. For calculation consider gap between electrodes being 2, 1.75, 1.5, 1, 0.75, 0.5 (all dimensions in microns).	10	3,4	3	2,3
3 (B)	Explain laser beam propagation theory in unconstraint depth resin with mathematical modelling.	10	4	4	4,5
4 (A)	Explain LIGA process with neat sketches. Provide merits of the process on other MEMS processes	10	2	5	5
4 (B)	Discuss part fabrication process plan in Bulk Lithography with neat sketches	10	2	3	6

5 (A)	With neat sketch explain dual axis motion sensor	10	4	4	4
5 (B)	Explain Scanning Electron Microscope with neat diagram	10	3	2	6
6 (A)	Explain Laser Doppler Vibrometer with neat diagram	10	3	4	6
6 (B)	Explain microstereolithography with neat sketch.	10			4,5
7 (A)	Explain impact of nanotechnology and its promising features	10	1	3	7
7 (B)	Explain smartness in micro systems. What are the technology driving smartness in micro systems. Discuss considering any one of the case study.	10	4	3	7

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End Semester Examination - DECEMBER 2022 Examinations

12/12/22

Program: BTECH (MECH.ENGG.) Sem VII

Course Code: OE-BTM717

Course Name: Introduction to Augmented Reality

Duration: 3hrs

Maximum Points: 100

Semester: VII

- All questions are compulsory
- Figures to the right indicate full marks
- Draw figures wherever necessary

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	Explain the Architecture/Framework of Augmented Reality with neat figure?	[15]	1,2,3	2	3.2.1
(b)	Explain hardware device used in AR with neat sketch?	[05]	1,2,3	1	3.2.1
Q.2 (a)	Explain the enabling technologies of Augmented Reality with neat sketches?	[15]	1,2,3	2	3.2.1
(b)	Explain the technological challenges faced by Augmented Reality technology?	[05]	1,2,3	2	3.2.1
Q.3 (a)	Explain the following with respect to Augmented Reality • Tracking • Registration • Recognition • Gesture Computing • Rendering along with neat figures	[10]	1,2,3	2	5.5.1
(b)	Explain BIM-AR integration with neat figure? Also explain the benefits of BIM-AR integration?	[10]	1,2,3	2	5.5.1
Q.4 (a)	What is the difference between Marker based & Marker less Augmented Reality? Explain the different types of marker used in AR?	[10]	1,2,3	3	5.5.1
(b)	Explain the integration of Augmented Reality and Internet of Things integration for remote maintenance using neat figures? Also explain	[10]	1,2,3	3	5.5.1

	the benefits of this integration?				
Q.5 (a)	Explain application of AR in Non Destructive Testing (NDT) along with neat figures? Also explain the benefits of AR – NDT integration	[10]	1,2,3	3	5.5.1
(b)	Explain application of AR in Product Development (PD) along with neat figures? Also explain the benefits of AR – Product Development integration	[10]	1,2,3	3	5.5.1
Q.6 (a)	Explain integration of Augmented Reality with enterprise software's along with neat figures? Also explain the benefits of the integration?	[15]	1,2,3	3	5.5.1
(b)	Explain New Business & Revenue Models that can be developed using Augmented Reality	[05]	1,2,3	3	5.5.1
Q.7	Write short notes on any three	[20]	1,2,3	3	5.1.2, 5.5.1
	• AR in Assembly • AR in Construction • Conversion of BIM model to AR model • Cloud Computing & AR • BIM Model				
********** All the Best **********					

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END SEMESTER EXAMINATION - DECEMBER 2022

Program: B.Tech. in Civil/Electrical/Mechanical Engineering Sem VII

Course Code: OE-BTM718

Course Name: Fundamentals of AI and Machine Learning

Duration: 3 Hours

Max. Points: 100

Semester: VII

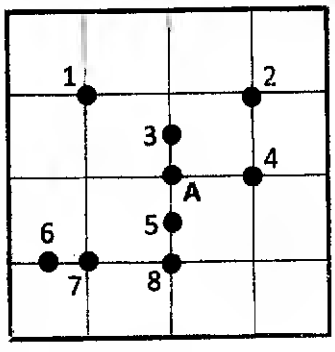
Notes:
1. Assume suitable data if necessary.
2. '***n***' is the single last digit (0 to 9) of the student's registration number.
3. **Question no. 1 is compulsory**. Attempt any 4 out of remaining 6 questions.

Q. No.	Questions	Points	CO	BL	Mod. No.
Q1 COMPULSORY	A) Give the PEAS description of the task environment for an agent who will assist a student to prepare for an end-semester examination. Under what conditions would you call such an agent as a "rational agent"?	(5)	1	3	1
	B) Explain the difference between the training, testing and validation datasets. Describe the scheme of K-fold cross-validation and explain its advantages.	(5)	2	3	3
	C) A cement manufacturer is aiming to build a logistic regression model to predict the acceptability of the concrete mix based on its compressive strength and the amount of cement in the mix. Partial data collected by the manufacturer is as follows.	(5)	2	3	3

Amount of Cement (kg/m^3 of mix) $\times 10^{-2}$	Compressive Strength (MPa $\times 10^{-1}$)	Acceptance (1 = Yes, 0 = No)
1.0	2.0	1
1.2	2.2	0
1.3	3.5	1

- The manufacturer sets the initial values of the model parameters as:
  $\theta_0 = 2 + 0.1 \times n,\ \theta_1 = -5,\ \theta_2 = 2$
- Calculate the predicted value and the cost function value for the **first** sample.
- Briefly justify the use of sigmoid function as the hypothesis function in the logistic regression.

	D) The data obtained from a solar energy power generation plant about the ambient temperature (T) in deg. C and power generated (P) in MW are given in the table. Classify the data samples in two categories using K-Means clustering. The initial cluster centers (T, P) are (4,5) and (8,15). Find the two cluster centers after the first round of calculations.	(5)	2	3	6

		T	2	4	6	10	12		
		P	2	1	10	10	20		
	How can one estimate the suitable number of clusters in K-means clustering?								
Q2	A) To use a credit card for shopping, depending on the type of machine, one must first either insert or swipe the card, enter the amount and the PIN code. Express this procedure using a single sentence of the propositional logic. Some of the credit cards will work only with a specific type of machine. Write this condition using First Order Logic (FOL). Define your own symbols and functions. Briefly describe the advantages of FOL over the propositional logic. 							**(5)**	1	3	2
	B) Briefly explain the main features of Deep Learning with Neural Network (DL). How DL is different from the classical neural network? Which is the major challenge within the DL research?							**(5)**	4	2	5
	C) Figure shows the distribution of samples in the feature plane. The internal grid has unit spacing in vertical and horizontal directions. One initiates the DBSCAN algorithm with the sample marked as "A" and with minPts = 3 and ε = 1.06 Identify the core points, reachable points, and outliers. State the criteria used for identification. What are the main disadvantages of DBCAN? 							**(5)**	2	4	6
	D) Explain with the help of an example, how reinforcement learning differs from classical supervised learning. Mention some of the real-world applications of the reinforcement learning.							**(5)**	4	2	7
Q3	A) Discuss and compare the Greedy best-first and A* search algorithms. Explain role of heuristic function in these algorithms. How the heuristic functions can be established?							**(5)**	1	2	1
	B) Following data has been obtained about the life of gears in a machine based on its module and hardness. To predict the life of the gears, a multivariate linear regression model is built. The regression model is initiated with its parameters as $\theta_0 = -0.6, \theta_1 = 0.3, \theta_2 = 0.2$.							**(10)**	2	3	3

Module (mm)	Hardness (BHN/100)	Life (million rev.)
3	$4 + 0.1 \times n$	1
4	$3.5 + 0.1 \times n$	1.2
5	$3 + 0.1 \times n$	1.3

Calculate the new value of θ_1 after the first iteration of gradient descent method. Consider learning rate = 0.2.

Briefly explain the concept of overfitting model and describe how regularization is used to control it.

C) Describe the hierarchical agglomerative clustering algorithm with a suitable example. Discuss the advantages and limitations of the method. What distance measures are used to compare the inter-cluster closeness?

(5) 2 2 6

Q4 A) Following 8 samples are taken from a dataset about fake news.

(10) 2 3 4

Word in title	W1	W2	W3	W1	W2	W2	W3	W1
Source domain	D1	D1	D2	D2	D1	D3	D2	D3
Tweets	High	Low	Low	High	High	Low	High	Low
Fake news	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**Yes**	**No**

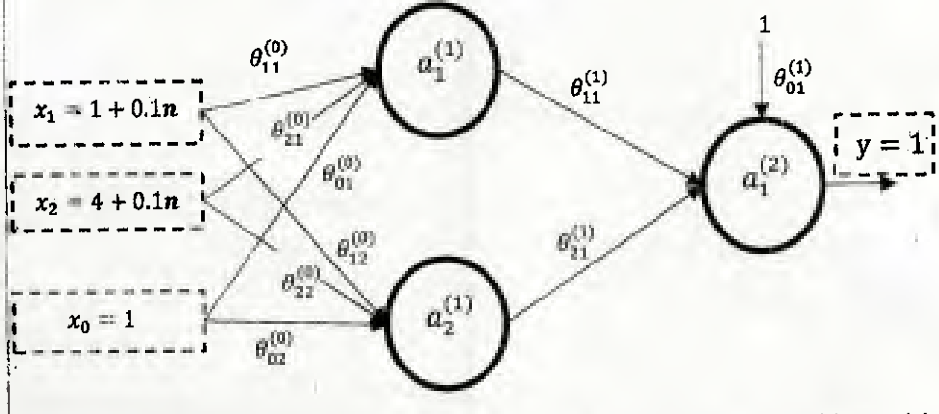
Apply the Naïve Bayes classifier to predict whether the news is fake in the following case.

- Odd n: Word = W2, Source domain = D2, Tweets = High
- Even n: Word = W1, Source domain = D3, Tweets = High

State the assumptions made in the Naïve Bayes classifier.

B) A neural network with sigmoid activation function is shown in the figure. Consider only one sample with inputs and output as shown in the figure.

(10) 4 3 5



The initial weights are $\theta_{01}^{(0)} = \theta_{02}^{(0)} = \theta_{11}^{(0)} = \theta_{12}^{(0)} = \theta_{21}^{(0)} = \theta_{22}^{(0)} = \theta_{01}^{(1)} = \theta_{11}^{(1)} = \theta_{21}^{(1)} = 0.05$

	Compute the updated values of the weights $\theta_{21}^{(1)}$ and $\theta_{12}^{(0)}$ after first run of backpropagation. Consider learning rate $\alpha = 0.1$				
Q5	A) Describe and compare the BFS and DFS search algorithms with suitable examples. How does their approach differ from that of the informed search algorithms?	(5)	1	2	1
	B) A machine learning classification model is developed for predicting rainy weather based on the climatic data collected over regular periods. The performance of the model is as shown in the table which lists the labelled targets from a test dataset and outputs from the classification model. (R = Rainy, S = Not Rainy).	(5)	2	4	3

Sample	1	2	3	4	5	6	7	8	9	10	11	12
Target	R	R	S	R	S	R	R	R	R	S	S	R
Prediction	S	R	S	R	R	R	R	S	R	R	S	R

Develop confusion matrix for the classification model. Compute the following metrics: (i) Accuracy, (ii) Precision, (iii) Recall.

Consider prediction of rainy weather as positive (P) case. Devise two user scenarios for the application of this model in which the user would preferentially use (i) Precision and, (ii) Recall metric.

C) A dataset with 3 features needs to be reduced to 2 dimensions using PCA. The eigenvectors for the covariance matrix obtained from the dataset are available as columns of the following matrix. (5) 2 3 3

$$\begin{bmatrix} 0 & 0.866 & -0.5 \\ 0 & 0.5 & 0.866 \\ 1 & 0 & 0 \end{bmatrix}$$

Reduce the sample $\begin{Bmatrix} 0.2+n \\ -0.2-n \\ n \end{Bmatrix}$ to two dimensions using PCA.

Discuss how you would establish the acceptability of the reduced features which are obtained after the PCA procedure.

	D) Describe the kNN classification algorithm and state its advantages and disadvantages. Why is it called an instance based and a lazy learning method?	(5)	2	3	4
Q6	A) Describe significance of following terms in machine learning: (i) hypothesis function, (ii) cost function, (iii) feature scaling, (iv) feature reduction, (v) E/P/T components of machine learning defined by Prof. Mitchell.	(5)	2	2	3
	B) Describe with a sketch, the concept of "support vectors" and "maximization of margin" in SVM for linearly separable problems. One of the approaches to solve classification problems with non-linear decision boundary is to add more dimensions which will allow to fit a linear decision plane. This approach should normally increase the	(5)	2	3	4

computational complexity but is nevertheless adopted in SVM with the kernel trick. Briefly explain the approach of Kernel SVM.

C) The following table gives information about ratings (on scale 0 to 5) for various machine learning books given by different data engineers (A, B, C, D) and estimated feature vectors of different books by a collaborative recommender system.

	A	B	C	D	Focus on theory	Focus on Coding
Book-1	5	4	1	1	0.9	0.3
Book-2	?	5	1	0	0.7	0.1
Book-3	3	3	0	4	0.8	0.5
Book-4	2	2	3	5	0.3	0.9
Book-5	1	2	5	4	0.1	0.8

At an intermediate step of a recommender system, the decision parameter vector for 'A' is estimated as $\begin{Bmatrix} 0.1 \\ 3 + 0.1 \times n \\ 1 - 0.1 \times n \end{Bmatrix}$. Compute the error in predicting rating by 'A' for Book-5. Also calculate the predicted rating for Book-2 by 'A'. State the cost function which needs to be minimized to improve the overall performance of the recommender system.

(5) | 4 | 3 | 7

D) The code for a machine learning model is shown in the box. Answer the following questions based on the code.

(i) What is the purpose of this code?

(ii) What is done in lines 1, 2 and 7?

(iii) Explain how this model can be tuned for its best performance.

(iv) Explain the significance of information gathered in lines 8 and 10.

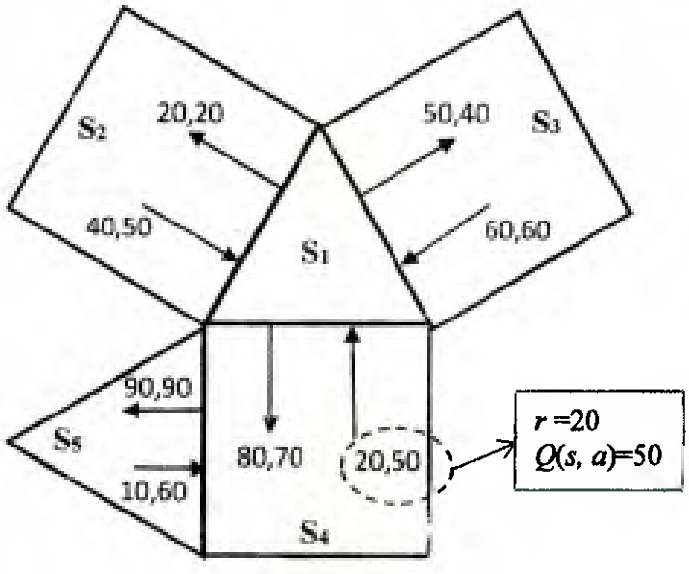
```
1 import pandas as pd
2 from sklearn.cluster import KMeans
3 df=pd.read_csv('Crimes.csv')
4 df2=df1.loc[: , ['Longitude','Latitude']]
5 model=KMeans(n_clusters=7, n_init=20,
6               init='random',max_iter=300)
7 model.fit(df2)
8 centroids = model.cluster_centers_
9 print("centroids", centroids)
10 inertia = model.inertia_
11 print("inertia", inertia)
```

(5) | 3 | 3 | 6

Q7 A) Explain the full syntax of First Order Logic (FOL) sentences. Explain the importance of quantifiers in FOL with supporting examples. **(5)** | 1 | 2 | 2

B) Briefly discuss the features of the decision-tree classification model. Explain how the root/parent-nodes and the subsequent children-nodes are selected. In this context, describe the significance of following terms: (i) Purity or Entropy of node and (ii) Information gain. **(5)** | 2 | 2 | 4

C)	Sketch a neural network with 3 inputs, two hidden layers of 2 neurons each and an output layer of 1 neuron. What are the hidden layers for, and what do these hide? Discuss the mathematical relationship between the output of any single neuron and its inputs with a neat sketch. Describe the significance of weights, bias, and activation function in the neural network.	**(5)**	4	2	5
D)	Figure shows a part of state space of a reinforcement learning agent. During one of the iteration steps, the estimated values of reward r and $Q(s,a)$ function for different states s and action a are shown in the figure.	**(5)**	4	3	7



(i) Calculate the optimal value function $V^*(s)$ for all states.
(ii) Find the optimum policy $\pi^*(s)$ for state S_1.
(iii) Update the value of the Q-function for moving from S_1 to S_4. Consider discount factor $\gamma = 0.9$.