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T.Y.B.Tech. Mech. Sem V

BHARATIYA VIDYA BHAVAN'S
SARDAR PATEL COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institute)

Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Examination; November 2017

Maximum Marks: 100 **Duration: 3 Hrs**

Class: **T.Y. B. Tech. (Mechanical)** Semester: **V**

Program: **B. Tech. (Mechanical Engineering)** Master file.

Name of the Course: **COMPLIANT MECHNISMS** Course Code: **BTM525**

Instructions:

1. **Question number 1 is compulsory and solution of Q. 1 will be collected after two hrs of examination. Students will not be permitted to attempt Q. 1 after initial two hrs of examination. Scissor, pasting glue, paper cutter, steel/plastic rule required for solving Q. 1 is allowed during examination. Every student shall have his/her own stationery for attempting questions. Exchange of stationery is strictly not allowed. Student shall write exam seat number on the developed compliant mechanism mentioned in Q. 1.**
2. **Solve any 3 questions from remaining questions (Question number 2 to 5)**
2. **Draw neat diagrams wherever necessary.**
3. **Assume suitable data if necessary.**

Q. No.		Max. Points	CO No.	M. No.
1	Students shall design and prepare a complaint mechanism illustrating the moving cubes. Moving cube consists of an array of 3x3 cubes (Total 9 cubes) shall be prepared using drawing paper. Prepared moving cube compliant mechanism shall show the relative motion of the cubes on application of moment on diagonally opposite cubes. Students shall plan and take appropriate dimensions of cube for effective utilization of drawing sheet.	40	4	4,6 ,7
2 (a)	With neat sketch explain Parallel Flexure hinge mechanism for ultra precision turning operation. Also explain the Mechatronics system employed for the ultra precision turning operation for feedback and control.	8	2	7
(b)	With neat sketches explain the primary ways to influence the flexibility	7	1	2
(c)	Discuss in detail the challenges involved in the compliant mechanisms	5	1	1
3 (a)	Figure 1 shows the parallelogram flexure mechanism, comprised of two identical simple beams (L = 250 mm, T = 5 mm, H = 50 mm, W = 75 mm, E = 1.4x10^9 N/m^2). Plot the graph of Normalised DoF Displacement (u_y) against Normalised DoC Displacement (u_x) solving given flexural mechanism by linear and beam constraint model (BCM). Consider force range of 1000 N to 10000 N in steps of 1000N for both Fx and Fy to obtain characteristics.	15	3	3,4

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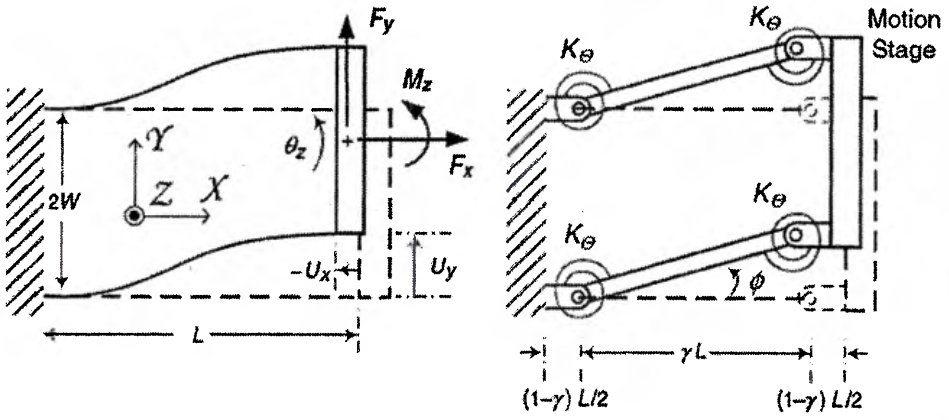

Figure 1: Parallelogram flexure and its pseudo-rigid body model.

Refer following table for the characteristics coefficients for simple beam.

$k_{11}^{(0)}$	12	$k_{11}^{(1)}$	6/5	$g_{11}^{(0)}$	−3/5	$g_{11}^{(1)}$	1/700	
$k_{12}^{(0)}$	−6	$k_{12}^{(1)}$	−1/10	$g_{12}^{(0)}$	1/20	$g_{12}^{(1)}$	−1/1400	$k_{33} = \frac{12}{(T/L)^2}$
$k_{22}^{(0)}$	4	$k_{22}^{(1)}$	2/15	$g_{22}^{(0)}$	−1/15	$g_{22}^{(1)}$	11/6300	

(b)	Draw schematics of spiral shaped flexural system used as linear guide ways. Explain various geometrical parameters governing the accuracy and resolution of the system.	**5**	**3**	**6**
4 (a)	Inverted spiral arm based flexural system for linear guideway of cutting tool in microdrilling operation is proposed. Brushless DC motor of 200 gm rotating at high speed of 20000 rpm is used in the system. The self mass of the flexural feed stage system consist of spiral disc set, flexible coupling, collect chuck and microtool is having weight of 150 gm. In the beginning of the operation, feed stage is to be operated under maximum feed acceleration of 0.25 mm/s^2. Maximum effective feed displacement is proposed to be 5 mm. The maximum reaction on the system during drilling operation is expected to be 1.5 N. Spiral disc of 100 mm diameter having thickness 0.7 mm is to be used in the flexural system. Find specification for linear actuator to be employed for the system. Find percentage variation in the actuation force if (i) disc of 80 mm diameter is used of thickens 0.7 mm (ii) Disc of 100 mm diameter and thickness 0.54 mm used in the system (iii) Disc of 80 mm diameter and thickness 0.54 mm used in the system.	**15**	**4**	**5,7**

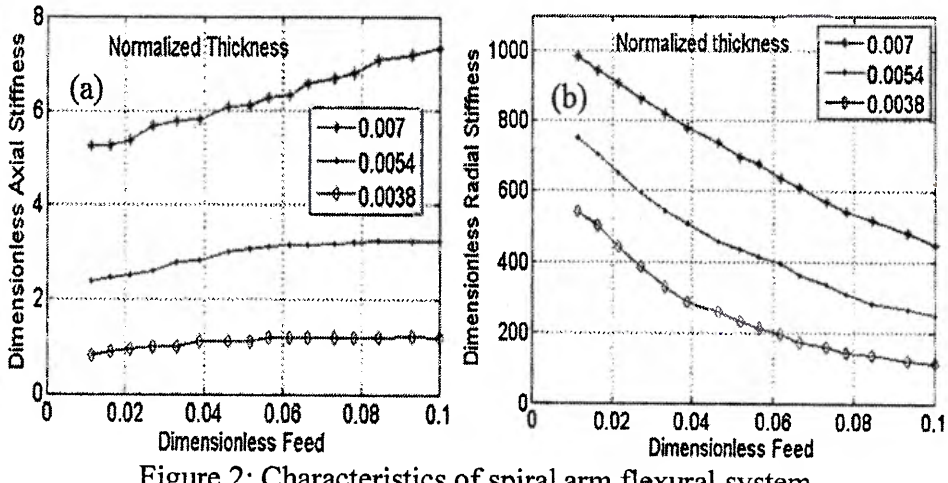

Figure 2: Characteristics of spiral arm flexural system

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(b)	Explain freedom and constraint topology (FACT) approach used for synthesis of compliant mechanisms	**5**	**3**	**6**
5 (a)	Find the force on free end of fixed-free beam deflected by an angle 15^0 and 20^0. Consider Pseudo-rigid-body model of a cantilever beam and horizontal to vertical force ratio being 1.5. Following are the geometric and material properties of the beam length, $L = 250$ mm, thickness, $T = 5$ mm, height, $H = 50$ mm, Youngs Modulus, $E = 210\,000$ N mm^{-2}. Also find new displaced position of the free end of the beam and maximum stress. Take γ=0.85 and K_θ=2.65.	**15**	**3**	**3,5**
(b)	Draw schematic diagram of flexural mechanism used for X-Y scanning of focused laser beam in on-axis microstereolithography. State advantages of the on-axis scanning.	**5**	**4**	**7**

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Munshi Nagar, Andheri (West), Mumbai – 400058.

(Value Added Course)

Max. Marks:100 Duration: 3hr

Class: T.Y B.tech Semester: V Program: B.Tech (Mech)

Name of the Course: Digital Manufacturing. Course Code : BTM526

Master file.

Instructions:

1. Solve any five questions out of seven
2. Figures to the right indicates full marks
3. Assume suitable data wherever necessary

Question no.	Questions	Maxi. marks	Course outcome no
Q.1 (a)	Explain Role of Digital Manufacturing in Automotive/Auto Component industries in detail along with neat figures	10	1
Q.1 (b)	Explain the concept of Virtual Commissioning?	10	1
Q.2 (a)	What is the significance of conversion of CAD to VR Model? Explain the steps in detail to convert a CAD Model to VR Model? Supplement your explanation with appropriate figures?	15	3
Q.2 (b)	Comment on the Research and Development Status of Digital Manufacturing	05	2
Q.3 (a)	Explain the procedure to import the ROBOT & Welding Gun from the DELMIA catalog?	10	2
Q.3 (b)	Explain the procedure to create a Digital factory using DELMIA Software tool?	10	4
Q.4(a)	Explain in the detail Virtual Ergonomics?	10	3
Q.4(b)	Explain the Hardware & Software technologies used for Digital Manufacturing?	10	2

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Q.5(a)	Explain the concept of Bionic Manufacturing?	10	2
Q.5(b)	Explain the concept of Holonic Manufacturing?	10	3
Q.6 (a)	Explain the Advantages of Digital Manufacturing?	10	1
Q.6 (b)	Explain the Architecture of Digital manufacturing?	10	1
Q.7(a)	Role of Manikins & Avatars in virtual Environment?	10	2
Q.7(b)	What is the role of Digital Manufacturing technology in Engineering Education?	10	3

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BHARATIYA VIDYA BHAVAN'S
SARDAR PATEL COLLEGE OF ENGINEERING
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Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Examination; November 2017

Maximum Marks: 100 **Duration: 3 Hrs**

Class: **T.Y. B. Tech. (Mechanical)** Semester: **V**

Program: **B. Tech. (Mechanical Engineering)**

Name of the Course: **HYDRAULIC MACHINERY** Course Code: **BTM505**

Master file.

Instructions:

1. **Question number 1 and 2 are compulsory.**
2. **Solve any 3 questions from remaining questions (Question number 3 to 7)**
2. **Draw neat diagrams wherever necessary.**
3. **Assume suitable data if necessary.**

Q. No.		Max. Points	CO No.	M. No.
1 (a)	Tests on a centrifugal pump gave the following results:- Q (lpm) | 0 | 200 | 400 | 600 | 800 | 1000 Hm (m) | 9.5 | 9.15 | 8.2 | 6.8 | 5.2 | 2 The pump supplies to two reservoirs A and B. The common pipe upto junction J is 300 m long and 15 cm diameter. The pipe from junction J to reservoir A is 150 m long and 10 cm diameter. The pipe from junction J to reservoir B is 100 m long and 10 cm diameter. The coefficient of friction for all pipes is 0.025 $\left(h_f = \frac{flv^2}{2gd}\right)$. The water levels in reservoir A and B are 4.6 m and 5.75 m above the suction tank level respectively. Estimate the discharge to reservoirs A and B.	10	2	7
(b)	In water power site, the available discharge is 340 m /s under a net head of 30 m. Assuming a turbine efficiency of 88% and rotational speed of 166.7 rpm, determine the least number of machines, all of the same size, that may be installed if the selection rests with- (i) Francis turbine with Ns not greater than 230. (ii) Kaplan turbine with Ns not greater than 685, What will be the output of each unit? Which of the two installations will be more economical? (reference Ns given by considering speed in rpm, power in KW, and head in meters)	10	4	1,3
2 (a)	Determine the overall efficiency of a Kaplan turbine developing 2850 KW under a head of 5.2 m. It is provided with a draft tube with its inlet (diameter 3 m) set 1.8 m above the tail race level. A vaccum gauge connected to the draft tube indicates a reading of 5.2 m of water (gauge). Assume draft tube efficiency as 75% and neglect head lost due to friction in draft tube.	10	3	3
(b)	Draw rough nature of Head-Discharge (Hm Vs Q) characteristics of forward faced, radial, and backward faced outlet vane angled impeller of centrifugal pump. Derive the expression for manometric head in terms of speed, discharge and design constants for backward faced vane impeller. Explain why generally centrifugal pump impeller with backward faced outlet vane angle is preferred in design?	10	1	6

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3 (a)	Manometric head discharge characteristics of a centrifugal pump is given by the equation: $Hm=20+15Q-600Q^2$ Where Hm is in m and Q is in m^3/s. System curve for a typical installation is estimated as $10+900Q^2$ (Q is in m^3/s), where 10 is static head in m. If the NPSHR characteristics of the pump is given by equation: $NPSHR=20Q+60Q^2$ where Q is in m^3/s, evaluate how high the pump can be safely installed above the sump if suction pipe diameter is 15 cm, pipe length on suction side is 1.5 times static suction lift and 'f' for the pipe is 0.016. Evaluate the cavitation parameter 'σ' if pump runs at 1440 rpm and operates at duty point. Calculate the specific speed and suction specific speed. Take atmospheric and vapour pressure being 10.3 and 2.5 mWc respectively.	**10**	**3**	**7**
(b)	The following data pertain to a Inward flow Francis turbine: Net head=70 m, Speed=700 rpm, Shaft Power =330 KW, Overall efficiency=85%, Hydraulic efficiency=92%, Flow ratio=0.22, Breadth ratio (width at inlet/Diameter at intlet) =0.1, Outer diameter of runner=2x inner diameter of runner Velocity of flow is constant with radial discharge at outlet. The thickness of vanes occupy 6% of circumferential area of the runner. Determine: (i) Diameters of runner at inlet and outlet (ii) Width of the wheel at inlet, (iii) Guide blade angle, and (iv) Runner vane angles at inlet and outlet.	**10**	**2**	**3**
4 (a)	The impeller of a centrifugal pump has an outer diameter of 250 mm and an effective area of 0.017 m^2. The blades are bent backwards so that the direction of outlet relative velocity makes an angle of 148^0 with the tangent drawn in the direction of impeller rotation, the diameters of suction and delivery pipes are 150 mm and 100 mm respectively. The pump delivers 0.031 m^3/s at 1450 rpm when the gauge points on the suction and delivery pipes close to the pumps shows heads of 4.6 m below and 18 m above atmosphere respectively. The head losses in the suction and delivery pipes are 2 m and 2.9 m respectively. The motor driving the pump delivers 8.67 KW. Assuming that water enters the pump without shock and whirl, determine: (i) The manometric efficiency, and (ii) The overall efficiency of the pump.	**10**	**2**	**6**
(b)	Write short note on (i) Cavitation in turbine (ii) Selection of turbines	**10**	**4**	**4**
5 (a)	The diameter and stroke of a single-acting reciprocating pump are 300 mm and 500 mm respectively. The pump takes its supply of water from a sump 3.2 m below the pump axis through a pipe 9 m long and 200 mm diameter. If separation occurs at 2.4 m of water absolute, determine: (i) The speed at which separation may take place at the beginning of suction stroke, and (ii) The speed of the pump if an air vessel is fitted on the suction side 6.75 m along the length measured from the sump water level. Take atmospheric pressure head=10.3 m of water, and friction co-efficient, f=0.04 (Take $h_f=flv^2/2gd$).	**10**	**3**	**5**
(b)	A centrifugal pump has a suction pipeline of 12.5 cm diameter and 10 m length. The static suction lift is 2m. Friction factor for pipe is 0.02. The pump delivers oil	**10**	**4**	**7**

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	of specific gravity 0.8, the vapour pressure for oil at ambient temperature being 0.015 kg/cm^2 absolute. The NPSHR characteristic of the pump is given by the equation $15Q+65Q^2$ where NPSHR is in meters of water column absolute and Q is in m^3/s. If the ambient pressure is 1 bar (abs) determine the maximum discharge the pump can handle without cavitating.			
6 (a)	What is negative slip in reciprocating pump? Explain the same with the help of indicator diagram.	5	1	5
(b)	Write short note on (i) working and significance of air vessel in reciprocating pump (ii) Gear Pump	10	1	5
(c)	A 1/5 scale turbine model is tested under a head of 15 m. The actual (prototype) turbine will work under head of 30 m and speed of 450 rpm. If model develops 100 KW of power using 1.1 m^3/s of water, then calculate: (i) speed of the model turbine (ii) Power developed by prototype.	5	3	4
7 (a)	A centrifugal pump has the following characteristics Q (m^3/s): 0 | 0.009 | 0.018 | 0.027 | 0.036 | 0.045 | 0.054 Hm (m): 22.6 | 21.8 | 20 | 17.6 | 14.5 | 10.6 | 4.8 The pump supplies water from a lake to a reservoir whose cross-sectional area is 40 m^2 via 65 m of 15 cm diameter pipe for which f=0.028 $\left(h_f = \frac{flv^2}{2gd}\right)$. The pump is switched on when the level in reservoir is 5 m above the water level in the lake and is switched off when the level is 18 m. By plotting the pump characteristic and the system curve at say 30 min intervals (assuming constant discharge during the chosen time interval) obtain a graph showing a relationship between the pump discharge and time for one cycle of operation. How long does the cycle last?	10	3	7
(b)	A single jet Pelton turbine is required to drive a generator to develop 10000 KW. The available head at the nozzle is 760 m. Assuming electric generation efficiency 95%, Pelton wheel efficiency 87%, coefficient of velocity for nozzle 0.97, mean bucket velocity 0.46 of jet velocity, outlet angle of bucket 15^0 and the relative velocity of the water leaving the buckets 0.85 of that relative velocity at inlet, find: (i) The flow in m^3/s, (ii) The diameter of jet, (iii) The force exerted by the jet on the buckets, and (iv) The best synchronous speed for generation at 50Hz and the corresponding mean diameter if the ratio of the mean bucket circle diameter to the jet diameter is not to be less than 10.	10	2	2

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Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Exam (Nov 2017)

Q. P. Code:

Max. Marks: 100 **Duration: 3 Hour**

Class: T.Y(Mechanical) Semester: V **Program: B.Tech**

Name of the Course: Mechatronics **Course Code : BTM503**

Master file.

Instructions:

1. Answer any five questions including Q.No.1 which is compulsory.

2. Assume suitable additional data if necessary and state the same.

Q. No		Max. Marks	CO No.	Module No
Q1	Answer any four :- a) Dominant ON and dominant OFF electrical circuit. b) Analog computer method for determining system response. c) Use of Counterbalance pressure control valve in arresting the free falling of hydraulic heavy duty piston. d) Open and close loop control systems. e)Advantages and applications of Microelectromechanical systems(MEMS) f) Components of a Mechatronics System.	20 (5each)	1,4,2,3,	3,5,1,2,4
Q2	A)Sketch the root locus systematically for open loop transfer function $G(s)H(S) = \frac{K(S+1)}{S^2(S+3)(S+5)}$ Find the value of K for any two arbitrary points on the root locus.(Use graph sheet for plotting)	12	3	6
	B)A system has the transfer function $\theta_0/\theta_i = 5(0.5S+1) / [(3D+1)(2D^2+4D+1)]$ Study the nature of the system by examining its response to a step input disturbance $\theta_i = 3$. (Refer Laplace conversion table)	08	3	5
Q3	A) Construct the Bode plot for a unity feedback control system having $G(s) = 10(S+10) / \{S(S+2)(S+5)\}$ Find the Gain margin and Phase margin and comment on the stability of the system.(Use semi log graph sheet for plotting)	12	5	4
	B) A system has the transfer function $\theta_0/\theta_i = K(1+T_1D) / [(1+T_2D)(1+T_3D)]$ Assuming K=20; T_1 =0.2 sec; T_2 =0.3 sec; T_3 = 0.05sec, establish the frequency response characteristic of the system. Make the polar plot of the data.	08	5	3

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Q4	A) Draw the block diagram of a microprocessor and explain the three segments (ALU, Register and Control unit) of a micro processor. State the characteristics, important features and functions of micro-processor. B) Obtain the transfer function for the given system by using Block Diagram reduction technique (Fig 1)	10 10	1 3	2 4
Q5	A) Construct ladder diagram, allocation table and PLC diagram for the following operation sequence. A Circuit that can be used to start a motor and then after a delay of 100s start a pump. When the motor is switched off there could be a delay of 10s before the pump is switched off. B)Examine the stability of the system by Routh's criterion: a) $S^4 + 10S^3 + 35S^2 + 50S + 24 = 0$ b) $S^6 + 4S^5 + 3S^4 - 16S^2 - 64S - 48 = 0$ c) $S[S3 + 5S^2 + 5S + 4] + K = 0$; find the range of values of K for stable system.	8 12	1 4	3 5
Q6	A)Three double acting cylinders A,B and C are used in an automation system and the sequence of motion for the three pneumatic cylinders are:- A + (BC) + /delay A -- / A +/delay A-- (BC)-- Auxiliary condition is single or continuous cycle. Use CASCADE method to draw the pneumatic circuit. Prepare the parts list. B) With own circuit show the application of counter relay in electro-pneumatic control.	14 06	2 4	3 7
Q7	A) An electro-hydraulic system is selected for a sequential hydraulic cylinders actuation in a stamping cycle. Cylinder A is hydraulic double acting clamping cylinder. Cylinder B is hydraulic double acting stamping cylinder. Cylinder C is hydraulic double acting ejecting cylinder. The sequence of movements for the three cylinders is: A + B + / delay B-- A-- C+ / delay C--. Cylinder A and C are having single solenoid valves and cylinder B is having double solenoid valve. The auxiliary condition is single cycle or continuous cycle. When an Emergency switch is actuated all the three cylinders are to retract to the home position and the cycle can commence only when the emergency switch is disabled. Draw the electro hydraulic circuit and prepare the parts list. B) Briefly explain the application of hydraulic accumulators and Pressure intensifiers.	14 06	2 2	3 7

T.Y.B.Tech. Mech Sem V

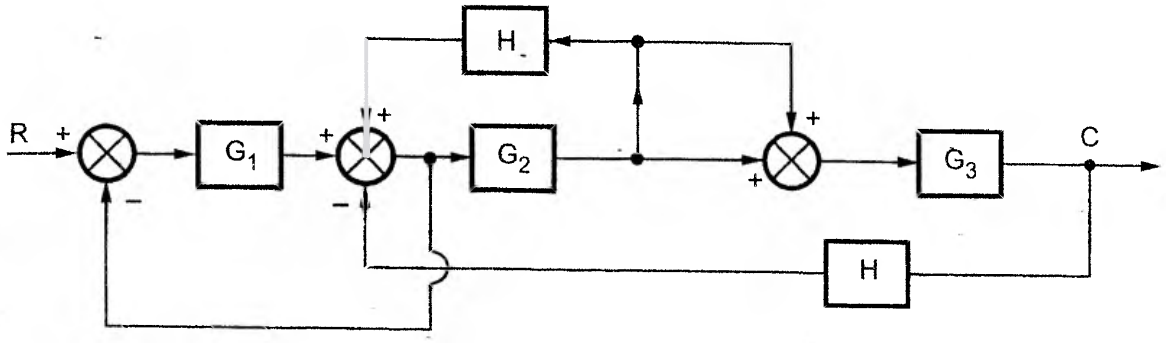

FIG: 1 Q 4 (B)

TABLE [redacted] *Laplace Transform Pairs Associated with the Factors* $\frac{\theta_o}{\theta_i} = \frac{K}{1 + Ts}$ *and* $\frac{\theta_o}{\theta_i} = \frac{K}{K_1 s^2 + K_2 s + 1}$ *Subjected to Free Response, Step, Ramp, and Sine Inputs*

No.	$F(s)$	$f(t)$	Comment
1	$\frac{H}{s}$	H	Step
2	$\frac{H}{s^2}$	Ht	Ramp
3	$\frac{H}{\omega + s^2/\omega}$	$H \sin \omega t$	Sine
4	$\frac{K}{1 + Ts}$	$\frac{K}{T} \cdot e^{-t/T}$	Free response of first-order system
5	$\frac{K}{(1 + T_1 s)(1 + T_2 s)}$	$\frac{K}{T_1 - T_2}(e^{-t/T_1} - e^{-t/T_2})$	Free response of second-order system, $\xi > 1$
6	$\frac{K}{(1 + Ts)^2}$	$\frac{Kt}{T^2} \cdot e^{-t/T}$	As for 5, with $\xi = 1$
7	$\frac{K}{s^2/\omega_n^2 + (2\xi/\omega_n)s + 1}$	$\frac{K\omega_n}{(1 - \xi^2)^{1/2}} \cdot e^{-\xi\omega_n t} \cdot \sin \omega_d t$	As for 5, with $\xi < 1$
8	$\frac{HK}{s(1 + Ts)}$	$HK(1 - e^{-t/T})$	First-order system, response to step input
9	$\frac{HK}{s^2(1 + Ts)}$	$HKT\left(e^{-t/T} + \frac{t}{T} - 1\right)$	First-order system, response to ramp input
10	$\frac{HK}{(\omega + s^2/\omega)(1 + Ts)}$	$\frac{HK}{(1 + \omega^2 T^2)^{1/2}}\left[\sin(\omega t - \phi) + \frac{\omega T}{(1 + \omega^2 T^2)^{1/2}} \cdot e^{-t/T}\right]$ where $\phi = \tan^{-1} \omega T$	First-order system, response to sine input
11	$\frac{HK}{s(1 + T_1 s)(1 + T_2 s)}$	$HK\left[1 + \frac{1}{T_2 - T_1}(T_1 e^{-t/T_1} - T_2 e^{-t/T_2})\right]$	Second-order system, response to step input when $\xi > 1$
12	$\frac{HK}{s(1 + Ts)^2}$	$HK\left[1 - \frac{T + t}{T} e^{-t/T}\right]$	Second-order system, response to step input when $\xi = 1$

No.	$F(s)$	$f(t)$	Comment
13	$\frac{HK}{s[s^2/\omega_n^2 + (2\xi/\omega_n)s + 1]}$	$HK[1 + (1 - \xi^2)^{-1/2} e^{-\xi\omega_n t} \sin(\omega_d t - \psi)]$ where $\psi = \tan^{-1}(1 - \xi^2)^{1/2}/-\xi$	Second-order system, response to step input when $\xi < 1$
14	$\frac{HK}{s^2(1 + T_1 s)(1 + T_2 s)}$	$HK\left[t - T_1 - T_2 - \frac{1}{T_1 - T_2}(T_2^2 e^{-t/T_2} - T_1^2 e^{-t/T_1})\right]$	Second-order system, $\xi > 1$, response to ramp input
15	$\frac{HK}{s^2(1 + Ts)^2}$	$HK[t - 2T + (t + 2T)e^{-t/T}]$	Second-order system, $\xi = 1$, response to ramp input
16	$\frac{HK}{s^2(s^2/\omega_n^2 + (2\xi/\omega_n)s + 1)}$	$HK[t - 2\xi/\omega_n + (e^{-\xi\omega_n t}/\omega_d) \cdot \sin(\omega_d t - \psi)]$ where $\psi = 2\tan^{-1}(1 - \xi^2)^{1/2}/(-\xi)$	Second-order system, $\xi < 1$, response to ramp input
17	$\frac{HK}{(\omega + s^2/\omega)(1 + T_1 s)(1 + T_2 s)}$	$HK\left[\frac{T_1^2 \omega e^{-t/T_1}}{(T_1 - T_2)(1 + T_1^2\omega^2)} + \frac{T_2^2 \omega e^{-t/T_2}}{(T_2 - T_1)(1 + T_2^2\omega^2)} + \frac{\sin(\omega t - \phi)}{[(1 + T_1^2\omega^2)(1 + T_2^2\omega^2)]^{1/2}}\right]$ where $\phi = \tan^{-1}\omega T_1 + \tan^{-1}\omega T_2$	Second-order system, $\xi > 1$, response to sine input
18	$\frac{HK}{(\omega + s^2/\omega)(1 + Ts)^2}$	$\frac{HK}{1 + T^2\omega^2}\left[\sin(\omega t - \phi) + \frac{\omega t + 2T\omega}{1 + T^2\omega^2} e^{-t/T}\right]$ where $\phi = 2\tan^{-1}\omega T$	Second-order system, $\xi = 1$, response to sine input
19	$\frac{HK}{(\omega + s^2/\omega)[s^2/\omega_n^2 + (2\xi/\omega_n)s + 1]}$	$\frac{HK}{[(1 - \omega^2/\omega_n^2)^2 + (2\xi\omega/\omega_n)^2]^{1/2}} \cdot \left[\sin(\omega t - \phi) + \frac{\omega}{\omega_d} \cdot e^{-\xi\omega_n t} \sin(\omega_d t - \psi)\right]$ where $\phi = \tan^{-1}\frac{2\xi\omega/\omega_n}{1 - \omega^2/\omega_n^2}$; $\psi = \tan^{-1}\frac{-2\xi(1 - \xi^2)^{1/2}}{\omega^2/\omega_n^2 - (1 - 2\xi^2)}$	Second-order system, $\xi < 1$, response to sine input

$\xi = \frac{1}{2} K_2 K_1^{-1/2}$ is the damping ratio
$\omega_n = K_1^{-1/2}$ is the undamped natural frequency
$\omega_d = \omega_n(1 - \xi^2)^{1/2}$ is the damped natural frequency

} { associated with the quadratic $K_1 D^2 + K_2 D + 1 = \frac{D^2}{\omega_n^2} + \frac{2\xi}{\omega_n} D + 1 = \frac{s^2}{\omega_n^2} + \frac{2\xi}{\omega_n} s + 1$

Q. 2(B)

T.Y.B.Tech. Sem V Mech.

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End Semester

November 2017

Date: 20/11/2017
Program: T. Y. B. Tech
Semester: V

Course code: BTM504
Duration: 3 Hours
Maximum Marks: 100

Name of the Course: Thermal Systems Master file.

Instructions: 1. Question number ONE is compulsory and solve any FOUR questions out of remaining SIX.
2. Steam table and Mollier diagram is allowed to use.
3. All sub questions to be grouped together.
4. Assume suitable assumptions and justify the same.

Question No.		Maximum Marks	Course Outcome Number	Module No.
Q1				
a)	Explain effect of pressure ratio on volumetric efficiency of reciprocating compressor.	05	CO1	2
b)	Describe all the elements of condensing plant with its use.	05	CO1	5
c)	Discuss about mountings and accessories of boilers.	05	CO4	4
d)	Discuss how reheating, regeneration and intercooling affect the efficiency and work output of open cycle gas turbine.	05	CO1	7
Q2				
a)	Consider a steam power plant operating on the simple ideal Rankine cycle. Steam enters the turbine at 3 MP and 350°C and is condensed in the condenser at a pressure of 75 kPa. Determine the thermal efficiency of this cycle.	08	CO1	3
b)	A two stage double acting air compressor delivers air at a rate of 1.35 kg/sec. The suction pressure is 1 bar and interstate pressure is 7 bar and delivery pressure 42 bar. Air enters the low pressure cylinder at 17°C and cooled in the intercooler to 32°C. The clearances in L.P. and H.P. cylinders are 6% and 8% of respective strokes. The law of compression and re-expansion is $pv^{1.21} = C$ in both cylinders. Speed of the compressor is 500 RPM. Find (i) The amount of cooling water required per minute in intercooler, if rise in temperature of water is limited to 20°C (ii) Power required (iii) Diameter and Stroke of L.P. cylinder if L=D.	12	CO3	2
Q3				
a)	Derive ideal intercooling pressure ratio with perfect intercooling of compressor for minimum work input.	10	CO1	2
b)	Steam at a pressure of 20 bar with 50°C of superheat is	10	CO3	6

	allowed to expand through a convergent-divergent nozzle. The exit pressure is 1 bar. If the nozzle is required to supply 2 kg/sec of steam to the turbine, then calculate (i) velocities at throat and exit (ii) areas at throat and exit.			
Q4				
a)	Explain with neat sketch working of root blower and vane-type blower.	**08**	CO2	3
b)	In a single stage impulse turbine, the diameter of the blade ring is 1m and speed is 3000 RPM. The steam is issued from a nozzle at 300 m/sec and the nozzle angle is 20°. The blades are equiangular. If the friction loss in the blade channel is 19% of the K.E. corresponding to the relative velocity at the inlet to the blades, find power developed in the blading when the axial thrust on the blades is 90 N.	**12**	CO3	6
Q5				
a)	Explain the working of locomotive boiler with neat sketch.	**10**	CO4	4
b)	Draw neat sketch of evaporative condenser and explain its working.	**10**	CO4	5
Q6				
a)	Differentiate between axial and centrifugal compressors.	**08**	CO2	3
b)	The following data apply to a gas turbine set using a heat exchanger: Isentropic efficiency of compressor = 0.83, Isentropic efficiency of turbine = 0.85, Mechanical transmission efficiency = 0.99, combustion efficiency = 0.98, Heat exchanger effectiveness = 0.80, Pressure ratio = 4.0, Maximum cycle temperature = 1100 K, Ambient condition = 1 bar and 288 K, Lower heating value of fuel = 43,100 kJ/g. Take C_p=1.005 kJ/kg.K, γ = 1.4 during compression and C_p = 1.147 kJ/kg.K, γ = 1.3 during combustion and expansion. Calculate specific work output, specific fuel consumption and cycle efficiency. Neglect all losses.	**12**	CO3	7
Q7				
a)	Derive equation for maximum efficiency of Parsons's steam turbine.	**10**	CO4	6
b)	Enlist at least four applications of each components listed below. (i) compressor (ii) steam nozzles (iii) steam generator (iv) steam turbines (v) gas turbines	**10**	CO4	1,4,6, 7

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T.Y.B.Tech. Mech. Sem V

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

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Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Exam

November 2017

Max. Marks: 100 Duration: 03 Hours

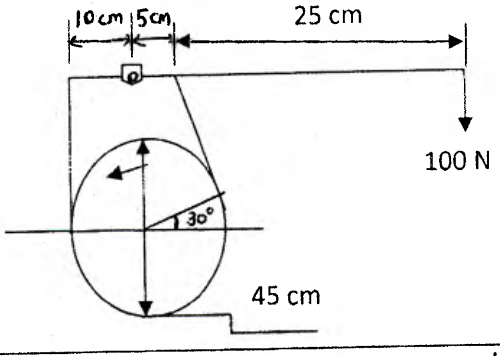
Class: T. Y. B. Tech Semester: V Program: Mechanical Engineering

Name of the Course: Theory of Machines II Course Code : BTM502

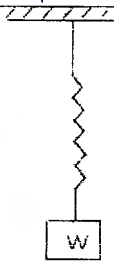
Master file.

Instructions:

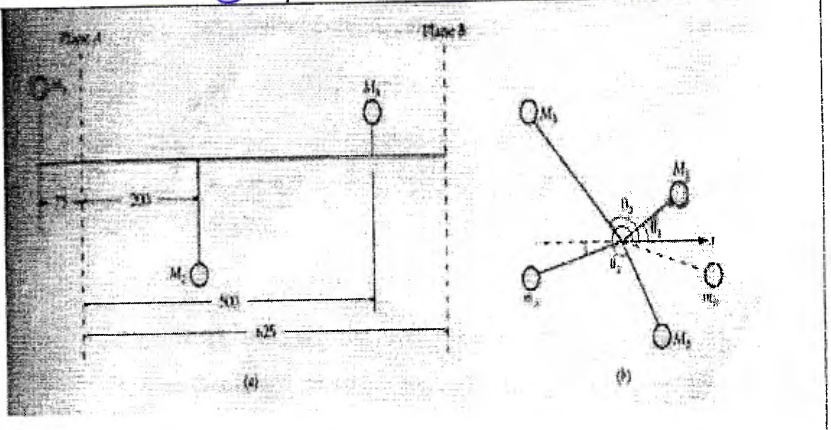
1. Attempt any five questions out of remaining six.
2. Draw neat diagrams wherever required.
3. Assume suitable data if necessary.

Question No		Maximum Marks	Course Outcome Number
1(a)	Explain Prony Brake Dynamometer.	05	1
(b)	Explain any five main causes of vibration.	05	3
(c)	Derive an expression for natural frequency by using Rayleigh's method.	10	4
Q2(a)	A multiplate disc clutch transmits 55 KW of power at 1800 r.p.m. The coefficient of friction is 0.1 and the axial intensity of pressure is not to exceed 160 KN/m^2. The internal radius is 80 mm and is 0.7 times the external radius. Find the number of plates needed to transmit the required torque.	10	1
(b)	The hand operated brake as shown in figure is fitted to a shaft carrying a flywheel of mass 400 kg with a radius of gyration 45 cm running at 360 rpm. Determine: (i) Torque applied due to pull of 100 N (ii) Number of revolutions of the flywheel before it is brought to rest (iii) Time required to bring the flywheel to rest Take coefficient of friction 0.2. 	10	1
Q3(a)	The helical spring as shown in figure has a mean coil diameter D=2.5 cm, a wire diameter d = 0.25 cm and contains n= 20 coils. The modulus of elasticity of the wire in shear is G = 8.4 X 10^5 Kg/cm^2 and the suspended weight is W=15 Kg. Calculate the period of free vibrations.	10	4

T.YB Tech. Mech. Sem V

			
(b)	A weight if 1 Kg is attached to a spring having stiffness 4 Kg/cm. The weight slides on a horizontal surface, the coefficient of friction between the weight and surface being 0.1. Determine the frequency of vibration of the system and the amplitude after one cycle if the initial amplitude is 0.25 cm. Determine the final rest position.	10	4
Q4(a)	Each arm of a porter governor is 250 mm long. The upper and lower arms are pivoted to links of 40 mm and 50 mm respectively from the axis of rotation. Each ball has a mass of 5 Kg and the sleeve mass is 50 Kg. The force of friction on the sleeve of mechanism is 40 N. Determine the range of speed of the governor for extreme radii of rotation of 125 mm and 150 mm.	12	1
(b)	Define the following terms relating to governors : i. Sensitiveness ii. Isochronism iii. Stability iv. Hunting	08	1
Q5	A ship is pitching a total angle of 15^0, the oscillation may be taken as simple harmonic and the complete period is 32 seconds. The turbine rotor mass is 600 Kg, its radius of gyration is 450 mm and it is rotating at 2400 r.p.m. Calculate the maximum value of gyroscopic value set by the rotor and its effect, when the bow is descending and the rotor is rotating clockwise looking from aft. What is the maximum angular acceleration to which the ship is subjected to while pitching?	20	1
Q 6	An epicyclic train is composed of fixed annular wheel A having 150 teeth. Meshing with A is wheel B which drives wheel D through an idle wheel C, wheel D being concentric with A. Wheels B and C are carried on an arm E which revolves clockwise at 100 r.p.m about the axis of A and D. If the wheel B and D have 25 and 40 teeth respectively, find the number of teeth on C and sense of rotation of C. Also sketch an arrangement.	20	1
Q7(a)	Three masses M_1, M_2 and M_3 which rotate in transverse planes 1, 2 and 3 are to be balanced by the addition of two rotating masses m_A in plane A and m_B in plane B at a radius of 250 mm each. Given that $M_1 = 4.0$ kg, $M_2 = 6.4$ kg and $M_3 = 2.0$ kg. The location of centre of gravity of masses M_1, M_2 and M_3 are 150 mm, 100 mm and 225 mm respectively, from the rotor axis. Also, the angular location of masses M_1, M_2 and M_3 from X axis are 30^0, 300^0 and 135^0 respectively as shown in figure	15	2

T.Y.B.Tech. Mech. Sem V

	 The distance of transverse planes of masses M1. M2, M3 and planes B from the reference transverse plane A, are 75 mm, 200 mm, 500 mm and 625 mm respectively. Determine m_A and m_B and show their angular positions for static balance of motor.		
(b)	Explain Balancing of i. In Line Engine ii. V Engine	05	2

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T.Y.B.Tech. (Mech) Sem V

BHARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

(A Government Aided Autonomous Institute)

Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Examination; November 2017

Maximum Marks: 100 **Duration: 3 Hrs**

Class: **T.Y. B. Tech. (Mechanical)** Semester: **V**

Program: **B. Tech. (Mechanical Engineering)**

Name of the Course: **HYDRAULIC MACHINERY** Course Code: **BTM505**

Master file.

Instructions:

1. **Question number 1 and 2 are compulsory.**
2. **Solve any 3 questions from remaining questions (Question number 3 to 7)**
2. **Draw neat diagrams wherever necessary.**
3. **Assume suitable data if necessary.**

Q. No.		Max. Points	CO No.	M. No.
1 (a)	Tests on a centrifugal pump gave the following results:-	10	2	7

Q (lpm)	0	200	400	600	800	1000
Hm (m)	9.5	9.15	8.2	6.8	5.2	2

The pump supplies to two reservoirs A and B. The common pipe upto junction J is 300 m long and 15 cm diameter. The pipe from junction J to reservoir A is 150 m long and 10 cm diameter. The pipe from junction J to reservoir B is 100 m long and 10 cm diameter. The coefficient of friction for all pipes is 0.025 $\left(h_f = \frac{flv^2}{2gd}\right)$.

The water levels in reservoir A and B are 4.6 m and 5.75 m above the suction tank level respectively. Estimate the discharge to reservoirs A and B.

(b)	In water power site, the available discharge is 340 m^3/s under a net head of 30 m. Assuming a turbine efficiency of 88% and rotational speed of 166.7 rpm, determine the least number of machines, all of the same size, that may be installed if the selection rests with- (i) Francis turbine with Ns not greater than 230. (ii) Kaplan turbine with Ns not greater than 685, What will be the output of each unit? Which of the two installations will be more economical? (reference Ns given by considering speed in rpm, power in KW, and head in meters)	10	4	1,3
2 (a)	Determine the overall efficiency of a Kaplan turbine developing 2850 KW under a head of 5.2 m. It is provided with a draft tube with its inlet (diameter 3 m) set 1.8 m above the tail race level. A vaccum gauge connected to the draft tube indicates a reading of 5.2 m of water (gauge). Assume draft tube efficiency as 75% and neglect head lost due to friction in draft tube.	10	3	3
(b)	Draw rough nature of Head-Discharge (Hm Vs Q) characteristics of forward faced, radial, and backward faced outlet vane angled impeller of centrifugal pump. Derive the expression for manometric head in terms of speed, discharge and design constants for backward faced vane impeller. Explain why generally centrifugal pump impeller with backward faced outlet vane angle is preferred in design?	10	1	6

T.Y.B.Tech. Mech. Sem V

3 (a)	Manometric head discharge characteristics of a centrifugal pump is given by the equation: $Hm=20+15Q-600Q^2$ Where Hm is in m and Q is in m^3/s. System curve for a typical installation is estimated as $10+900Q^2$ (Q is in m^3/s), where 10 is static head in m. If the NPSHR characteristics of the pump is given by equation: $NPSHR=20Q+60Q^2$ where Q is in m^3/s, evaluate how high the pump can be safely installed above the sump if suction pipe diameter is 15 cm, pipe length on suction side is 1.5 times static suction lift and 'f' for the pipe is 0.016. Evaluate the cavitation parameter 'σ' if pump runs at 1440 rpm and operates at duty point. Calculate the specific speed and suction specific speed. Take atmospheric and vapour pressure being 10.3 and 2.5 mWc respectively.	**10**	**3**	**7**
(b)	The following data pertain to a Inward flow Francis turbine: Net head=70 m, Speed=700 rpm, Shaft Power =330 KW, Overall efficiency=85%, Hydraulic efficiency=92%, Flow ratio=0.22, Breadth ratio (width at inlet/Diameter at intlet) =0.1, Outer diameter of runner=2x inner diameter of runner Velocity of flow is constant with radial discharge at outlet. The thickness of vanes occupy 6% of circumferential area of the runner. Determine: (i) Diameters of runner at inlet and outlet (ii) Width of the wheel at inlet, (iii) Guide blade angle, and (iv) Runner vane angles at inlet and outlet.	**10**	**2**	**3**
4 (a)	The impeller of a centrifugal pump has an outer diameter of 250 mm and an effective area of 0.017 m^2. The blades are bent backwards so that the direction of outlet relative velocity makes an angle of 148^0 with the tangent drawn in the direction of impeller rotation, the diameters of suction and delivery pipes are 150 mm and 100 mm respectively. The pump delivers 0.031 m^3/s at 1450 rpm when the gauge points on the suction and delivery pipes close to the pumps shows heads of 4.6 m below and 18 m above atmosphere respectively. The head losses in the suction and delivery pipes are 2 m and 2.9 m respectively. The motor driving the pump delivers 8.67 KW. Assuming that water enters the pump without shock and whirl, determine: (i) The manometric efficiency, and (ii) The overall efficiency of the pump.	**10**	**2**	**6**
(b)	Write short note on (i) Cavitation in turbine (ii) Selection of turbines	**10**	**4**	**4**
5 (a)	The diameter and stroke of a single-acting reciprocating pump are 300 mm and 500 mm respectively. The pump takes its supply of water from a sump 3.2 m below the pump axis through a pipe 9 m long and 200 mm diameter. If separation occurs at 2.4 m of water absolute, determine: (i) The speed at which separation may take place at the beginning of suction stroke, and (ii) The speed of the pump if an air vessel is fitted on the suction side 6.75 m along the length measured from the sump water level. Take atmospheric pressure head=10.3 m of water, and friction co-efficient, f=0.04 (Take $h_f=flv^2/2gd$).	**10**	**3**	**5**
(b)	A centrifugal pump has a suction pipeline of 12.5 cm diameter and 10 m length. The static suction lift is 2m. Friction factor for pipe is 0.02. The pump delivers oil	**10**	**4**	**7**

	of specific gravity 0.8, the vapour pressure for oil at ambient temperature being 0.015 kg/cm^2 absolute. The NPSHR characteristic of the pump is given by the equation $15Q+65Q^2$ where NPSHR is in meters of water column absolute and Q is in m^3/s. If the ambient pressure is 1 bar (abs) determine the maximum discharge the pump can handle without cavitating.			
6 (a)	What is negative slip in reciprocating pump? Explain the same with the help of indicator diagram.	5	1	5
(b)	Write short note on (i) working and significance of air vessel in reciprocating pump (ii) Gear Pump	10	1	5
(c)	A 1/5 scale turbine model is tested under a head of 15 m. The actual (prototype) turbine will work under head of 30 m and speed of 450 rpm. If model develops 100 KW of power using 1.1 m^3/s of water, then calculate: (i) speed of the model turbine (ii) Power developed by prototype.	5	3	4
7 (a)	A centrifugal pump has the following characteristics Q (m^3/s): 0 | 0.009 | 0.018 | 0.027 | 0.036 | 0.045 | 0.054 Hm (m): 22.6 | 21.8 | 20 | 17.6 | 14.5 | 10.6 | 4.8 The pump supplies water from a lake to a reservoir whose cross-sectional area is 40 m^2 via 65 m of 15 cm diameter pipe for which f=0.028 $\left(h_f = \frac{flv^2}{2gd}\right)$. The pump is switched on when the level in reservoir is 5 m above the water level in the lake and is switched off when the level is 18 m. By plotting the pump characteristic and the system curve at say 30 min intervals (assuming constant discharge during the chosen time interval) obtain a graph showing a relationship between the pump discharge and time for one cycle of operation. How long does the cycle last?	10	3	7
(b)	A single jet Pelton turbine is required to drive a generator to develop 10000 KW. The available head at the nozzle is 760 m. Assuming electric generation efficiency 95%, Pelton wheel efficiency 87%, coefficient of velocity for nozzle 0.97, mean bucket velocity 0.46 of jet velocity, outlet angle of bucket 15^0 and the relative velocity of the water leaving the buckets 0.85 of that relative velocity at inlet, find: (i) The flow in m^3/s, (ii) The diameter of jet, (iii) The force exerted by the jet on the buckets, and (iv) The best synchronous speed for generation at 50Hz and the corresponding mean diameter if the ratio of the mean bucket circle diameter to the jet diameter is not to be less than 10.	10	2	2

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T.Y.B.Tech. Mech. Sem V

BharatiyaVidyaBhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)

Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Exam, Nov 2017

Max. Marks: **100** Duration: **3 hrs**

Class: **T. Y. B. Tech.** Semester: **V** Program: **Mech. Engg.**

Name of the Course: **Heat and Mass Transfer** Course Code : **BTM501**

Master file.

Instructions:

- **Question No 1 is compulsory.**
- Attempt **any Four questions** out of Six questions.
- Answers to all sub questions should be grouped together.
- Figures to the right indicate full marks.
- Make suitable assumptions with proper explanations.
- Draw the suitable sketches wherever necessary

Q. No		Marks	CO NO	M No.
Q1	**Answer the following questions (any four)**	**20**		**1-7**
A.	Differentiate between steady and transient heat conduction with specific examples. How does heat convection differ from conduction?		**1**	
B.	Explain the criteria of selection of fins. Define fin efficiency. Explain the importance of insulated tip solution for the fins used in practice.		**1**	
C.	What is LMTD correction factor? Why is a counter flow heat exchanger more effective than a parallel flow heat exchanger? How does fouling factor affect the performance of a heat exchanger?		**1**	
D.	State the examples of mass transfer in day-to-day life and industrial applications. What are the various mechanisms of mass transfer?		**1**	
E.	What does the Grashof Number represent? How is it different from the Reynolds number? Explain the significance of Grashof Number in Natural convection heat transfer.		**1**	
Q2 (A)	A furnace wall is made up of refractory brick, red (fire) brick and outside plaster. There is an air gap with a thermal resistance of 0.15 m^2K/W between the refractory brick and the red brick. The refractory brick, 120 mm thick, has K = 1.58 W/mK. The red brick, 120 mm thick has K = 0.3 W/mK. The outside plaster, 15 mm thick, has K = 0.15 W/mK. The two extreme temperatures of this wall are 1000°C and 100°C. (b) Determine (a) the heat flow rate in kJ/hour.m^2, and the interface temperatures.	**10**	**4**	**2**

T.Y. B.Tech. Mech. Sem V

(B)	A hot cylindrical ingot (K = 60 W/mK, ρ = 7850 kg/m^3, Cp = 0.430kJ/kgK) of 50 mm diameter and 250 mm length is removed from a furnace at 850°C and suddenly quenched in water at 20°C until its temperature drops to 550°C. Subsequently, the ingot is exposed to ambient air at 20°C and allowed to cool slowly to 100°C. The convective heat transfer coefficient is 250 W/m^{2}K when the cooling medium is water and 25 W/m^{2}K with air is the cooling fluid. Estimate the total time required for cooling from 850°C to 550°C in water. As well as estimate the time required for cooling from 550°C to 100°C in air. Estimate the total time required for cooling the ingot. State and justify any assumptions made.	**10**	**4**	**3**
Q3 (A)	Air at 1 bar pressure and at 20°C flows over a rectangular container, with top surface 750 mm long in direction of flow and one meter wide, at 35 m/s. Determine the heat transfer from the top surface maintained at 60°C. Use the co-relation as: $\overline{Nu} = 0.664\,(Re)^{0.5}\,(\mathrm{Pr})^{0.33}$ if $\mathrm{Re} \leq 5\,X\,10^5$ $\overline{Nu} = [0.037\,(Re)^{0.5} - 850]\,(\mathrm{Pr})^{0.33}$ if $\mathrm{Re} > 5\,X\,10^5$ Use property table for properties of air at bulk temperature.	**07**	**4**	**4**
(B)	A refrigerated truck is moving at a speed of 90 km/hr where the ambient temperature is 50°C. The body of the truck is of rectangular shape of size 10m (length) x 4m (width) x 3m (height). Assume that the boundary layer is turbulent on the four walls and the wall surface temperature is at 10°C. Neglect heat transfer from vertical front and backside of truck and flow of air is parallel to 10 m long side, calculate the heat loss from the four surfaces and power required to overcome the resistance acting on the four surfaces. For turbulent flow over flat surfaces: $\mathbf{Nu = 0.036\,(Re)^{0.8}\,(Pr)^{0.33}}$ Use property table for properties of air at bulk temperature.	**10**	**4**	**4**
(C)	What is Reynolds analogy? Describe the relation between fluid friction and transfer.	**03**	**1**	**4**
Q4 (A)	A cylindrical body of 300 mm diameter and 1.6 m height is maintained at a constant temperature of 36.5C. The surrounding temperature is 13.5C. Find out the amount of heat to be generated by the body per hour. Use the co-relation as: $Nu = 0.12\,(Gr.Pr)^{0.33}$ Use property table for properties of air at bulk temperature.	**06**	**4**	**4**
(B)	What is natural convection? How is it different from forced convection? In which mode of heat transfer will the convective heat transfer coefficient usually be higher, and why?	**04**	**2**	**4**
(C)	Consider two large parallel plates one at temperature 727°C with emissivity 0.8 and other at 227°C with emissivity 0.4. An aluminium radiation shield with an emissivity 0.05 on both sides is placed between the plates. Calculate the percentage reduction in heat transfer rate between the two plates as a result of the shield.	**10**	**4**	**5**

T.Y.B.Tech. Mech. Sem V

Q5 (A)	A counter flow heat exchanger is employed to cool 0.55 kg/sec (Cp = 2.45 kJ/kgK) of oil from 115°C to 40°C by the use of water (Cp = 4.18 kJ/kgK). The inlet and outlet temperatures of cooling water are 15°C and 75°C, respectively. The overall heat transfer coefficient is expected to be 1450 W/m^{2}K. Using NTU method, calculate the following: (a) mass flow rate of water (b) effectiveness of heat exchanger (c) surface area required	**08**	**4**	**6**
(B)	Liquid oxygen (boiling temperature = - 182°C) is to be stored in spherical container of 300 mm diameter. The system is insulated by an evacuated space between inner space and surrounding 450 mm inner diameter concentric sphere. For both spheres emissivities are 0.03 and temperature of the outer sphere is 30°C. Estimate the rate of heat flow by radiation to the oxygen in the container.	**07**	**4**	**5**
(C)	Prove that emissive power of a black body is equal to π times the intensity of radiation of black body.	**05**	**2**	**5**
Q6. (A)	Hydrogen gas at 25°C and 2.5 bar pressure flows through a rubber tubing of 12 mm inside radius and 24 mm outside radius. The binary diffusion coefficient of hydrogen is 2.1×10^{-8} m^2/s and the solubility of hydrogen is 0.055 m^3 of hydrogen per m3 of rubber at 1 bar. If the gas constant for hydrogen is 4160 J/kg.K and the concentration of hydrogen at the outer surface of tubing is negligible, calculate the diffusion flux rate of hydrogen per meter length of rubber tubing.	**08**	**4**	**7**
(B)	Estimate the heat transfer from a 40 W incandescent bulb at 125°C to 25°C in quiescent air. Approximate the bulb as a 50 mm diameter sphere. What percent of the power is lost by free convection? Assume that the characteristic length is the diameter of the sphere. Using equation: $\mathbf{Nu = 0.6\{(Gr.\ Pr)^{0.25}}$	**07**	**4**	**4**
(C)	Explain with neat sketches the different types of fins used in practice.	**05**	**1**	**2**
Q7	**Solve Following Questions (Any Four)** A) Differentiate between isotropic and anisotropic materials. What is meant by thermal contact resistance? B) What is meant by lumped capacity analysis? What is the criterion of its validity? C) Describe the salient aspects in the selection and design of heat exchangers. D) Explain in details of Shape Factor Algebra with examples. E) Define various types of concentrations, velocities and fluxes used in mass transfer. F) Explain the Physical interpretation of the Biot number and Fourier number.	**20**	**1**	**1-7**

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T.Y B.Tech. Mech. Sem V

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

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Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Examination, November 2017

T.Y.B.Tech., Sem-V **B.Tech. in Mechanical Engineering**

Course: **NUMERICAL METHODS (BTM 506)** Master file.

Max. Marks: 100 **Duration: 3 Hours**

Instructions:

- **Question no.1 is compulsory**. Answer any FOUR (04) from remaining six questions,
- Answers to all sub questions must be grouped together,
- Make suitable assumption if needed with proper reasoning,
- Figures on right in square bracket shows maximum marks for a particular sub-question,
- Figures on the extreme right show **CO** and **Module Number** respectively as per syllabus of the course.

1. **(A)** Answer any **four (04)** of the following: **[12]** 1/1, 2,3

(i) Distinguish between lumped and distributed approach of mathematical modeling. Give one example for each approach.

(ii) Define terms: (a) accuracy, (b) precision, and (c) truncation error.

(iii) When do we terminate an iterative solution of a system? Which method, Jacobi method or Gauss-Seidel method converges faster for linear system of algebraic equation? Give reason.

(iv) Write the method of Regula-Falsi to obtain a root of $f(x) = 0$. Discuss its limitations.

(v) Using Taylor series suggest a second order accurate representation of dy/dx and d^2y/dx^2

(B) A solid cube of dimension L is originally at a temperature T_0. The cube is then dropped into a large bath where the cube rapidly settles flat on the bottom. The fluid in the bath provides convective heat transfer coefficient h(W/m^2K) from the fluid at constant temperature T_∞. **[08]** 1/1

Analyze the case and answer following.

(a) Develop a mathematical model to obtain transient temperature of cube with all significant assumptions.

(b) List initial condition and show boundary condition with appropriate sketch.

(c) Formulate for a numerical calculation and state the numerical techniques which can used to capture transient variation of cube temperature.

2. **(A)** In a manufacturing process, a spherical piece of metal is subjected to radiative-convective heat transfer, resulting in the energy balance equation, **[12]** 2/3

$$0.6 \times 5.67 \times 10^{-8}\left[(850)^4 - T^4\right] = 40 \times (T - 350)$$

Consider the surface emissivity as 0.6, temperature of the radiating source 850 K, Stefan-Boltzman constant 5.67×10^{-8} $W/(m^2K^4)$, the ambient fluid temperature 350 K and the convective heat transfer coeffcient 40 $W/(m^2 \cdot K)$.

Find the temperature T by applying the **SECANT** method.

(B) Differentiate between initial value and boundary value problem. Explain the logic of shooting method and discuss its execution methodology. **[8]** 1/5

3. **(A)** A copper sphere of diameter 5 cm is initially at temperature 200°C. It cools in air by convection and radiation. The temperature T of the sphere is governed by the energy equation **[12]** 2/5

$$\rho CV\frac{dT}{dt} = -\left[\varepsilon\sigma(T^4 - T_a^4) + h(T - T_a)\right]A$$

All terms carries their usual meaning.

Evaluate the temperature variation with time using the RK-II method and determine the time needed for the temperature to drop below 100°C.

T. Y. B. Tech. Mech. Sem IV

The following values may be used for the physical variables: $\rho = 9000$ kg/m3, $C = 400$ J/(kg·K), $\varepsilon = 0.5$, $\sigma = 5.67 \times 10^{-8}$ W/(m^2·K^4), $T_a = 25°C$, and $h = 15$ W/(m^2·K).

(B) What is the need of numerical integration? Explain your understanding of Newton-cotes formula of numerical integration. Derive the trapezium rule of numerical integration using the Lagrange linear interpolating polynomial. **[8]** 1/6

4. **(A)** An industry produces four items x_1, x_2, x_3, and x_4. A portion of the amount produced for each is used in the manufacture of other items, and the net product is sold. The balance between the output and the production rate, resulting from various inputs, gives rise to the following four linear equations: **[12]** 3/2

$$2x_1 + x_2 + +6x_4 = 64$$
$$5x_1 + 2x_2 = 37$$
$$7x_2 + 2x_3 + 2x_4 = 66$$
$$8x_3 + 9x_4 = 104$$

Name different iterative method to estimate the amount of items x_1, x_2, x_3, and x_4 . Which method provides solution faster? State reason.

Use an iterative method (with formulation for iterative solution) to the show progress of converged solution in tabular form. Choose an appropriate convergence criterion and state it.

(B) Discuss technique of spline interpolation. To develop a piecewise quadratic polynomial with a sets of 5 data points such as (x_i, y_i), construct a system of required equation to obtain required unknowns. **[8]** 1,2/6

5. **(A)** An outcome of experimental investigation is depicted in following table in the form of input variable and output f(x). **[12]** 2/6

x	1	3	4	5	7	10
f(x)	3	31	69	131	351	1011

(a) Construct Newton's forward divided difference table and develop interpolating polynomial.

(a) Predict maximum order of polynomial through the table of divided difference.

(b) Compare the values obtained from two quadratic polynomial using any two different data set of three, for f(4.5), f(8) and the second derivative of f(x) at x=3.2.

(B) Explain following terms with examples: **[8]** 1/1

(i) Mathematical modeling and its need,

(ii) Numerical computation,

(iii) Errors associated to numerical computation.

6. **(A)** A solid of revolution is formed by rotating about the x-axis, the area between the x-axis, the line x=0 and x=1, and a curve through the points with the following coordinates: **[12]** 2/4

x	0	0.25	0.50	0.75	1.00
y	1.000	0.9896	0.9589	0.9089	0.8415

Using 1/3 Simpson formula, estimate the volume of the solid formed, $V = \pi \int_0^1 y^2 dx$, giving the answer to three decimal places.

(B) Using Newton-Raphson method solve x log10 x = 12.34 with $x_0 = 10$. **[08]** 2/3

7. **(A)** Solve following system of equation by LU decomposition **[12]** 3/2

$$2x + 3y + z = 9$$
$$x + 2y + 3z = 6$$
$$3x + y + 2z = 8$$

Compare the result with Matrix Inversion method.

(B) What do you understand by well conditioned system and ill conditioned system. Which parameters are used to recognize them. Illustrate with the help of an appropriate example. **[08]** 1/2

T.Y B.Tech. Mech Sem V

BharatiyaVidyaBhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)

Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Exam, Nov 2017

Max. Marks: **100** Duration: **3 hrs**

Class: **T. Y. B. Tech.** Semester: **V** Program: **Mech. Engg.**

Name of the Course: **Heat and Mass Transfer** Course Code : **BTM501**

Master file.

Instructions:

- **Question No 1 is compulsory.**
- Attempt **any Four questions** out of Six questions.
- Answers to all sub questions should be grouped together.
- Figures to the right indicate full marks.
- Make suitable assumptions with proper explanations.
- Draw the suitable sketches wherever necessary

Q. No		Marks	CO NO	M No.
Q1	**Answer the following questions (any four)**	**20**		**1-7**
A.	Differentiate between steady and transient heat conduction with specific examples. How does heat convection differ from conduction?		**1**	
B.	Explain the criteria of selection of fins. Define fin efficiency. Explain the importance of insulated tip solution for the fins used in practice.		**1**	
C.	What is LMTD correction factor? Why is a counter flow heat exchanger more effective than a parallel flow heat exchanger? How does fouling factor affect the performance of a heat exchanger?		**1**	
D.	State the examples of mass transfer in day-to-day life and industrial applications. What are the various mechanisms of mass transfer?		**1**	
E.	What does the Grashof Number represent? How is it different from the Reynolds number? Explain the significance of Grashof Number in Natural convection heat transfer.		**1**	
Q2 (A)	A furnace wall is made up of refractory brick, red (fire) brick and outside plaster. There is an air gap with a thermal resistance of 0.15 m^2K/W between the refractory brick and the red brick. The refractory brick, 120 mm thick, has K = 1.58 W/mK. The red brick, 120 mm thick has K = 0.3 W/mK. The outside plaster, 15 mm thick, has K = 0.15 W/mK. The two extreme temperatures of this wall are 1000°C and 100°C. Determine (a) the heat flow rate in kJ/hour.m^2, and the interface temperatures. (b)	**10**	**4**	**2**

TY B Tech. Mech. Sem V

(B)	A hot cylindrical ingot (K = 60 W/mK, ρ = 7850 kg/m^3, Cp = 0.430kJ/kgK) of 50 mm diameter and 250 mm length is removed from a furnace at 850°C and suddenly quenched in water at 20°C until its temperature drops to 550°C. Subsequently, the ingot is exposed to ambient air at 20°C and allowed to cool slowly to 100°C. The convective heat transfer coefficient is 250 W/m^{2}K when the cooling medium is water and 25 W/m^{2}K with air is the cooling fluid. Estimate the total time required for cooling from 850°C to 550°C in water. As well as estimate the time required for cooling from 550°C to 100°C in air. Estimate the total time required for cooling the ingot. State and justify any assumptions made.	10	4	3
Q3 (A)	Air at 1 bar pressure and at 20°C flows over a rectangular container, with top surface 750 mm long in direction of flow and one meter wide, at 35 m/s. Determine the heat transfer from the top surface maintained at 60°C. Use the co-relation as: $\overline{Nu} = 0.664\,(Re)^{0.5}\,(Pr)^{0.33}$ if $Re \leq 5\,X\,10^5$ $\overline{Nu} = [0.037\,(Re)^{0.8} - 850]\,(Pr)^{0.33}$ if $Re > 5\,X\,10^5$ Use property table for properties of air at bulk temperature.	07	4	4
(B)	A refrigerated truck is moving at a speed of 90 km/hr where the ambient temperature is 50°C. The body of the truck is of rectangular shape of size 10m (length) x 4m (width) x 3m (height). Assume that the boundary layer is turbulent on the four walls and the wall surface temperature is at 10°C. Neglect heat transfer from vertical front and backside of truck and flow of air is parallel to 10 m long side, calculate the heat loss from the four surfaces and power required to overcome the resistance acting on the four surfaces. For turbulent flow over flat surfaces: $Nu = 0.036\,(Re)^{0.8}\,(Pr)^{0.33}$ Use property table for properties of air at bulk temperature.	10	4	4
(C)	What is Reynolds analogy? Describe the relation between fluid friction and heat transfer.	03	1	4
Q4 (A)	A cylindrical body of 300 mm diameter and 1.6 m height is maintained at a constant temperature of 36.5°C. The surrounding temperature is 13.5°C. Find out the amount of heat to be generated by the body per hour. Use the co-relation as: $Nu = 0.12\,(Gr.Pr)^{0.33}$ Use property table for properties of air at bulk temperature.	06	4	4
(B)	What is natural convection? How is it different from forced convection? In which mode of heat transfer will the convective heat transfer coefficient usually be higher, and why?	04	2	4
(C)	Consider two large parallel plates one at temperature 727°C with emissivity 0.8 and other at 227°C with emissivity 0.4. An aluminium radiation shield with an emissivity 0.05 on both sides is placed between the plates. Calculate the percentage reduction in heat transfer rate between the two plates as a result of the shield.	10	4	5

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Q5 (A)	A counter flow heat exchanger is employed to cool 0.55 kg/sec (Cp = 2.45 kJ/kgK) of oil from 115°C to 40°C by the use of water (Cp = 4.18 kJ/kgK). The inlet and outlet temperatures of cooling water are 15°C and 75°C, respectively. The overall heat transfer coefficient is expected to be 1450 W/m^{2}K. Using NTU method, calculate the following: (a) mass flow rate of water (b) effectiveness of heat exchanger (c) surface area required	**08**	**4**	**6**
(B)	Liquid oxygen (boiling temperature = - 182°C) is to be stored in spherical container of 300 mm diameter. The system is insulated by an evacuated space between inner space and surrounding 450 mm inner diameter concentric sphere. For both spheres emissivities are 0.03 and temperature of the outer sphere is 30°C. Estimate the rate of heat flow by radiation to the oxygen in the container.	**07**	**4**	**5**
(C)	Prove that emissive power of a black body is equal to π times the intensity of radiation of black body.	**05**	**2**	**5**
Q6. (A)	Hydrogen gas at 25°C and 2.5 bar pressure flows through a rubber tubing of 12 mm inside radius and 24 mm outside radius. The binary diffusion coefficient of hydrogen is 2.1×10^{-8} m^2/s and the solubility of hydrogen is 0.055 m^3 of hydrogen per m3 of rubber at 1 bar. If the gas constant for hydrogen is 4160 J/kg.K and the concentration of hydrogen at the outer surface of tubing is negligible, calculate the diffusion flux rate of hydrogen per meter length of rubber tubing.	**08**	**4**	**7**
(B)	Estimate the heat transfer from a 40 W incandescent bulb at 125°C to 25°C in quiescent air. Approximate the bulb as a 50 mm diameter sphere. What percent of the power is lost by free convection? Assume that the characteristic length is the diameter of the sphere. Using equation: $\mathbf{Nu = 0.6\{(Gr.\ Pr)^{0.25}}$	**07**	**4**	**4**
(C)	Explain with neat sketches the different types of fins used in practice.	**05**	**1**	**2**
Q7	**Solve Following Questions (Any Four)** A) Differentiate between isotropic and anisotropic materials. What is meant by thermal contact resistance? B) What is meant by lumped capacity analysis? What is the criterion of its validity? C) Describe the salient aspects in the selection and design of heat exchangers. D) Explain in details of Shape Factor Algebra with examples. E) Define various types of concentrations, velocities and fluxes used in mass transfer. F) Explain the Physical interpretation of the Biot number and Fourier number.	**20**	**1**	**1-7**

L:b

(3)

T.Y.B.Tech Mech, Sem V

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T.Y.B.Tech. Mech. Sem IV

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T.Y.B.Tech. Mech. Sem V

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