Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

21/12/24

END SEMESTER/ ~~RE~~ EXAMINATION DECEMBER/ ~~JANUARY~~ 2024-25

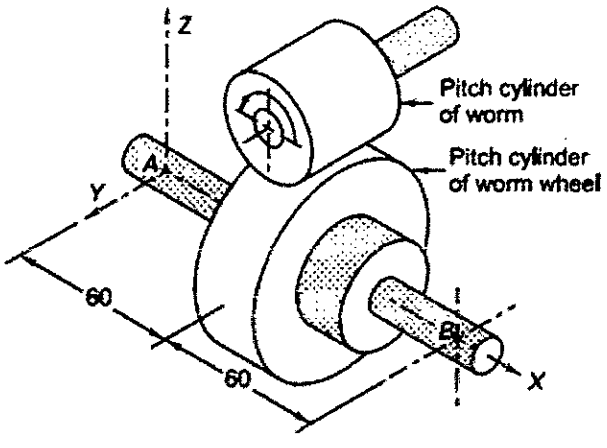
Program: B.Tech. in Mechanical Engineering Sem VII **Duration: 3 Hours**

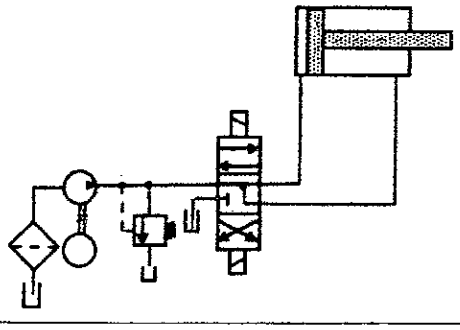
Course Code: PC-BTM711 **Max. Points: 100**

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

Notes:

1. Use of the Design Data book by V. B. Bhandari is permitted.
2. Assume suitable data if necessary and justify the same.
3. Attempt any 5 questions.

Q. No.	Questions	Points	CO	BL	Mod. No.
Q1	a) Derive the expression for wear strength of Bevel gear. b) 5KW of power at 720 rpm is supplied to the worm shaft as shown in figure. The worm gear drive is designated as 2/40/10/5  The worm has right hand threads and the pressure angle is 20^0. The worm wheel is mounted between two bearings A and B. It can be assumed that the bearing A is located at the origin of the co ordinate system and the bearing B takes complete thrust load. Determine the reaction at the two bearings.	05 15	1	3	i
Q2	a) Derive Stribeck's equation for Rolling Contact Bearing. b) A single row deep groove ball bearing is subjected to a radial force of 8 KN and the thrust force of 3 KN. The shaft rotates at 1200 rpm. The expected life L_{10h} of the bearing is 20000 h. The maximum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application.	10 10	1	3	2
Q3	a) Explain Mckee's investigation for hydrodynamic bearings. b) Design a full hydrodynamic bearing with the following specification for machine tool application: Journal diameter = 75 mm Radial load = 10 KN	08 12	1	3	3

	journal speed 1440 rpm minimum oil film thickness = 22.5 microns inlet temperature = 40^0C bearing material = babbitt Determine the length of the bearing and select a suitable oil for this application.				
Q4	a) An automobile vehicle weighing 13.3 KN is moving on a level road at a speed of 95 km/h. When the brakes are applied, it is subjected to a uniform deceleration of 6 m/s^2. There are brakes on all four wheels. The tyre diameter is 750 mm. The kinetic energy of the rotating parts is 10% of the kinetic energy of the moving vehicle. The mass of each brake drum assembly is 10 kg and the specific heat capacity is 460 J/Kg^{0}C. Calculate i. The braking time ii. The braking distance iii. The total energy absorbed by each brake iv. The torque capacity of each brake v. The temperature rise of brake drum assembly.	**12**	1	4	4
	b) Explain the two theories applied to friction plates.	**08**	2	3	4
Q5	a) Explain hydraulic actuators and its types in detail with suitable examples.	**10**	1	3	5
	b) A double acting cylinder is used in a regenerative circuit as shown in figure. The relief valve is set at 7.5 N/mm^2, the piston area is 150 cm^2, the rod area is 40 cm^2 and the flow is 20 gallons/min. Find the cylinder speed and local carrying capacities for various DCV. 	**10**			
Q6	A 4-fall EOT crane has following specifications: • Safe Working Load in kN = 80 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	**20**	1	4	6

	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 pulley-gearbox as 0.9.				
Q7	a) Centrifugal pumps are commonly utilized in municipal water supply systems to transport water at ambient temperature. Design a centrifugal pump for a system requiring a total head of 55 meters and a flow rate of 100 cubic meters per hour. The pump is directly coupled to an electric motor. Determine the required power, select an appropriate motor, and calculate the dimensions of the suction pipe and the impeller.	**15**	1 3	2 4	7 7
	b) Explain discharge of single acting reciprocating pump.	**05**			

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

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

  - D_{min}/D as a function of number of bends in system
- 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 = $\frac{F_r'}{w \times s}$
  - Standard diameters of rope drum at the bottom of groove: 200, 250, 315, 400, 500, 630, 710, 800, 900, 1000, 1250 mm.
- Wheel Design
  - $p = \frac{P}{C_1 C_2 D K_0}$; 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, $b_1 = \frac{Q'}{\pi D_1 V_0}$

Outlet vane width, $b_2 = \frac{Q'}{\pi D_2 V_{m3}}$ where $V_{m3} = (0.8\ to\ 0.9) \times V_0$

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

$$\tan\beta_1 = \frac{1.25V_0}{u_1}, \quad u_1 = \frac{\pi n D_1}{60}$$

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 $\rho_\theta = \frac{\theta^o}{c} + \sqrt{2r_3\frac{\theta^o}{c}}$, $C = \frac{2\times360^\circ\times\pi g H_{th}}{wQ'}$

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 / ~~RE EXAM~~ DEC2024 4/12/24

- **Class: BTech Mech,** Sem VII
- **Course IEPM Course,**
- **Duration 3 hrs,**

Sem VII
Code PC-BTM 714
Points 100

Industrial engg. Project mgt.

- **Solve any 5 out of 7 Questions**
- **Figures to right indicate the full points**
- **Assume Suitable data wherever needed.**
- **ND table are permitted.**

Que. No.	Question Statement	Points	Module	BL	CO
Q1A	What do you mean by Productivity?. What is the importance of Productivity? Explain the relationship between productivity and standard of living. State the benefits of improving the productivity to various stakeholders.	10	1	3	CO1
Q1B	State and explain the productivity measurement with necessary example.	10	1	3	CO1
Q2A	Draw the figure showing the basic procedure of work study.	10	2	4	CO2
Q2B	What do you mean by standard time?. What allowances are used in computation of standard time?. Draw the relevant diagram. The elemental timings are given in table to produce a component. Compute the standard time. Assume rest and personal allowance as 12% and contingency allowance 2 %. Compute no of units to be produced in 8 hours. All work elements are manual elements.	10	2	4	CO3

Element	Observed time	Rating	Remark
A.	0.2	90	-
B.	0.05	80	-
C.	0.03	95	-
D.	0.78	90	-
E.	0.06	110	-
F.	0.05	105	-
G.	0.02	85	Once in 5 pieces
H.	0.06	80	
I.	0.10	90	
J.	0.04	90	Once in 20 pieces

Q3A	What do you mean by Ergonomic Product Design? Illustrate the concept using 10 useful examples.	10	3	4	CO3
Q3B	Illustrate the concept of Design for Manufacturing and assembly with suitable examples.	10	3	4	CO3
Q4A	Illustrate the adoption of industry 4.0 technologies to orgnise a Technical Festival in SPCE. Consider all key technologies in industry 4.0 basket. Prepare a table with following columns.	10	3	5	CO2, CO3

	Name of key activity/ name of industry 4.0 technology / potential feature of technology impact expected in terms of time , efforts, cost , quality, delivery , service etc.				
Q4B	Prepare a Roadmap for lean implementation in Automobile industry.	10	4	4	CO2, CO3
Q5A	Prepare a Project Charter for the project of your choice like SPCE Racing Car Design manufacturing and participation , SPCE WAVE –aeroplane Design manufacturing and participation etc. Prepare the project life cycle.	10	5	5	CO1, CO4
Q5B	The time estimates for the activities of a PERT network is given below. Activity | t_o | t_m | t_p 1-2 | 1 | 4 | 9 1-3 | 2 | 5 | 9 1-4 | 2 | 5 | 9 2-5 | 3 | 4 | 10 3-5 | 4 | 6 | 13 4-6 | 3 | 7 | 10 5-6 | 5 | 8 | 14 1.Draw the project network and identify all paths through it. 2.Find project duration and CP. 3.Compute standard deviation and variance of project length. 4. What is probability that the project will be completed at least 4 weeks earlier than expected? Show the method only.	10	6	5	CO1, CO3 CO4
Q6A	Refer the Project Data given below. Find Normal duration and Minimum Duration. What is the percentage increase in cost to complete the project in 2days lesser than Normal duration? Activity | Dependence | Normal duration | Crash Duration | Normal cost | Crash Cost A | -- | 8 | 6 | 700 | 900 B | A | 3 | 2 | 600 | 700 C | A | 5 | 4 | 500 | 700 D | A | 5 | 6 | 400 | 600 E | B,C | 6 | 4 | 500 | 600 F | C,D | 4 | 3 | 600 | 700 G | E,F | 4 | 3 | 700 | 900	10	6,7		CO3, CO4
Q6B	Refer the following project data. The contract specifies the project must be completed in 14 weeks. The company will assign a fixed minimum number of workers to the project for entire duration. Find the optimum schedule. Activity | Duration | Predecessor | Crew size A | 4 | None | 4 B | 7 | None | 2 C | 3 | A | 2 D | 3 | A | 4 E | 2 | B | 6 F | 2 | B | 3 G | 2 | D,E | 3 H | 3 | F,G | 4	10	6,7		CO3 CO4
Q7A	Draw a detailed cause and effect Diagram to showcase the Risk involved in Project Procurement Process. Consider Plan, Conduct, Control and Close as the important processes in Project Procurement Process.	10	M6 , M7	5	CO1 CO4

Q7B	Refer the following project data. Draw the project Network. Find Critical Path and Project duration. Find E and L for each event. If the activities 6-9, 7-8,4-5 require a piece of equipment one at a time, Will it affect the project? Find the schedule.	10	M6 , M7		CO2 CO3

Activity	Time in days
1-2	3
1-4	10
1-7	3
2-3	5
3-6	7
4-5	6
4-8	3
5-6	2
6-9	4
7-8	5
8-9	6

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7/12/24

End Semester/~~Re-Examinations~~, December/~~January~~ 2024-~~25~~

B.Tech. (Mechanical Engineering), Semester-VII Duration: **3 Hour**

PE BTM708: COMPUTATIONAL FLUID DYNAMICS Max. Points :**100**

Notes

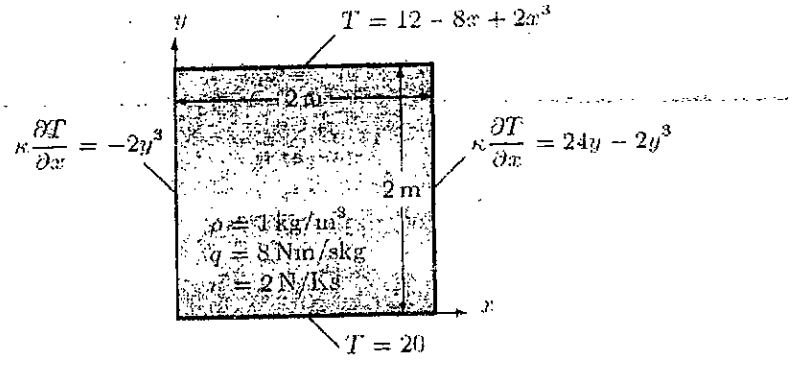
- Answer any **FIVE** questions and make suitable assumptions if required.
- Figures on right in square bracket shows maximum marks for a particular sub-question
- Figure on the extreme right shows **course outcome number (CO)/ Bloom's Taxonomy (BT).**

1.	**A.** Examine the mathematical structure of Partial Differential Equations (PDEs) and outline their key characteristics. Based on this, provide an analysis of how energy conservation and momentum conservation equations reflect these properties.	10	1/2
	B. A cubical metal block of a side length L, is melted in a furnace. The initial temperature of the block is Ti, the melting point is Tm, and the final temperature is T_f, where $T_f > T_m > Ti$. The block receives a constant heat flux q due to radiation from a heat source and also loses energy by convection (heat transfer coefficient h) and radiation to the surrounding air at T_a. (a) Listing all assumptions develop a mathematical model for it (b) Interpret the case and plot the variation of temperature with time. (c) Select and name a numerical scheme to obtain the solution.	10	1,4/3
2.	**A.** Enumerate and elaborate on the commonly used flow and thermal boundary conditions, providing detailed real-life examples to illustrate each scenario effectively.	10	1/2
	B. A plate of thickness 3 cm and is initially at a uniform temperature of 1000°C. At time t = 0, the temperature at the two surfaces is dropped to 0°C and maintained at this value. The thermal diffusivity of the material is $\alpha = 5 \times 10^{-6}$ m²/s. Write an appropriate mathematical model and develop discretized equations for it. Solve this problem by a numerical method to obtain the temperature distribution as a function of time and space. Show results in tabular form. The case can be modeled as 1D -- transient heat conduction problem.	10	3/3,4
3.	**A.** What is the significance of the ADI (Alternating Direction Implicit) scheme? Explain the procedure for its numerical implementation. Demonstrate how this method enhances the solution of a transient problem.	10	1/2
	B. The temperature variation in an extended cylindrical surface, for the one dimensional approximation, is given by the equation $\frac{d^2T}{dx^2} - \frac{hP}{kA}(T - T_a) = 0$ at $x = 0$: $T = T_o$ and at $x = L$: $\frac{dT}{dx} = 0$ Where L,D are length and diameter respectively of extended surface. D=2cm, h=20W/m²K, k=15W/mK, L=25 cm, T_0=80°C , T_A=20°C Use finite difference method to evaluate temperature at 5 evenly spaced locations. Show calculation for five iteration in tabular form using appropriate numerical technique.	10	3,4/3
4.	**A.** For monotonic convergence of one dimensional convection-diffusion problem the stability is limited by $\lvert Pe \rvert < 2$ if central difference scheme is used to treat convective terms. How this restrictions can be avoided. Explain any two methods.	10	1/1
	B. An industrial organization 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:	10	2,3/3,4

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

Solve this set of equations by the Gauss-Seidel and Jacobi method.

5. Consider the heat conduction in a square plate of unit thickness as shown below; Using finite-volume method with an appropriate number of grids (4×4) points. Develop all discretized equations and show the calculation for 3 iterations excluding initial guess. **20** **3,4/4,5**



6. **A.** What is the checkerboard problem? Illustrate it and explain how staggered and semi-staggered meshes resolve this issue. **5** **1/2**

B. How do numerical solutions for flow problems differ from thermal diffusion problems? Discuss the complexities of solving flow problems. **5**

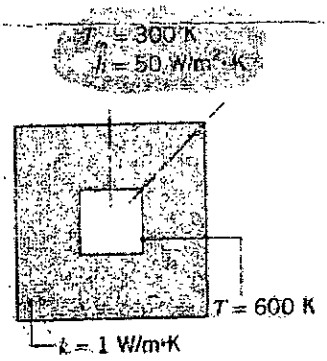
C. What is SIMPLE algorithm? Derive pressure correction equation for a 2D flow problem. **10**

7. Consider the square channel shown in the sketch operating under steady-state conditions. The inner surface of the channel is at a uniform temperature of 600 K, while the outer surface is exposed to convection with a fluid at 300 K and a convection coefficient of 50 W/m² K. **20** **3,4/4,5**

(a) Analyze and Identify a mathematical model for the case in the differential form

(b) Find an optimized computation domain for it and explain.

(c) Suggest a solution with relevant calculations which shows the nodal equations of all nodes and the temperature distribution.



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7/12/24

END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

Program: Mechanical Engineering B.Tech Sem VII
Course Code: PE-BTM 755
Course Name: Automobile Engineering

Duration: 3 hour
Maximum Points: 100
Semester: VII

Note: Attempt any FIVE questions out of remaining six questions.
Draw neat schematic diagrams wherever is necessary, highlight important points of answer
Assume suitable data if necessary and mention it.

Q No	Questions	Pt	BL	CO	M
Q1 A	Draw neat sketch of entire set up of hydraulic power steering? Give function of each elements of set-up?	10	3	4	2
B	Obtain expression for maximum possible brake force from rear wheel and front wheel?	10	3	2	5
Q2 A	Draw neat sketch of Friction ellipse, Friction coefficient Vs Wheel slip ratio? Give its significance in respect of antilock brake system?	10	1	2	5
B	Obtain expression for dimension of links (track rod and tie rod) using trapezoidal steering mechanism?	10	3	4	2
Q3 A	Obtain expression for maximum tractive effort available in case of Front wheel drive?	10	3	2	3
B	Write short note on Unibody construction and Space frame?	10	1	1	7
Q4 A	Draw sketch of Air suspension system and explain its different functions? Give classification of suspension system based on two criteria?	10	2	2	3
B	Draw neat sketch of typical passenger car type automobile body? Give any of its 4 parts function/purpose?	10	3	1	7
Q5 A	Draw and explain real prime mover characteristic for torque and power characteristic Vs engine speed? Estimate torque transmission capability by a three plate clutch, which has an average radius of 25 cm and it is coated using organic material (having coefficient of friction as 0.35)? After release of the clutch pedal, spring assembly applies 75 N of axial load on the clutch plate.	10	3	2	3

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END SEM/~~RE-EXAM~~ EXAMINATION DEC/~~JAN~~ 2024-25

B	Write short note on Ignition advance and explain any one mechanism using sketch for attaining Ignition advance?	10	2	4	4
Q6 A	Give classification of Automobile vehicles based on Load, Fuel source, Body, and Transmission? Also draw its sketch?	10	2	1	1
B	Give working principle of motor vehicle horn system with the help of neat sketch?	10	2	4	6
Q7 A	Derive final expression for thermal efficiency of Dual air standard cycle with the help of necessary P-V and T-S diagram?	10	2	2	1
B	Explain any one type of window regulator system?	5	2	4	6
C	Draw neat sketch for Capacitance Discharge Ignition System?	5	3	4	4

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END SEM/ ~~RE-EXAMINATION~~ DEC/~~JAN~~ 2024-~~25~~

Program: B.Tech. Mechanical **Duration: 3 Hour**

Course Code: PEC-BTM753 **Maximum Points: 100**

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

Notes:

1) **Solve: Any FIVE Questions.**
2) Answers must be **SPECIFIC** and in **legible** handwriting.
3) Draw **neat system diagram/s and T-s diagrams** wherever necessary.
4) **Use of charts / tables for material properties and T-s chart for cryogens approved by examiner is permitted.**
5) **Assume suitable data wherever necessary and state the same.**

Q. No.	Question	Points	CO	BL	Module
1.	**a) Define:** Cryogenics. **Differentiate:** between refrigertaion and cryogenics. **Describe:** Applications of cryogenics in i) space sciences ii) Food preservation.	10	1	I, II, IV	1
	b) Explain: i) Meissener effect. **Draw:** Neat sketch ii) Transition temperature iii) Critical field strength and iii) Critical current. **Evaluate:** Threshold current for an Indium wire of 1.3 mm diameter at 3 K. Assume parabolic rule holds true.	10	2	II, III VI	2
2.	**a) State:** Any two materials which are **the most preferred** in cryogenic applications. **Explain:** Reasons for the same in terms of properties of these materials. **Choose:** The suitable material from the materials listed in the table below for the Inner vessel of dewar for storage of LH_2 at 1 atm. **Justify:** Reasons for the choice of material with the criterion applied.	10	2, 4	I, II	2

Material	Density (kg/m^3)
2024 T4 Aluminum	2740
SS-304	7806
Monel	8885
Beryllium Copper	8300
Teflon	2300

END SEM/ RE-EXAMINATION DEC/JAN 2024-25

	b) Explain: Criterion for determination of specific heat of solids at cryogenic temperatures with terms and formulae used. **Evaluate:** Percentage contribution of electronic specific heat ($c_{v,e}$) in the total specific heat (c_v) for Aluminum at temperature of i) *20 K* and ii) *2K*. Universal Gas Constant $\bar{R}$ = *8.31434 J/mol.K* and atomic weight of Copper = *27 g/mol*. **Discuss:** Variation of electronic and lattice specific heat of metals at extreme low temperatures from the results obtained.	**10**	2	II, VI	2
3.	**a) Explan:** i) Inversion curve and ii) Maximum inversion tempertue ($T_{i,Max.}$). **Compare:** Advantages and disadvantages of use of Isenthalpic and isentropic expansion in the gas liquefaction system. **Evaluate:** μ_{JT} and μ_s for expansion of air from 200 atm, 300 K to 100 atm. **Draw:** neat T-s diagram.	**10**	4	III, IV, VI	3
	b) In an Ammonia pre-cooled Linde-Hampson liquefaction system for Argon gas, the gas enters the reversible isothermal compressor at *285 K* and *101.3 kPa* and is compressed to *100 atm*. Refrigerant Ammonia gas enters the compressor at *620 kPa* with an enthalpy of *1454.2 J/g* and is compressed reversibly and adiabatically to *1970 kPa* with an enthalpy of *1618 J/g*. Ammonia is then condensed in a water-cooled condenser and enters the expansion valve as a saturated liquid with an enthalpy of *416.14 J/g*. The refrigerant mass flow rate ratio *r = 0.070*. **Evaluate:** i) Liquid yield ii) Work of compression per unit mass of the gas liquefied and iii) Figure of Merit. **Draw:** neat system diagram and T-s diagram.	**10**	4	III, VI	3
4.	**a) Explain:** o-H_2 and p-H_2. **Draw**: a neat sketch. **Discuss:** Significance of ortho to para-Hydrogen conversion for LH_2 from cryogen storage point of view and remedial measures to control ortho to para-Hydrogen. **Draw:** neat system diagrams of arrangements for the same.	**10**			2,4

END SEM/ RE-EXAMINATION DEC/JAN 2024-25

	b) In a simple Linde-Hampson liquefaction system, Nitrogen gas at *101.3 kPa* is compressed to the compressor exit condition of *200 atm* and *300 K*. The effectiveness of heat exchanger is *0.965*. **Evaluate:** i) Liquid yield ii) Work of compression per unit mass of the gas liquefied iii) Minimum effectiveness of heat exchanger required. **Draw:** neat system diagram and T-s diagram.	**10**	4	I, V	4
5.	**a) Justify:** Necessity of i) vacuum and ii) insulation in cryogenic applications. **Draw:** Neat sketch of a cryogenic storage vessel showing main parts and insulation.	**10**	4	III, VI	5
	b) Explain: Classification of cryogenic insulations with example and significance, advantages and drawbacks of each. **Justify:** Preferred use of Multilayer Insulation (MLI) in cryogenic systems as compared to other types.	**10**	3	II, VI	2,4
6.	**a) State:** Different types of vacuum pumps. **Explain:** Working of diffusion pump. **Draw:** neat sketch.	**10**	3	I, II	6
	b) Discuss: Various Health hazards associated with cryogenic systems and measures for personal safety in cryogenic plants.	**10**	3	II	7
7.	Write short notes on **ANY THREE** of the following:	**20**		II	
	a) Phases and isotopes of Helium		2		2
	b) Claude system of liquefaction		4		3
	c) LN2 pre-cooled Linde -Hampson system for liquid Neon		2		2,4
	d) Vacuum gauges for cryogenic applications		3		6
	e) Safety considerations for cryogenic plant		3		7

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9/12/24

END SEMESTER EXAM/~~RE-EXAM~~ DECEMBER 2024/~~JANUARY 2025~~

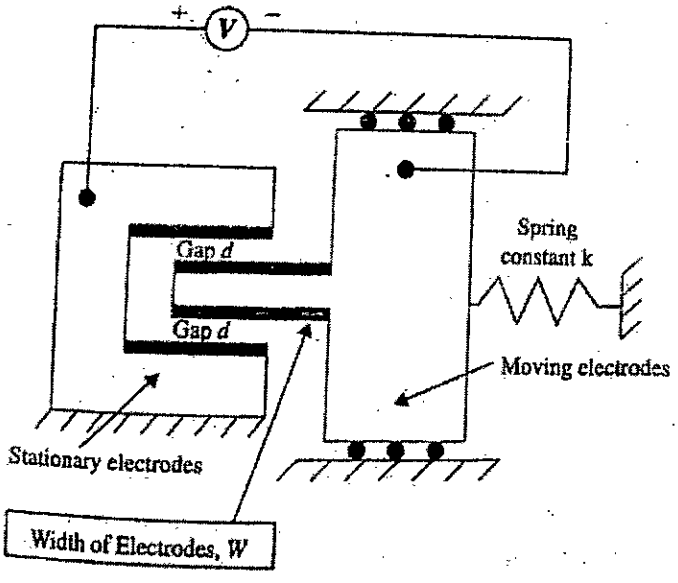
Program: B. Tech. Mech Sem VII **Duration: 03 Hrs**

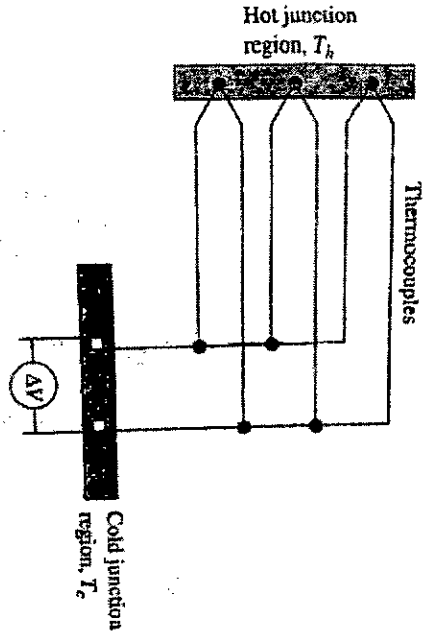
Course Code: OE-BTM714 **Maximum Points: 100**

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

Notes:

1. **Question number 1 is compulsory**
2. **Solve any four questions from Q. 2 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) Chemical Vapour Deposition Technique (ii) Electrophoresis systems (iii) Micro pressure sensor (iv) Optical Lithography	20	1 to 4	5	1 to 7
2 (A)	For the comb-driven actuator shown in Figure 1, determine the voltage supply required to pull the moving electrode 10 microns from the unstretched position of the spring. The spring constant k is 0.05 N/m. The comb drive is operated in air. The gap d between the electrodes and the width W of the electrodes are 2 microns and 5 microns respectively. The e_r=1.0 for air as dielectric material and e_0=8.85 Pf/m  Figure 1 Comb drive actuator	10	3,4	4	3

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 Reactive Ion Etching (RIE) and Chemical Etching with neat sketches.	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

END SEMESTER EXAM/~~RE-EXAM~~ DECEMBER 2024/~~JANUARY 2025~~

5 (B)	Explain with neat diagram Scanning Electron Microscope	10	3	2	7
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)	Differentiate between Micro-electromechanical Systems and Micro-electronics	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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9/12/24

END SEM/~~RE-EXAM~~ EXAMINATION DEC/JAN 2024-25

Program: BTECH (MECH.ENGG.) Sem VII

Duration: 3 hrs.

Course Code: OE-BTM717

Maximum Points: 100

Course Name: Digital Twin

Semester: VII

- Solve any 5 questions out of seven
- Figures to the right indicate full marks
- Draw neat sketches & figures wherever required

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	(1) Explain the fundamental principles of Industry 4.0. How do these principles differ from the previous industrial revolutions? (2) Describe the lifecycle of a Digital Twin Prototype (DTP) transitioning to a Digital Twin Instance (DTI) and finally a Digital Twin Aggregate (DTA). How do these stages add value to engineering processes? Provide neat sketches.	[05] [05]	1,2,3	2	3.2.1
(b)	Discuss how Block chain ensures data integrity and security in Digital Twin ecosystems. Provide an example of its application in supply chain management.	[10]	1,2,3	2	3.2.1
Q.2 (a)	What is Predictive Maintenance? Explain how data is analyzed using Predictive Maintenance machine learning algorithm along with neat figures	[10]	1,2,3	2	5.4.1
(b)	Discuss how Digital Twins enable simulation-driven design in engineering. Provide examples from fields like Mechanical, electrical engineering and construction.	[10]	1,2	2	5.4.1
Q.3 (a)	Imagine a Digital Twin system integrated with AR/MR technologies for urban planning. Propose a solution to enhance public engagement using these technologies.	[10]	2,3	3	5.5.1
(b)	A manufacturing company plans to use a Digital Twin for predictive maintenance. Analyze how Big Data Analytics and Machine Learning can process and interpret data to	[10]	2,3	3	5.5.1

	optimize maintenance schedules.				
Q.4 (a)	A manufacturing unit wants to implement an IIoT platform for predictive maintenance. Describe how data is collected, stored, analyzed, and visualized in this process with neat figures?	[10]	2,3	3	5.5.1
(b)	Explain the role of Building Information Modeling (BIM) data in Digital Twins. How does integrating IoT, BIM, and machine learning enhance their functionality?	[10]	1,2,3	2	5.5.1
Q.5 (a)	Explain application of digital twin in Smart Cities in detail along with neat sketch?	[10]	3,4	3	5.5.1
(b)	Digital Twin technology is transforming industries by enabling new business and revenue models in Smart Cities, Smart Manufacturing, and Smart Factories. Discuss how Digital Twins can be leveraged to create innovative business models in these domains.	[10]	2,3	3	5.1.2
Q.6 (a)	A factory uses ERP for resource allocation and MES for production control. Propose a framework for integrating Digital Twins into these systems with neat figure to achieve better synchronization and decision-making.	[10]	3,4	3	5.5.1
(b)	How can Digital Twins be integrated with Customer Relationship Management (CRM) to personalize customer experiences and enhance satisfaction? Propose a framework of their integration with neat figure?	[10]	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
	• Digital twin in Smart Containers • Digital twin in Warehouse management (WMS) • DT in Product Development • DT in Logistics • DT in Construction Industry • Digital twin driven power transformer • DT in Asset Maintenance				

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

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END SEM/RE-EXAM EXAMINATION DEC/JAN 2024-25

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

Course Code: OE-BTM618 **Maximum Points:** 100

Course Name: Smart City for Sustainable development **Semester:** VII

- Solve any 5 questions out of seven
- Figures to the right indicate full marks
- Draw neat sketches & figures wherever required

Q.No.	Questions	Points	CO	BL	PI
Q.1 (a)	(1)Identify the primary drivers of Industry 4.0 in the context of Smart Cities. How can these drivers address issues like urban pollution and energy inefficiency? (2)How can SCAN-to-BIM technology be used to modernize old buildings in Traditional Cities and make them compatible with Smart City standards?	[05] [05]	1,2,3	2	3.2.1
(b)	What is a digital twin? What is the role of Digital Twins in Smart City development? How can AR, VR, and MR be integrated with Digital Twins for better visualization?	[10]	1,2,3	2	3.2.1
Q.2 (a)	Explain the impact of AR, VR, and MR technologies on urban education systems. How can these technologies bridge learning gaps? Provide with neat figure	[12]	1,2,3	2	5.4.1
(b)	Explain the various dimensions of BIM with neat sketches?	[08]	1,2	2	5.4.1
Q.3 (a)	Explain the integration benefits of following enabling technologies with Smart Cities along with neat figures? • Internet of Things (IOT) • Big data Analytics • Machine Learning	[20]	2,3	3	5.5.1
Q.4 (a)	Explain Smart Parking System (SPS) along with neat sketch? Also write the benefits of the same?	[10]	2,3	3	5.5.1
(b)	Discuss how a Smart Traffic Lighting System could leverage real-time data and machine learning to reduce congestion and improve safety in urban areas.	[10]	1,2,3	2	5.5.1

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Q.5 (a)	What are the key differences between Traditional, Digital & Smart Governance? Explain Smart Governance along with various stakeholders in terms of citizen participation and decision-making with neat figures?	[10]	3,4	3	5.5.1
(b)	Explain Future of Smart Cities? Also explain new business & revenue models with respect to Smart Cities	[10]	2,3	3	5.1.2
Q.6	A Smart City uses an IIoT platform to monitor traffic patterns. How can the collected data be leveraged to improve urban mobility and reduce congestion? Also Provide neat sketch of architecture.	[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
	• Smart Economy • Smart Transportation • Smart Buildings • Smart Education • Smart Maintenance • Smart Environment				
********** All the Best **********					