Bharatiya Vidya Bhavan's

# SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 400058

## PREVIOUS SEMESTER EXAMINATION FEBRUARY 2024

**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 | The following data is given for a pair of parallel helical gears made of steel.<br>• Power transmitted = 15 kW<br>• Speed of pinion = 1000 rpm<br>• Number of teeth on pinion = 35<br>• Number of teeth on gear = 70<br>• Centre distance = 340 mm<br>• Normal module = 6 mm<br>• Face width = 60 mm<br>• Normal pressure angle = 20 deg.<br>• Ultimate tensile strength = 600 MPa<br>• Surface hardness = 300 BHN<br>• Grade of machining = Gr.6<br>• Service factor = 1.25<br>Calculate:<br>i. Helix angle<br>ii. Bending strength<br>iii. Wear Strength<br>iv. Tangential force<br>v. Dynamic load by Buckingham's equation<br>vi. Effective load<br>vii. FOS against bending failure | 20 | 1 | 3 | 1 |
| Q2 | A ball bearing subjected to a radial load of 5000 N is expected to have satisfactory life of 12,000 hr at 1000 rpm with a reliability of 97%. Calculate the dynamic load carrying capacity of the bearing, so that it can be selected from a manufacturer's catalogue based on 90% reliability. If there are four such bearings each with a reliability of 97% in a system, what is the reliability of the complete system? | 20 | 1 | 3 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| Q3 | The following data is given for a $360^0$ hydrodynamic bearing:<br>Radial load = 10 KN<br>journal speed 1440 rpm<br>unit bearing pressure 1000 kPa<br>clearance ratio (r/c) = 800<br>viscosity of lubricant = 30 mPa s<br>Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate:<br>(i) dimension of bearing;<br>(ii) coefficient of friction;<br>(iii) power lost in friction;<br>(iv) total flow of oil;<br>(v) side leakage;<br>(vi) and temperature rise. | **20** | 1 | 3 | 3 |
| Q4 | a) Derive the expression for block brake with long shoe.<br>b) A single plate clutch consists of only one pair of contacting surfaces it is used for an engine which develops a maximum torque of 120 Nm. Assume a factor of safety of 1.5 to account for slippage at full engine torque. The permissible intensity of pressure is 350 kPa and the coefficient of friction is 0.35. Assuming uniform wear theory, calculate inner and outer diameters of the friction lining. | **10**<br><br>**10** | 1<br><br>2 | 4<br><br>3 | 4<br><br>4 |
| Q5 | Design the hydraulically driven 1000 kgf device to meet a positive load in a normal working environment. The device involves the following medium quality components;<br>• Double acting cylinder with a stroke of 75 cm,<br>• Pump and coupled motor,<br>• Reservoir<br>• Fluid,<br>• Strainer and filter<br>• PRV<br>• Pressure gauge<br>• 4/3 DC valve and necessary conductors.<br>• Conductors<br>The cylinder is to move with a maximum speed of 10m/s. Assume the ambient temperature as 27 deg. and the maximum design temperature as 50 deg. Also draw the hydraulic circuit to implement the control scheme. The leakage flows in the pump and actuator can be taken at least 10% (each) and frictional losses in the pump and the actuator can be taken at least 10 % (each).<br>Assume:<br>Flow rate 13.5 lpm. N of pump 1410 rpm, Fluid velocity 5 m/s, friction factor = 0.048 Fluid density = 820 kg/$m^3$ | **20** | 1 | 3 | 5 |

| | | | | | |
|---|---|---|---|---|---|
| Q6 | A 4-fall EOT crane has following specifications:<br>• Safe Working Load in kN = 80 kN<br>• Height to which load is raised = 15 m<br>• 2500 hours of service/year<br>• Dead weight of hoisting system = 4 kN<br>• Hoisting velocity = 10 m/min<br>• Braking distance for hoist = 80 mm<br>• Hook shank diameter = 90 mm<br>• Hook nut outside diameter = 200 mm<br>• Distance between side plates of snatch block = 400 mm<br>(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. | **20** | 1 | 4 | 6 |
| Q7 | a) In municipal water supply system centrifugal pumps are extensively used to pump normal temperature water. Design centrifugal pump for Total head = 55 m, Discharge = 100 m³/hr. Prime over electric motor is coupled directly to the pump. Determine power requirement and select suitable motor for the pump. Calculate the suction pipe diameter and impeller dimensions.<br>b) Sketch and Explain different centrifugal pump casings. | **15**<br>**05** | 1<br>3 | 2<br>4 | 7<br>7 |

**Annexure 1**

(All symbols indicate their conventional meaning)

**EOT Crane Design**

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

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

- Factors for permissible stress calculations
  - $C_{df}$ = duty/impact factor from DDB
  - $C_{bf}$ = basic stress factor = 3.15 for normal loading
  - $C_{sf}$ = safety factor = 1.12 for mild steel
- Rope drum
  - Length of rope drum = $\left(\frac{2H \times i}{\pi D} + 12\right) s + l_1$

- Crushing stress below rope groove of drum = $\frac{F_r'}{w \times s}$
- 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) × $Q$, $V_s = V_0 = V\epsilon$, $V = \sqrt{2gH}$, $\epsilon = 0.023\sqrt{n_q}$

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 $V_{m3} = (0.8 \text{ to } 0.9) \times V_0$

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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Munshi Nagar, Andheri (W) Mumbai – 400058

## END-SEMESTER EXAMINATION - DECEMBER 2023

**Program: B.Tech. in Mechanical Engineering** Sem VII

**Course Code: PC-BTM711**

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

**Duration: 3 Hours**

**Max. Points: 100**

**Semester: VII**

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# SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

## END SEM EXAM DEC2023

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

29/11/23

**Sem VII**
**Code PEC-BTM 705**
**Points 100**

- **Q1 is compulsory**
- **Solve any 4 out of remaining 6**
- **Figures to right indicate the full points**
- **Assume Suitable data wherever needed.**
- **ND table are permitted.**

Industrial Engg & Proj Mgt.

| Que. No. | Question Statement | Points | Module | CO |
|---|---|---|---|---|
| Q1 | Explain the following terms<br>1. HR Barriers to project risk management in international projects<br>2. Graph showing concepts of Earned Value Management<br>3. Productivity improvement techniques<br>4. Control Charts | 20 | M7<br>M6<br>M1<br>M6 | CO1<br>CO2<br>CO3<br>CO4 |
| Q2A | The time estimates for the activities of a PERT network is given below.<br>Activity \| $t_o$ \| $t_m$ \| $t_p$<br>1-2 \| 2 \| 3 \| 8<br>1-3 \| 2 \| 5 \| 8<br>1-4 \| 3 \| 4 \| 8<br>2-5 \| 2 \| 3 \| 9<br>3-5 \| 3 \| 5 \| 12<br>4-6 \| 3 \| 5 \| 9<br>5-6 \| 4 \| 7 \| 13<br>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? | 10 | M6 | CO1,<br>CO3<br>CO4 |
| Q2B | State the purpose of carrying out method study. Show the Activity symbol and their purpose. Draw a flow process chart Admission to Engineering College through centralized admission process. Consider start event Declaration of 12th standard Result and end event as receipt of fees payment to college. | 10 | M3 | CO1<br>CO3 |

| | | | | |
|---|---|---|---|---|
| Q3A | Refer the Project Data given below. Find Normal duration and Minimum Duration. What is the percentage increase in cost to complete the project in 4days lesser than Normal duration? | 10 | M6, M7 | CO3, CO4 |

| Activity | Dependence | Normal duration | Crash Duration | Normal cost | Crash Cost |
|---|---|---|---|---|---|
| A | -- | 6 | 3 | 600 | 900 |
| B | A | 3 | 1 | 500 | 700 |
| C | A | 6 | 4 | 500 | 700 |
| D | A | 5 | 3 | 900 | 1000 |
| E | B,C | 6 | 4 | 700 | 1100 |
| F | C,D | 4 | 3 | 900 | 1400 |
| G | E,F | 5 | 3 | 900 | 1800 |

| | | | | |
|---|---|---|---|---|
| Q3B | What do you mean by Ergonomics? Explain methods to improve work environment. Identify at least 20 examples of wrong designs/ poor designs of various products from ergonomics perspective. Draw the sketches and justify your comments. | 10 | M3 | CO1 CO2 CO3 |
| Q4A | 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. | 10 | M6, M7 | CO2 CO3 |

| 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 |

| | | | | |
|---|---|---|---|---|
| Q4B | 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 | CO1 CO4 |

<table>
<tr><td>Q5A</td><td>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.
<table>
<tr><th>Activity</th><th>Time in days</th></tr>
<tr><td>1-2</td><td>2</td></tr>
<tr><td>1-4</td><td>9</td></tr>
<tr><td>1-7</td><td>1</td></tr>
<tr><td>2-3</td><td>4</td></tr>
<tr><td>3-6</td><td>8</td></tr>
<tr><td>4-5</td><td>5</td></tr>
<tr><td>4-8</td><td>3</td></tr>
<tr><td>5-6</td><td>1</td></tr>
<tr><td>6-9</td><td>5</td></tr>
<tr><td>7-8</td><td>4</td></tr>
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</table></td><td>10</td><td>M6, M7</td><td>CO2 CO3</td></tr>
<tr><td>Q5B</td><td>Draw the Project risk management framework based on Industry 4.0 technologies and explain it.</td><td>10</td><td>M6, M7</td><td>CO2, CO3, CO4</td></tr>
<tr><td>Q6A</td><td>A refrigerator manufacturing company is working on a Project of launching a New Product - a new energy efficient refrigerator. The new product development project manager has three options for its product to meet the demand.<br>1.Arrange overtime working<br>2.Give subcontracting<br>3.Carry out expansion of existing unit<br>The correct choice largely depends upon future demand which may be low, medium, and high with probabilities as shown in table. The cost analysis reveals effect upon the payoffs [profits] as shown in table. The payoffs are thousand of rupees.
<table>
<tr><th rowspan="2">Demand</th><th rowspan="2">Probability</th><th colspan="3">Payoffs for Courses of action</th></tr>
<tr><th>Overtime</th><th>Sub Contract</th><th>Expansion</th></tr>
<tr><td>Low -L</td><td>0.15</td><td>-25</td><td>20</td><td>-150</td></tr>
<tr><td>Medium-M</td><td>0.40</td><td>50</td><td>55</td><td>50</td></tr>
<tr><td>High-H</td><td>0.45</td><td>80</td><td>75</td><td>170</td></tr>
</table>
Draw the decision tree. Recommend your decision to project manager with appropriate justification.</td><td>10</td><td>M7</td><td>CO1, CO3</td></tr>
<tr><td>Q6B</td><td>Explore the barriers for improving the agility in project procurement process.</td><td>10</td><td>M5, M6, M7</td><td>CO1 CO4</td></tr>
<tr><td>Q7A</td><td>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.</td><td>10</td><td>M1, M2</td><td>CO1</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| | <table><tr><th>Element</th><th>Observed time</th><th>Rating</th><th>Remark</th></tr><tr><td>A.</td><td>0.2</td><td>90</td><td>-</td></tr><tr><td>B.</td><td>0.15</td><td>90</td><td>-</td></tr><tr><td>C.</td><td>0.13</td><td>95</td><td>-</td></tr><tr><td>D.</td><td>0.90</td><td>95</td><td>-</td></tr><tr><td>E.</td><td>0.16</td><td>110</td><td>-</td></tr><tr><td>F.</td><td>0.15</td><td>115</td><td>-</td></tr><tr><td>G.</td><td>0.12</td><td>95</td><td>Once in 5 pieces</td></tr><tr><td>H.</td><td>0.16</td><td>90</td><td></td></tr><tr><td>I.</td><td>0.15</td><td>95</td><td></td></tr><tr><td>J.</td><td>0.25</td><td>95</td><td>Once in 20 pieces</td></tr></table> | | | |
| Q7B | A milk factory seeks advice from an external consulting company concerning its business and production processes. The final consulting report describes several steps to increase productivity including implementation of cutting-edge processing techniques through more powerful filtering systems.<br>a) Calculate the labor productivity for the existing as well as the proposed system.<br>b) Find the All-Factor Productivity for both systems.<br>c) Assume that current processing includes 700 gallons of Grade-A milk sold at $2.40/gallon and 300 gallons of Grade-B milk at $1.90/gallon. Furthermore, assume that under the proposed system, processing will include 600 gallons of Grade-A milk at $2 40/gallon and 400 gallons of Grade-B milk at $1.90/gallon. Compare all-factor productivity for both the existing and the new system. | 10 | M1 | CO1<br>CO4 |

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(A Government Aided Autonomous Institute)

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

Re-Examination, FEBRUARY 2024

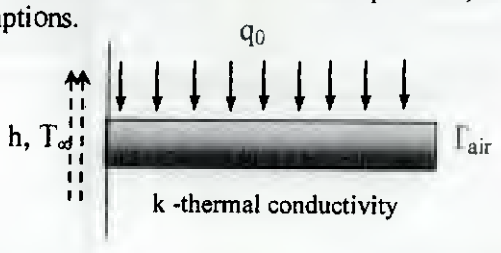
**B.Tech. (Mechanical Engineering), Semester-VII** Max. Marks: 100

**BTME708: COMPUTATIONAL FLUID DYNAMICS** Duration: 3 Hours

**Instructions:**

- Answer any **FIVE** questions
- Answers to all sub questions of a particular question must be grouped together for their evaluation
- Make suitable assumption if needed with proper reasoning
- Figures on right in square bracket shows maximum marks for a particular sub-question
- Figure on the extreme right shows **course outcome number (CO)/ Bloom's Taxonomy (BT).**

| | | | | |
|---|---|---|---|---|
| 1. | A. | What is the need of modeling and simulation in designing of a mechanical system? Why does a model need to be validated? | [10] | 1/2 |
| | B. | A flat fin of length $L$, width $w$, and thickness $d$ is exposed to a uniform heat flux of $q_o$ along its length. The base of the fin is attached to fluid stream whose free stream temperature is $T_\infty$ heat transfer coefficient $h$. The opposite end of the fin is held at $T_{air}$. Analyze the situation and develop a mathematical model to estimate its temperature, T = f(x, t). List down all applicable assumptions. | [10] | 1/6 |




| | | | | |
|---|---|---|---|---|
| 2. | A. | Discuss convergence and stability issues associated with one dimensional uncoupled convection-diffusion heat transfer under central difference interpolation of convective terms.<br>For monotonic convergence of one dimensional convection-diffusion problem the stability is limited by $\|Pe\| < 2$ if CDS is used to treat convective terms. | [10] | 2/5 |
| | B. | Determine the temperature distribution in a plane wall of thickness 60 mm, which has an internal heat source of 0.3MW/m$^3$ and the thermal conductivity of the material is 21 W/m °C. Assume that the surface temperature of the wall is 40 °C. Model the problem to obtain steady state temperature at least 6 internal points.<br>If the left-hand face wall is insulated and the right-hand face is subjected to a convection environment at 93 °C with a surface heat transfer coefficient of 570W/m$^2$ °C. Determine the temperature distribution within the wall. | [10] | 3/3,4 |
| 3. | A. | Discuss and explain following terms:<br>i) Explicit and implicit Scheme<br>ii) Over and under relaxation<br>iii) Ill-conditioned system of equations<br>iv) Time step size in transient analysis | [10] | 2/2 |
| | B. | Formulate the following set of linear algebraic equations, for converged iterative solution and solve it by using the Gauss-Seidel up to 5 iterations. Show the result in the tabular form. | [10] | 4/6 |

$$\begin{bmatrix} 2 & 2 & 1 & 2 \\ 1 & -2 & 0 & -1 \\ 3 & -1 & -2 & -1 \\ 1 & 0 & 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 7 \\ 2 \\ 3 \\ 0 \end{bmatrix}$$

4. **A.** Discuss the fundamental conservation law required for the analysis of a thermo-fluid system. Listing all assumptions, derive general differential form of mass balance equation. **[10]** 1/4

   **B.** Consider one-dimensional conduction in a plate that is part of a thermal system. The plate is 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 a = 5 × 10–6 m2/s. Solve this problem by any finite difference method to obtain the temperature distribution as a function of time. **[10]** 2/3,4

5. **A.** With proper example and illustration, explain following terms: **[10]** 1/4
   a) Orthogonal and non-orthogonal mesh
   b) Structured and unstructured mesh
   c) Conformal and non-conformal mesh

   **B.** For the equation, **[10]** 3/3,4

   $$(t - \phi)\frac{d\phi}{dt} = -\phi^2, \qquad \phi=2 \text{ when } t=0$$

   use the following methods with time-step $\Delta t=0.25$ to find the value of $\phi$ at $t = 1$:
   (a) fully explicit,
   (b) fully implicit,
   (c) Semi-implicit.

6. **A.** a) What is alternating direction implicit scheme (ADI)? Where it can be used? **[10]** 2/4,5
   b) Mathematically represent ADI scheme applying it to a 2D transient conduction.
   c) How does it differ from explicit and implicit scheme?
   d) Where are the advantages of ADI scheme. **[10]** 3/4

   **B.** What do you understand by
   (i) Staggered mesh,
   (ii) Semi-staggered mesh and
   (iii) Checker board problem?
   Numerically, how flow problem analysis differs from thermal diffusion problem? Discuss the complexity associated with flow problems.

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

   **B.** State the important characteristics of a turbulent flow. What is RANS equation? Name any four turbulence models. **[10]** 1/2

Bharatiya Vidya Bhavan's

# SARDAR PATEL COLLEGE OF ENGINEERING

(A Government Aided Autonomous Institute)

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

**End Semester Examination, DECEMBER 2023**

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

**BTM 708: COMPUTATIONAL FLUID DYNAMICS** Duration: 3 Hours

**Instructions:**

- Answer any **FIVE** questions
- Answers to all sub questions of a particular question must be grouped together for their evaluation
- Make suitable assumption if needed with proper reasoning
- Figures on right in square bracket shows maximum marks for a particular sub-question
- Figure on the extreme right shows **course outcome number (CO)/ Bloom's Taxonomy (BT).**

| | | | | |
|---|---|---|---|---|
| 1. | A. | What do you understand by modeling and simulation of a mechanical system? Explain their needs and limitations. Why does a model need to be validated? | **[10]** | 1/2 |
| | B. | A rectangular solar panel of size length (L), width (B) and thickness (T), is irradiated by a solar flux 'q' normal to the panel's front face. After a certain period of exposure to the radiation, the solar panel reaches to a thermal equilibrium. Assuming the system as a lumped body, develop mathematical models<br>a) To evaluate the panel temperature at steady state condition<br>b) To evaluate the transient variation of panel temperature<br>Consider convection and radiation as important mode of heat exchange. | **[10]** | 1/6 |
| 2. | A. | Consider 1D convection-diffusion problem. Under central difference scheme for the convective term the numerical stability of the problem is limited by $\|Pe\| < 2$ if is used to treat convective terms. How these restrictions can be avoided? Explain the concept of up-winding. | **[10]** | 2/5 |
| | B. | Determine the temperature distribution in a plane wall of thickness 50 mm, which has an internal heat source of $0.3 MW/m^3$ and the thermal conductivity of the material is 21 W/m °C. Assume that the surface temperature of the wall is 40 °C. Model the problem to obtain steady state temperature at least 6 internal points.<br>i) Write differential form of the governing equation and BCs,<br>ii) Using FDM to develop the discretized equations for all nodes,<br>iii) Calculate temperature at equally spaced 6 points along the wall thickness. | **[10]** | 3/3,4 |
| 3. | A. | Discuss and explain following terms:<br>i) Difference between Elliptical and Hyperbolic form of the partial differential equations<br>ii) Over and under relaxation<br>iii) Role Eigen values in solution of linear algebraic equations<br>iv) Time step size in transient analysis | **[10]** | 2/2 |
| | B. | Formulate the following set of linear algebraic equations, for converged iterative solution and solve it by using the Gauss-Seidel up to 5 iterations. **Show the result in the tabular form.** | **[10]** | 4/6 |

$$5x_1 + x_2 + 2x_3 = 19$$
$$x_1 + 4x_2 - 2x_3 = -2$$
$$2x_1 + 3x_2 + 8x_3 = 39$$

4. **A.** What are the different approach to investigate a thermo-fluid problem? Discuss merits and demerits associated with each approach. **[10]** 1/4

**B.** A wall 0:12 m thick having a thermal diffusivity of $1.5\times10^{-6}$ $m^2/s$ is initially at a uniform temperature of 85°C. Suddenly one face is lowered to a temperature of 20°C, while the other face is perfectly insulated. Consider discretized space and time as, $\Delta x$ =30 mm and $\Delta t$= 300 s. **[10]** 2/3,4

a) Write governing equation, BCs and initial conditions,
b) Develop the discretized the equation using FVM,
c) Using explicit scheme, tabulate the temperature variations along wall thickness at 4 time steps.

5. **A.** With proper example and illustration, explain following terms: **[10]** 1/4

a) Orthogonal and non-orthogonal mesh
b) Structured and unstructured mesh
c) Conformal and non-conformal mesh

**B.** Write the differential form of governing equation applicable to following problem and use FDM to develop the nodal equations for the specified node under following configurations. **[10]** 3/3,4

(i) (Figure 1) Node ($m$, $n$) on a diagonal boundary subjected to convection with a fluid at $T$ and a heat transfer coefficient $h$. Assume $\Delta x = \Delta y$.
(ii) (Figure 2) Node ($m$, $n$) at the tip of a cutting tool with the upper surface exposed to a constant heat flux $qo$, and the diagonal surface exposed to a convection cooling process with the fluid at $T$ and a heat transfer coefficient $h$. Assume $\Delta x = \Delta y$.

6. **A.** Discuss the fundamental conservation law required for the analysis of a thermo-fluid system. Listing all assumptions, derive general differential form of mass balance equation. **[10]** 2/4,5

**B.** Discuss different approach of modeling transient heat transfer. Identify stability issues for one-dimension transient heat conduction with convection using FDM. **[10]** 3/4

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

**B.** State the important characteristics of a turbulent flow. What is RANS equation? Name any four turbulence models. **[10]** 1/2

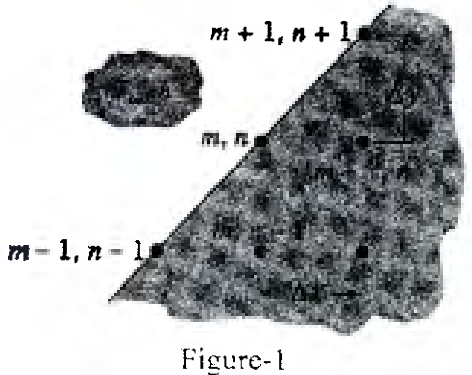


Figure-1

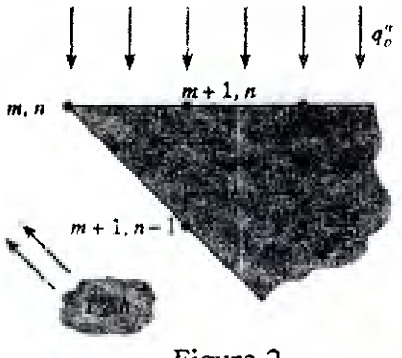


Figure-2

Bharatiya Vidya Bhavan's

# SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 4

## End Semester Examination December2023

B.Tech (M) Sem VII

**Program:** MECHANICAL ENGINEERING **Duration: 03 Hrs**

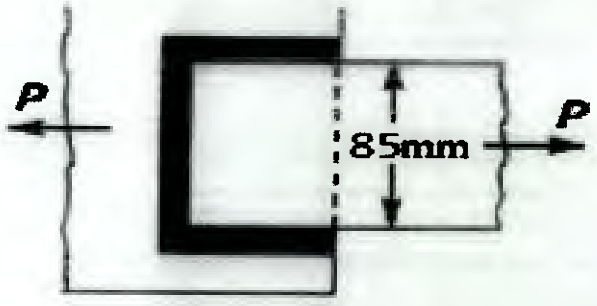
**Course Code:** PE-BTM735 **Maximum Points: 100**

**Course Name: Welding Process And Welding Technology** **Semester: VII**

11/12/24

**Notes:**
1. **Question no 1 is compulsory**
2. Attempt any **four questions** from the remaining six questions.
3. If necessary **assume suitable** data with justification
4. Draw **neatly labeled sketches** wherever required.

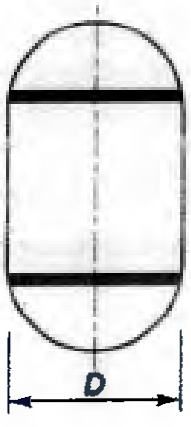
| Q. No. | Questions | Points | CO | BL | PI |
|---|---|---|---|---|---|
| 1. | A. Analyze the diverse arc forces encountered in welding. Discuss the specific types of arc forces and their practical implications on weld pool dynamics and bead geometry. Support your analysis with real-world welding scenarios. | 10 | 1,4 | 4 | 2 |
| | B. A plate 85 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Fig. The maximum tensile and shear stresses are 90 MPa and 62 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading. | 10 | 2 | 3,4 | |

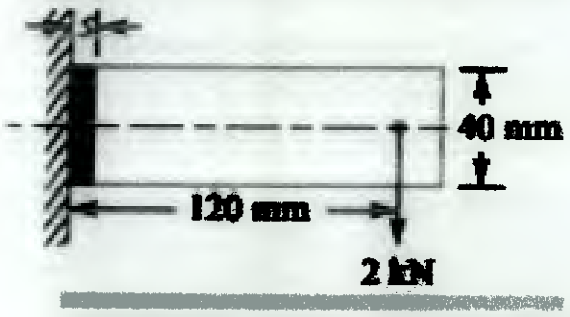


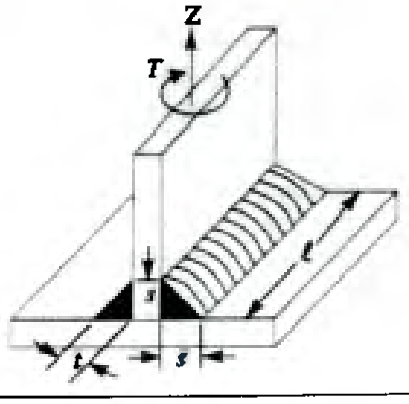

Stress concentration factor for welded joints.

| Type of joint | Stress concentration factor |
|---|---|
| 1. Reinforced butt welds | 1.2 |
| 2. Toe of transverse fillet welds | 1.5 |
| 3. End of parallel fillet weld | 2.7 |
| 4. T-butt joint with sharp corner | 2.0 |

**End Semester Examination December2023**

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | A. | Describe the welding process where a high-velocity beam of electrons, possessing kinetic energy, strikes metal pieces, and the kinetic energy of the electrons transforms into heat. Elaborate on the working principles, components, and applications of this welding method. | 06 | 1,4 | 5 | 2 |
| | B. | Explain the working principle and construction of the explosive welding process; explain the key components and the underlying mechanisms. | 06 | 4 | 3 | |
| | C. | A gas tank consists of a cylindrical shell of 180cm inner radius. It is enclosed by hemispherical shells by means of butt welded joint as shown in Figure. The thickness of the cylindrical shell as well as the hemispherical cover is 1.4 cm. Determine the allowable internal pressure (MPa) to which the tank may be subjected, if the permissible tensile stress in the weld is 105 N/mm$^2$.Assume efficiency of the welded joint as 0.82.   | 08 | 2,3 | 4 | |
| 3 | A. | Investigate and analyze the effects of MIG welding process parameters, specifically focusing on burnoff rate and electrode extension. Provide a comprehensive discussion on the significance of burnoff rate and electrode extension in MIG welding with schematic diagram, its overall welding performance, supporting your analysis with real-world applications. | 8 | 4,1 | 3,4 | 3 |
| | B. | Elaborate on the cooling curve of the nugget zone, emphasizing how the rate of cooling influences the properties of both the nugget zone and HAZ. Ensure to discuss the key factors and mechanisms involved. | 06 | 3 | 4 | |
| | C. | Draw a schematic diagram illustrating the typical solidification zone, weld pool dynamics, and nomenclature of a Submerged Arc Welding (SAW) process. Label the key components and zones. Following the diagram, explain the | 06 | 3,4 | 4 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | necessity of fluxes in SAW, providing their classifications and discussing the functions they serve in the welding process.. | | | | |
| 4 | A. | Explain the concept of power density in welding. Subsequently, elaborate on the importance of power density across various welding processes, highlighting the effects of energy density and time on overall energy input.With the aid of a labeled schematic diagram, illustrate and discuss the impact of power density of a heat source on the heat input required for welding, emphasizing the relationship between power density and efficient heat transfer in welding applications. | 10 | 1,3,4 | 2 | 4 |
| | B | A welded joint as shown in figure is subjected to an eccentric load of 2 kN. Find the size of weld, if the maximum shear stress in the weld is 25 MPa Explain the concept of hardfacing in welding and provide practical applications in mechanical engineering, detailing the specific components or structures involved and the engineering benefits gained from hardfacing.   | 10 | 2 | 6 | |
| 5 | A. | An arc welding DC power source has a linear power source characteristic with open circuit voltage $V_0$=90 Volts and $I_s$=1200amps.The voltage length characteristic of the arc has given by V=40+5L Volt where L is the arc length in mm. Calculate the optimum length of arc for obtaining max. arc power at welding. What voltage and current setting should be done on the power source for max.arc power. Also calculate net heat input for process if the arc heat transfer efficiency is 0.83 and welding speed is 7mm/sec. | 10 | 2,4 | 4 | 5 |
| | B. | Explain following NDT of welded joints with schematic diagram.<br>I. Dye penetrant test<br>II. Ultrasonic transmission approach testing. | 10 | 4 | 2 | |
| 6 | A. | Examine the coating ingredients used in welding electrodes, detailing their respective functions throughout the welding process. Discuss Cellulose-sodium and Rutile-sodium | 08 | 1,4 | 3 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | electrode. Additionally, explain the AWS standards for welding electrodes, specifying the criteria and significance of adherence to these standards in ensuring welding quality and performance. | | | | |
| | B. | Explain the generation of the laser in a laser welding machine, incorporating a schematic diagram to illustrate the process. Furthermore, discuss the various types of modes associated with the generated laser, considering their characteristics and applications. | 06 | 1,4 | 3 | |
| | C. | Examine the role of welding in manufacturing processes and compare it with other common joining process in manufacturing . Highlight a specific application where welding is the preferred and perhaps the only viable joining process, providing reasons for its superiority in that particular scenario | 06 | 1 | 3 | |
| 7 | A. | Examine various types of weld defects in welding. Select five specific defects, elucidate their causes with schematic diagrams, and propose effective remedies for each. Justify the chosen remedies and discuss how they contribute to defect prevention. | 10 | 1,4 | 6 | 7 |
| | B. | DC power source for arc welding has the characteristic 3V+I=240, V=voltage and I= current in amps. Determine the voltage that should be set for maximum power at the electrode. | 04 | 2 | 5 | |
| | C. | A plate 1 m long, 60 mm thick is welded to another plate at right angles to each other by 15 mm fillet weld, as shown in Fig. Find the maximum torque that the welded joint can sustain if the permissible shear stress intensity in the weld material is not to exceed 80 MPa.   | 06 | 4 | 3 | |

Bharatiya Vidya Bhavan's

# SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 4

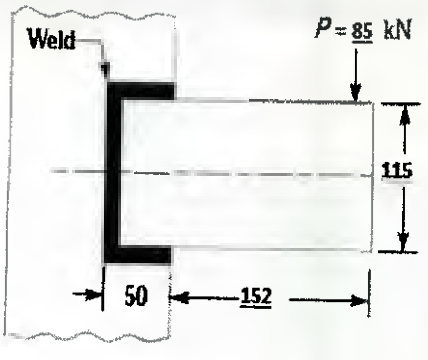
**Re-Examination-Feb 2024**

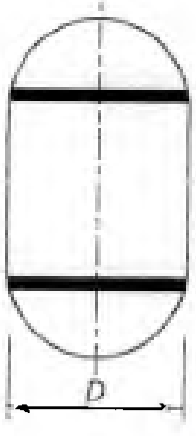
**Program:** MECHANICAL ENGINEERING **Duration: 03 Hrs**

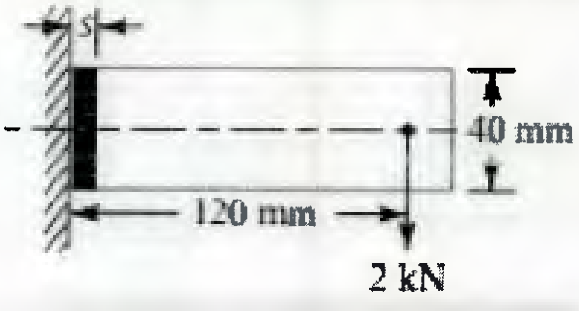
**Course Code:** PE-BTM735 **Maximum Points: 100**

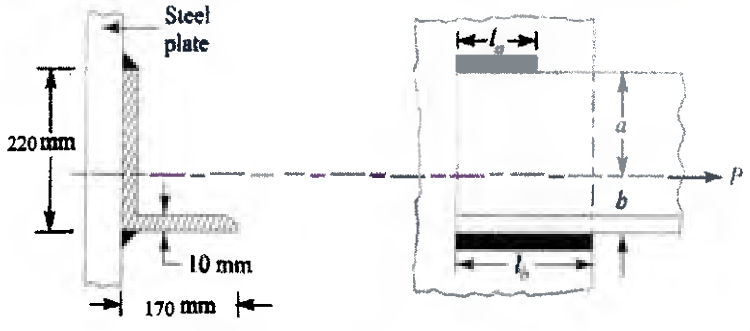
**Course Name: Welding Process And Welding Technology** **Semester: VII**

**Notes:**
1. **Question no 1 is compulsory**
2. Attempt any **four questions** from the remaining six questions.
3. If necessary **assume suitable** data with justification
4. Draw **neatly labeled sketches** wherever required.

| Q. No. | Questions | Points | CO | BL | PI |
|---|---|---|---|---|---|
| 1. | A. An arc welding DC power source has a linear power source characteristic with open circuit voltage $V_0$=85 Volts and $I_s$=1250amps.The voltage length characteristic of the arc has given by V=40+5L Volt where L is the arc length in mm. Calculate the optimum length of arc for obtaining max. arc power at welding. What voltage and current setting should be done on the power source for max.arc power. Also calculate net heat input for process if the arc heat transfer efficiency is 0.86 and welding speed is 7mm/sec. | 10 | 1,4 | 4 | 2. |
| | B. A rectangular steel plate is welded as a cantilever to a vertical column and supports a single concentrated load P, as shown in Fig. Determine the weld size if shear stress in the same is not to exceed 140 MPa.<br>  <br><br>All dimensions in mm. | 10 | 2 | 3 | 2.4.1 |
| 2 | A. Describe the welding process where a high-velocity beam of electrons, possessing kinetic energy, strikes metal pieces, and the kinetic energy of the electrons transforms into heat. Elaborate on the working principles, components, and | 06 | 1,4 | 5 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | applications of this welding method. | | | | |
| | B. | Explain the working principle and construction of the explosive welding process; explain the key components and the underlying mechanisms. | 06 | 4 | 3 | |
| | C. | A gas tank consists of a cylindrical shell of 185cm inner radius. It is enclosed by hemispherical shells by means of butt welded joint as shown in Figure. The thickness of the cylindrical shell as well as the hemispherical cover is 1.4 cm. Determine the allowable internal pressure (MPa) to which the tank may be subjected, if the permissible tensile stress in the weld is 105 N/mm$^2$.Assume efficiency of the welded joint as 0.82.   | 08 | 2,3 | 4 | |
| 3 | A. | Investigate and analyze the effects of MIG welding process parameters, specifically focusing on burnoff rate and electrode extension. Provide a comprehensive discussion on the significance of burnoff rate and electrode extension in MIG welding with schematic diagram, its overall welding performance, supporting your analysis with real-world applications. | 8 | 4,1 | 3,4 | 3 |
| | B. | Elaborate on the cooling curve of the nugget zone, emphasizing how the rate of cooling influences the properties of both the nugget zone and HAZ. Ensure to discuss the key factors and mechanisms involved. | 06 | 3 | 4 | |
| | C. | Why SAW considered more efficient compared to other arc welding processes?<br>Additionally, explain how the following process parameters affect weld quality when all other process parameters are kept at their optimum values in SAW:<br>1. Discuss the impact of high and low welding currents on weld quality.<br>2. Elaborate on the effects of a long arc length and a short arc | 06 | 3,4 | 4 | |

| | | | | | |
|---|---|---|---|---|---|
| | length on weld quality.<br>3. Explain how longer stick-out and shorter stick-out influence the quality of the weld.<br>Support your answers with relevant examples or reasons for the observed effects | | | | |
| 4 | A. Explain the concept of power density in welding. Subsequently, elaborate on the importance of power density across various welding processes, highlighting the effects of energy density and time on overall energy input. With the aid of a labeled schematic diagram, illustrate and discuss the impact of power density of a heat source on the heat input required for welding, emphasizing the relationship between power density and efficient heat transfer in welding applications. | 10 | 1,3,4 | 2 | 4 |
| | B A welded joint as shown in figure is subjected to an eccentric load of 2 kN. Find the size of weld, if the maximum shear stress in the weld is 25 MPa Explain the concept of hardfacing in welding and provide practical applications in mechanical engineering, detailing the specific components or structures involved and the engineering benefits gained from hardfacing.<br>  <br> | 10 | 2 | 6 | |
| 5 | A. Analyze the diverse arc forces encountered in welding, Discuss the specific types of arc forces and their practical implications on weld pool dynamics and bead geometry. Support your analysis with real-world welding scenarios. | 10 | 2,4 | 4 | 5 |
| | B. Explain following NDT of welded joints with schematic diagram.<br>I. Dye penetrant test<br>II. Ultrasonic transmission approach testing. | 10 | 4 | 2 | |
| 6 | A. Examine the coating ingredients used in welding electrodes, detailing their respective functions throughout the welding process. Discuss Cellulose-sodium and Rutile-sodium electrode. Additionally, explain the AWS standards for | 08 | 1,4 | 3 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | welding electrodes, specifying the criteria and significance of adherence to these standards in ensuring welding quality and performance. | | | | |
| | B. | Explain the generation of the laser in a laser welding machine, incorporating a schematic diagram to illustrate the process. Furthermore, discuss the various types of modes associated with the generated laser, considering their characteristics and applications. | 06 | 1,4 | 3 | |
| | C. | Excavator bucket top skin part has cracking, side part and tooth of excavator wear out due continuous use of it in industry. Due to this, the life of the excavator was reduced. Explain a technique to improve an excavator bucket's life without replacing the entire bucket. | 06 | 1 | 3 | |
| 7 | A. | Examine various types of weld defects in welding. Select five specific defects, elucidate their causes with schematic diagrams, and propose effective remedies for each. Justify the chosen remedies and discuss how they contribute to defect prevention. | 10 | 1,4 | 6 | 7 |
| | B. | DC power source for arc welding has the characteristic 4V+I=250, V=voltage and I= current in amps. Determine the voltage that should be set for maximum power at the electrode. | 04 | 2 | 5 | |
| | C. | A 220 × 170 × 10 mm angle is to be welded to a steel plate by fillet welds as shown in Fig. If the angle is subjected to a static load of 210 kN, find the length of weld at the top and bottom. The allowable shear stress for static loading may be taken as 80 MPa.   | 06 | 4 | 3 | |

Bharatiya Vidya Bhavan's

# SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)
Munshi Nagar, Andheri (W) Mumbai – 400058

11/24

## END SEMSTER EXAMINATION DECEMBER-JANUARY 2023-24

**Program: B.Tech. Mechanical** Sem VII — **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:** Ant two applications of cryogenics in space sciences. **Discuss:** developments in cryogenics in India and achievements of Indian space program. | **10** | 1 | i, II, IV | 1 |
| | **b) Explain:** i) Meissner effect. **Draw:** neat sketch, ii) Transition temperature iii) Critical field. **Differentiate:** between type-I and type-II superconductors. **Evaluate:** Threshold current for an Indium wire of 1.3 mm diameter at 3 K. Assume parabolic rule holds true. | **10** | 2 | II, IV, V | 1, 2 |
| 2. | **b) 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 | I, II | 2, 4 |
| | **b) Explain:** Criterion for determination of specific heat of solids at cryogenic temperatures with terms and formulae used. **Determine:** Percentage contribution of electronic specific heat ($c_{v,e}$) in the total specific heat ($c_v$) for Copper at temperature of i) *20 K* and ii) *2K*. Universal Gas Constant $\bar{R}$ = *8.31434 J/mol* and.relative molecular mass of Copper, *RMM = 63.54 g/mol*. **Discuss:** Variation of | **10** | 2 | II, V | 2 |

**END SEMSTER EXAMINATION DECEMBER-JANUARY 2023-24**

| | | | | | |
|---|---|---|---|---|---|
| | electronic and lattice specific heat of metals at extreme low temperatures from the results obtained. | | | | |
| 3. | **a) Explain:** operation of basic Claude liquefaction system. **Derive:** Expression for i) yield and ii) work of compression per unit mass of gas compressed for the system. **Draw:** neat system diagram and T-s diagram. | **10** | **4** | I, II, IV | 3 |
| 4. | **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** | I, V | 3 |
| 4. | **a) State:** Various systems for liquefaction of i) Neon and Hydrogen and ii) Helium. **Explain:** Operation of LN2 pre-cooled Linde-Hampson system for liquefaction of Hydrogen. **Derive:** Expression for system yield. **Draw:** neat system diagram. | **10** | **4** | I, II, IV | 4 |
| | **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) Define:** i) Joule-Thomson coefficient ($\mu_{JT}$) and ii) Isentropic expansion coefficient ($\mu_s$). **Compare:** Advantages and disadvantages of use of Isenthalpic and isentropic expansion in the gas liquefaction system. **Evaluate and compare:** $\mu_{JT}$ and $\mu_s$ for air for its expansion from 200 atm, 300 K to 100 atm. Draw: neat T-s diagram. | **10** | 4 | I, IV, V | 3 |

Bharatiya Vidya Bhavan's

# SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

## END SEMSTER EXAMINATION DECEMBER-JANUARY 2023-24

| | | | | | |
|---|---|---|---|---|---|
| | **a) 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 | 5 |
| **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: | | | | |
| | a) CERN and ITER | 20 | 1 | II | 1 |
| | b) Phases and isotopes of Helium | | 2 | | 2 |
| | c) Heylandt system | | 4 | | 3 |
| | d) Vacuum gauges for cryogenic applications | | 3 | | 6 |
| | e) Safety considerations for cryogenic plant | | 3 | | 7 |