Time: 3 Hour **Total Marks: 80**

Note:

1. **Question one is compulsory.**
2. **Solve any three out of remaining five.**

Q.1		**Write Short notes with sketch wherever applicable. (Solve any Four)**	**20**
	a	Pattern Allowances	
	b	Electron beam welding	
	c	Rolling mills	
	d	Gear Hobbing	
	e	Industry 4.0	
Q.2	**a**	Explain different design principles of gating and risering system	**10**
	b	Classify Welding processes and compare arc, gas and resistance welding	**10**
Q.3	**a**	Describe different sheet metal operations with neat sketches	**10**
	b	Write short not on Radial drilling machine	**10**
Q.4	**a**	List various methods of taper turning and Explain any one in detail.	**10**
	b	Explain stepwise procedure of powder metallurgy	**10**
Q.5	**a**	Describe the investment casting with working principle, advantages, limitations and applications	**10**
	b	Write short note on gas welding with different types of flames produced in it.	**10**
Q.6	**a**	Compare the following 1. Shaper and Planer 2. Hot working and cold working	**10**
	b	List various nontraditional machining methods and explain Ultrasonic machining in detail	**10**

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3 Hours *Total Marks: 80*

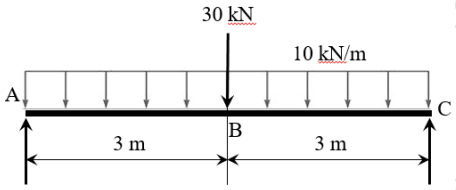
N.B.

1. Question no. 1 is compulsory.
2. Attempt any **THREE** from **remaining questions.**
3. Figures to the right indicates maximum marks.
4. Assume suitable data if needed and state it clearly.

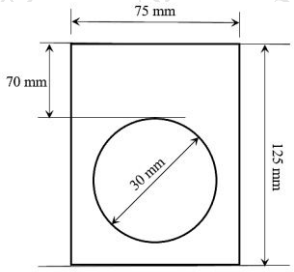
Q1 Attempt any **FOUR** of the following. **(20M)**

a) A bar of 30 mm diameter and 300 mm length is subjected to a tensile load of 54×10^3 N. The change in length is 0.112 mm and the change in diameter is 0.00366 mm. Calculate poisons ratio and modulus of elasticity.

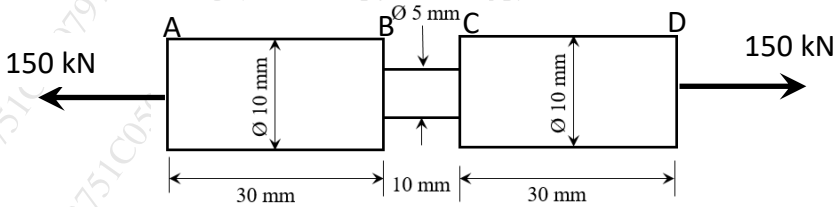
b) A simply supported beam AB is acted upon by UDL of 10 kN/m intensity over the entire length of 6 m and a point load of 30 kN exactly at the middle. Draw shear force diagram for the beam.



c) Calculate the section modulus about horizontal neutral axis for the section of the beam shown below.

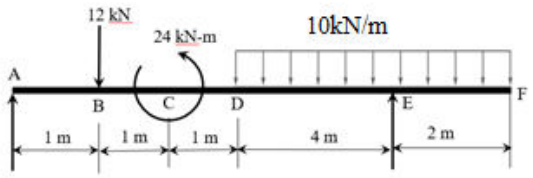


d) A circular shaped machine member shown in figure is acted upon by the load of 150 kN. Calculate the strain energy of the member.
Take E = 200×10^3 N/mm^2.

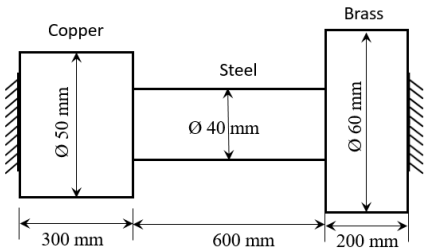


e) State assumption in the theory of pure torsion.

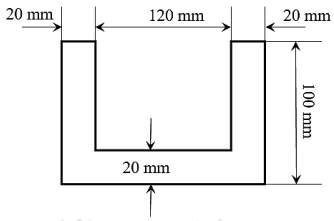
Q2a) An overhanging beam with supports at points A and E is loaded as shown in figure. Draw shear force and bending moment diagram for the beam. **(10M)**



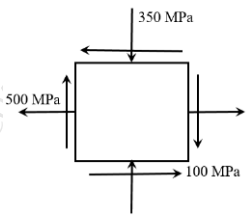
Q2b) A composite bar of circular section made up of copper, steel and brass is rigidly attached at the ends. Determine the stresses in the three portions of the bar, if the temperature of the bar is raised by 70°C. Take E for copper, steel and brass as 100 GPa, 205 GPa and 95 GPa, respectively and coefficient for linear expansion as 18×10^{-6} per °C, 11×10^{-6} per °C and 19×10^{-6} per °C, respectively. **(10M)**



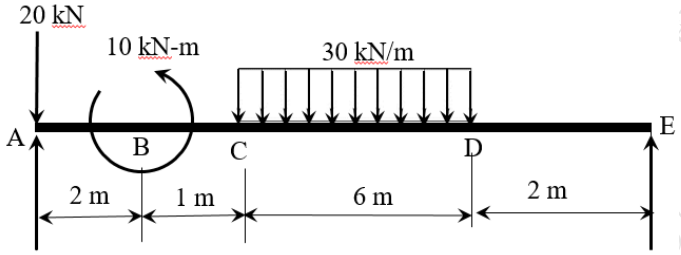
Q3a) The section of a beam as shown in figure is acted upon by the maximum sagging bending moment of 4 kNm. Calculate the maximum bending stress intensity induced in the beam. Also, draw the bending stress distribution diagram. **(10M)**



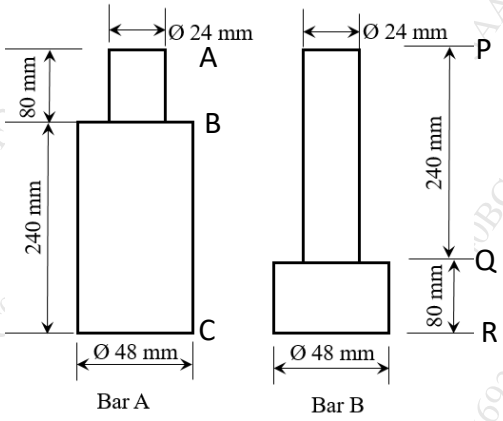
Q.3b) An element in a stressed material has tensile stress intensity of 500 MPa and compressive stress intensity of 350 MPa acting on two mutually perpendicular planes. A shear stress of 100 MPa accompany theses stresses as shown in figure. Find the principal stresses, maximum shear stress and position of principal planes. Verify the answer graphically using Mohr's circle method. **(10M)**



Q4a) For the beam loaded as shown in figure, determine the deflections at point C and D and slope at point A. **(10M)**



Q.4b) The two bars shown in figure are made up of same material and each of 320 mm in length. An axial blow to bar A produces maximum stress of 160 N/mm^2. Determine, for same axial blow, the maximum stresses produced in the bar B. Take E = 200×10^3 N/mm^2. **(10M)**



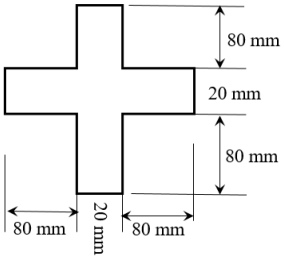
Q5a) A hollow shaft of diameter ratio 3/8 is required to transmit 600 kW at 110 RPM. The maximum torque being 20% greater than the mean torque. The shear stress is not to exceed 63 N/mm^2 and the angle of twist in a length of 3 m not to exceed 1.4°. Calculate maximum estimated external diameter of the shaft for these conditions. Take Modulus of rigidity as 84×10^3 N/mm^2. **(10M)**

Q.5b) A thin cylindrical tube of 200 mm internal diameter and 600 mm in length is 6 mm thick. The tube is filled with water at 8 N/mm^2. **(10M)**

Assuming E = 210×10^3 N/mm^2 and poisons ratio of 0.25, determine:

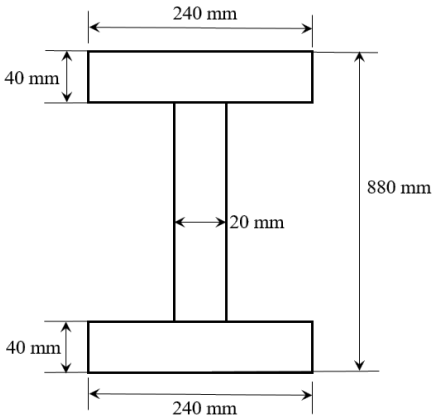
1. Circumferential and longitudinal stresses
2. Change in length
3. Change in diameter
4. Change in volume

Q6a) A 4 m long simply supported beam is in the form of cross bar as shown in figure. It carries a UDL of 40 kN/m over the entire length. Calculate the maximum shear stress and draw shear stress distribution diagram for the given section. **(10M)**



Q.6b) A column of I-section with both ends fixed has cross sectional dimensions as shown in figure. The length of the column is 12 m. Determine the safest load it can carry using Eulers column theory. **(10M)**

Take E = 205 GPa and factor of safety as 5.



Time (3 Hours) **Max. Marks: 80**

Note: (1) Question No. 1 is Compulsory.

(2) Answer any three questions from Q.2 to Q.6.

(3) Figures to the right indicate full marks.

1. (a) Find the eigen values of $A^2 + 2I$ where $A = \begin{bmatrix} 1 & 0 & 0 \\ 2 & -2 & 0 \\ 3 & 5 & 3 \end{bmatrix}$ (5)

(b) Find the Laplace transform of *f(t),* where

$$f(t) = \begin{cases} t^2, 0 < t < 1, \\ 1, \quad t > 1 \end{cases}$$ (5)

(c) Determine the constants a, b, c, d if

$f(z) = x^2 + 2axy + by^2 + i(cx^2 + 2dxy + y^2)$ is analytic. (5)

(d) Obtain half range Sine Series for f(x) $= x^2$, in 0 < x < 3. (5)

2.(a) Find $L^{-1}\left(\frac{4s+12}{(s^2+8s+12)}\right)$ (6)

(b) Find the Laplace transform of $e^{-4t}\int_0^t u \sin 3u \, du$. (6)

(c) Obtain the Fourier expansion for $f(x) = \begin{cases} \pi x & 0 \le x \le 1 \\ \pi(2-x) & 1 \le x \le 2 \end{cases}$ and

hence deduce that

$$\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \cdots ..$$ (8)

3(a) Use Cayley- Hamilton theorem to find $2A^4 - 5A^3 - 7A + 6I$ where $A = \begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix}$. (6)

(b)Determine the solution of one-dimensional heat equation

$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ under the boundary conditions u (0, t) =0, u (*l*, t) =0 and u (x, 0) =x, (0<x<*l*), *l* being the length of the rod. (6)

(c) Using Convolution theorem find the inverse Laplace transform of $\frac{(s+2)^2}{(s^2+4s+8)^2}$ (8)

4 (a) Find the orthogonal trajectory of the family of curves given by $x^3y - xy^3 = c$ (6)

(b) Prove that $\int_0^\infty e^{-t}\frac{sin^2 t}{t}\,dt = \frac{1}{4}\log 5$. (6)

(c) Using Crank-Nicholson formula, Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0. u(0,t) = 0, u(4,t) = 0,$

$u(x,0) = \frac{x}{3}(16 - x^2)$. Find u_{ij} for i=0, 1, 2, 3, 4 and j=0, 1, 2 taking $h = 1$. (8)

5 (a) Find inverse Laplace transform of $\log\left(\frac{s^2+a^2}{\sqrt{s+b}}\right)$. (6)

(b) Show that the function $u = \frac{1}{2}\log(x^2 + y^2)$ is harmonic and find its corresponding analytic function and its harmonic conjugate. (6)

(c) Solve $\frac{\partial^2 u}{\partial x^2} - 32\frac{\partial u}{\partial t} = 0$ by Bender-Schmidt method, subject to the conditions, $u(0,t) = 0\,, u(x,0) = 0, u(1,t) =$ t, taking h=0.25, 0<x<1. (8)

6 (a) Using Laplace transform Evaluate

$\int_0^\infty e^{-2t}\left(\int_0^t \frac{e^{-u}\sin u}{u}\,du\right)dt$ (6)

(b) Obtain Fourier series for $f(x) = x\cos x$ in $(-\pi, \pi)$. (6)

(c) Show that the matrix $A = \begin{bmatrix} -9 & 4 & 4 \\ -8 & 3 & 4 \\ -16 & 8 & 7 \end{bmatrix}$ is diagonalisable. Find the diagonal form D and the diagonalising matrix M. (8)

Time: 3 Hour **Max. Marks: 80**

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N. B.
1) Question No.1 is compulsory.
2) Attempt any three questions from remaining five questions.
3) All questions carry equal marks.

Q1. Write notes on any FOUR **[20]**
- (a) Burgers vector.
- (b) Allotropic form of iron.
- (c) Sub-zero treatment.
- (d) Fracture toughness.
- (e) Composite Materials.

Q2. (a) What is recrystallization annealing? Discuss the various stages of recrystallization annealing in detail. **[10]**

(b) Draw neat Fe-Fe3Ccarbide diagram indicating all important temperature, phases and composition. Also write the invariant reactions. **[10]**

Q3. (a) Define strain hardening. Explain the phenomenon on the basis of dislocation theory. **[10]**

(b) Define Critical Cooling Rate. Describe various cooling curves on TTT diagram for eutectoid steel. **[10]**

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Q4. (a) How is surface hardening different from case hardening? Discuss any one of the case hardening methods in detail. **[10]**

(b) Define fatigue failure. Discuss fatigue testing. Explain interpretation of S-N curve for ferrous and non –ferrous metals. **[10]**

Q5. (a) What are Nano Materials? Explain methods used for Nano materials synthesis. **[8]**

(b) What are polymers and its types? Explain the advantages of polymer over metallic materials **[7]**

(c) Explain Tempering and its different types. **[5]**

Q6. (a) Explain Creep resistant materials. **[6]**

(b) What is Nondestructive testing and explain any one type of it in detail? **[8]**

(c) What are smart materials? Explain any one in detail. **[6]**

Duration: 3Hrs **[Max Marks:80]**

N.B. : 1) Question No 1 is Compulsory.
2) Attempt any three questions out of the remaining five.
3) All questions carry equal marks.
4) Assume suitable data, if required and state it clearly.
5) Use of steam table, mollier diagram.

Qu.1 Attempt any Five of the following **[20]**

a) State the zeroth law of thermodynamics. What is its significance?

b) Difference between heat engine, refrigerator, heat pump

c) Show that internal energy is property of system

d) Define a) Wet steam b) Superheated steam c) Dryness fraction d) Saturation temperature.

e) What is cut off ratio? What are assumptions of air standard cycle?

f) Explain Joule –Thomson coefficient? Define inversion point and inversion curve.

g) Explain the effect of variation in back pressure on C-D nozzle performance.

Qu.2 **a)** 0.2 m^3 of an ideal gas at a pressure of 2 Mpa and 600K is expanded isothermally to 5 times the initial volume. It is then cooled to 300K at constant volume and then compressed back polytropically to its initial state. Determine the net work done and heat transfer during the cycle. Draw P-V and T-S dia. **[12]**

b) State and explain the Kelvin plank and Clausius statements of the second law of thermodynamics **[08]**

Qu.3 **a)** A household refrigerator absorbs heat at 2^oC and reject heat to the surrounding at 50^oC. It compressor is driven by 3 kw motor and 50 MJ/hr are absorbed at the low temperature. Evaluate the amount of heat rejected per hr and the irreversibility in J/hr. **[06]**

b) Prove that Steady flow energy equation. Apply to it compressor and Turbine. **[06]**

c) In centrifugal compressor, the suction and delivery pressure are 100kpa and 550 kpa resp. The compressor draws $15m^3$/min of air which has a specific volume of $0.77m^3$/kg. At delivery point the specific volume is $0.20m^3$/kg. The compressor is driven by a 40 kw motor and during passage of air through the compressor, the heat lost to the surrounding is 30 kJ/kg of air. Neglect KE, PE. Make calculations for increase in internal energy per kg of air. **[08]**

Qu.4 **a)** Explain various components of a simple steam power plant with sketch **[06]**

b) Write short note on Mollier's Diagram **[04]**

c) State the Maxwell's relation. **[06]**

d) Define 1) Mach No., 2) Stagnation temperature,3) Stagnation Pressure 4) Sonic flow. **[04]**

Qu.5 **a)** Derive an expression of air standard efficiency for Diesel cycle. **[08]**

b) In a thermal power plant operating on an ideal Rankine cycle, steam at 15 bar and 250^oC enters a turbine which generates 40 kw indicated power. If the steam consumption is 300 kg/hr and condenser is maintained at 0.15 bar, determine the final condition of steam, Rankine efficiency and relative efficiency. Neglect pump work. **[12]**

Qu.6 **a)** Explain the Rankine Reheat cycle with the help of T-S diagram. **[08]**

b) Consider an air standard Otto cycle that has a heat addition of 2800 kJ/kg of air, a compression ratio of 8, and a pressure and temperature at the beginning of compression process of 1 bar, 300K. Determine a) The maximum pressure and temperature in the cycle. b) The thermal efficiency c) Mean effective pressure. **[12]**

Take C_P =1.005 KJ/kg K, C_V = 0718 KJ/kg K, R = 287 KJ/kgK.

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