(3 Hours) *Total Marks :80*

Note: 1) Question No.1 is compulsory
2) Attempt any Three from the remaining

Q1

A) Find $L\left\{\int_0^t e^{-u}\, u^n\, du\right\}$ **5**

B) Prove that $f(z) = e^z$ is analytic everywhere. **5**
Hence find $f'(z)$

C) Find half range sine series of $f(x) = x$ in $(0, \pi)$ **5**

D) If A=$[a_{ij}]$ is a matrix of order 3×3 such that $a_{ij} = \begin{cases} 1, & if\ i \neq j \\ 0, & if\ i = j \end{cases}$ **5**

Find an eigen value of
i) A
ii) adjoint of A
iii) $A^2 - 2A + 2I$

Q2

A) If L[f(t)] = $\frac{1}{9s^2-3s+1}$ then Find L[te^t f(3t)] **6**

B) Find Fourier series for $f(x)$ =x $, if\ 0 < x < 2\pi$ **6**
and $f(x + 2\pi) = f(x)$

C) Find analytic function f(z) in terms of z where **8**
$u = y^2 - x^2$

Q3

A) A string is stretched and fastened to two points distance l apart. Motion is started by displacing the string in the form **6**
y=a sin(πx/ l) from which it is released at time t=0.Show that the displacement of a point at a distance x from one end at time t is given by y = a sin(πx/ l) cos (πct / l)

B) Prove that **6**
$u = e^x cosy$ is harmonic function hence find it's harmonic conjugate function

C) Find the Fourier Series for $f(x)$ in $(-\pi, \pi)$where **8**

$$f(x) = |x|$$

Q4

A) Evaluate $\int_0^{\infty} \left[\frac{cos2t-cos4t}{t}\right] dt$ **6**

B) Find Inverse Laplace transform of $\frac{s+1}{(s-1)^2(s-2)}$ **6**

C) *Is the matrix* $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ Diagonalizable? If so find the Diagonal form of A **8**
and transforming matrix of A

Q5

A) If A=$[a_{ij}]$ is a matrix of order 3×3 such that **6**

$$a_{ij} = \begin{cases} 2, & if\ i = j \\ -1 & ,if\ i + j = 3\ or\ 5 \\ 1\ , & if\ i + j = 4\ and\ i \neq j \end{cases}$$

Compute: $A^9 - 6A^8 - 9A^7 - 4A^6 + A^5 - 12A^4 - 18A^3 - 8A^2 + 2A + I$

B) Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2} - 16\frac{\partial u}{\partial t} = 0$, **6**

$0 \leq x \leq 1$ subject to the condition $u(0,t) = 0, u(1,t) = 100t$,

$u(x,0)$=0 h=0.25 for one-time step

c) Find inverse Laplace transform of $(i)\ log[z^2 - 4]$ $(ii)\ \frac{s+2}{(s+16)^2}$ **8**

Q6

A) Find the Laplace Transform of $\int_0^t \cos(u)\sin(u)du$ **6**

B) Find the solution of **6**

$4\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0, 0 < x < 8, \quad u(x,0) = 4x - \frac{1}{2}x^2$, u(0,t)=0, u(8,t)=0

Taking $h = 1, k = \frac{1}{8}$ $for\ 0 \leq t \leq 5/8$

Where h is the step length for $x\ axis$ and k is the step size in time direction using Bender –Schmidt method

C) Find inverse Laplace transform of $\frac{1}{(s^2+16)((s^2+49)}$ using convolution theorem **8**

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

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) Explain the advantages of polymer over metallic materials.
- (b) Allotropic form of iron
- (c) Critical Resolved Shear Stress (C.R.S.S.)
- (d) Ductile to Brittle Transition Temperature (DBTT)
- (e) Normalizing

Q2. (a) Classify various types crystal defects? Discuss line defects and their types. **[10]**

(b) State and explain Griffith's theory for brittle material with derivation **[10]**

Q3. (a) Draw the iron -iron carbide equilibrium diagram and write the important transformation seen in the diagram. **[10]**

(b) What is Nitriding and explain types of nitriding processes. Explain the heat treatment before nitriding. **[10]**

Q4. (a) What is recrystalliztion annealing? Discuss the various stages of recrystallization annealing with neat sketch **[10]**

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

Q5. (a) Draw a binary alloy phase diagram with example. **[10]**
(b) Write note on Shape Memory alloys **[6]**
(c) Explain ceramics and its applications. **[4]**

Q6. (a) Write note on composites and its applications. **[8]**
(b) Explain Magnetic Particle Testing with neat sketch **[8]**
(c) Define nano materials. Discuss their applications. **[4]**

Duration: 3 Hours **Total Marks- 80**

1) First Question (Q.1) is Compulsory.
2) Attempt any 3 questions from the remaining 5 (Q.2 - Q.6) questions.
3) Figures to the right indicate full marks
4) Proportionate and labelled free-hand sketches would do

Q. 1 Solve any **Four out of Six.** **20**

a) Explain shell moulding process.
b) Explain adhesive bonding process.
c) Write short note defects in rolling process.
d) Explain Internet of Things.
e) Discuss Laser beam machining process.
f) With the help of neat sketch explain working of compound die.

Q. 2 a) What is riser? Write the functions of risers. List types of risers and explain any one. **10**

b) Explain working oxy-acetylene gas welding. Sketch three types of flames and write its uses. **10**

Q. 3 a) Explain working, advantages and limitations of electro-discharge machining. **10**

b) Define extrusion process. With the help of neat sketch write the difference between direct extrusion and indirect extrusion. **10**

Q. 4 a) Explain construction and working of centre lathe. **10**

b) The tool life equation for machining C40 steel with a 18:4:1 H.S.S. cutting tool at a feed of 0.2mm/min and depth of cut 2mm is given by $VT^n = C$, where n and C are constants. The following observations have been noted :

V,m/min	25	35
T, min	90	20

Calculate n and C.
Hence recommend the cutting speed for a desired tool life of 60 minutes. **10**

Q. 5 a) Explain the various steps in powder metallurgy. **10**

b) Write the classifications of sheet metal operations. Explain any four sheet metal operations with neat sketch. **10**

Q. 6 Write short notes on **(Any four)** **20**

a) Write the difference between shaper and planer.
b) Classify Production Processes.
c) Write the difference between hot working and cold working.
d) Laser beam machining.
e) Gear hobbing.
f) Cloud manufacturing.

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3 Hours **Total Marks: 80**

- **Question-1 is compulsory.**
- **Answer any three from remaining five questions.**
- **Assume any suitable data, wherever required, but justify the same. Assumptions made should be clearly stated.**
- **Illustrate the answers with sketches, wherever required.**

1 *Answer any four of the following:*

a. A material has Young's modulus of 2×10^5 N/mm^2 Poisson's ratio of 0.32, determine rigidity and Bulk modulus of the material. *(05)*

b. A rectangular beam 300mm deep is simply supported over a span 4m. What uniformly distributed load the beam can carry if the bending stress is not to exceed 120MPa. Take I $=8\times10^6$ mm^4. *(05)*

c. A water main 800mm diameter contains water at a pressure head of 100m. If the weight of water 10kN/m^3, find the thickness of metal required for the water main if permissible stress in metal is 20N/mm^2. *(05)*

d. State the assumptions made in the analysis of struts and columns by Euler's buckling theory. *(05)*

e. Draw shear stress distribution for I section, T section and rectangular section. *(05)*

f. Establish the relationship between shear force, bending moment and rate of loading. *(05)*

2 a) A solid circular shaft has to transmit 300 kW power at 100 rpm. If the shear stress is not to exceed 80 N/mm^2, find the diameter of the shaft. If this shaft were replaced by a hollow one whose internal diameter is 0.6 of its external diameter, What will be the % of saving of material. The length, material and shear stress are kept same. *(10)*

2 b) A composite bar is made of Steel and Aluminium is held between two supports as shown in fig 1. The bars are stress free at temp 38°C. What will be the stress in the two bars when temperature decreased to 21°C, the supports come near to each other by 0.1mm. Take Es $=210$ GN/m^2, $E_{Al}=100$ GN/m^2, $\alpha_s = 11.7\times10^{-6}$/°C and $\alpha_{Al} = 23.4\times10^{-6}$/°C *(10)*

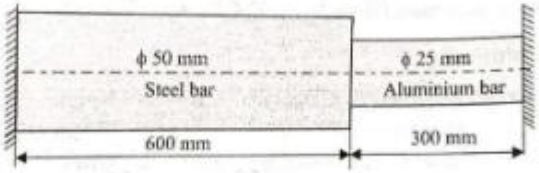

Fig.1

3 a) A T section (Flange =200mm×10mm, web=10mm×240mm) is used as struts which is 6m long, one end is hinged and other end is fixed. Determine the buckling load using Euler's formula. E=200×10^3 N/mm^2 *(10)*

3 b) Figure 2, shows a C section subjected to a shear force of 18 kN intensity. Draw the shear stress distribution diagram across the section and obtain the shear stress values at all the salient points including the neutral axis. *(10)*

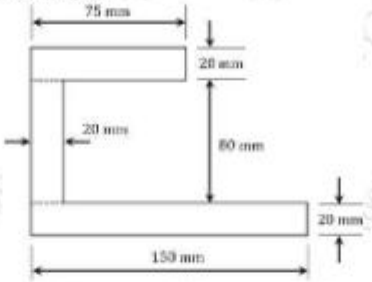

Fig.2

4 a) A cylindrical vessel of 1.5m diameter and 4m long is closed at ends by rigid plate. It is subjected to an internal pressure of 3N/mm². If the maximum circumferential stress is not to exceed 150N/mm², find the thickness of shell. Also change in diameter length and volume of the shell. Take E=2×10⁵ N/mm², 1/m =0.25 *(10)*

4 b) Draw shear force and bending moment diagram for beam shown in fig. 3 *(10)*

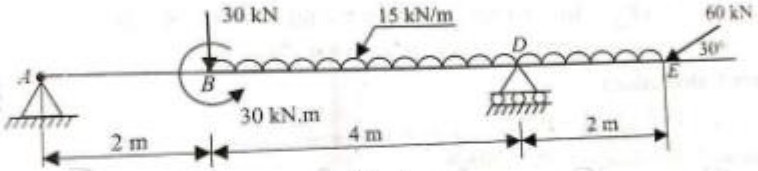

Fig.3

5 a) The beam has a T-shaped cross-section with a top flange measuring 90 mm × 20 mm and a web measuring 20 mm × 90 mm. The beam is a simply supported on a span of 8m and subjected to 1200N/m over entire span. Determine bending stresses in compression and tension, also sketch the bending stress distribution. *(10)*

5 b) Find the slope at A and deflection at a point C for the beam loaded shown in fig.4. Assume moment of inertia and modulus of elasticity as I=20×10⁶ mm⁴ and E =200 kN/mm². *(10)*

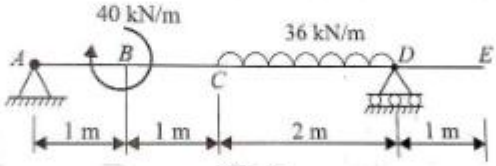

Fig. 4

6 a) Two mutually perpendicular plane of an element subjected to σ_x =100MPa (tensile) and σ_y =40MPa (compressive) and shear stress =30MPa. Locate the principal planes and determine the principal stresses, maximum shear stresses using Mohr's circle verify answers with analytical method. *(10)*

6 b) Determine instantaneous stress and deformation of a rod of length 1.2m and the diameter 8mm. If a mass of 90kg falls through a height f 15cm and strike the bottom of the rod. The rod is freely suspended and fixed at the top. Take E=210GPa. *(10)*

Time : 3 Hours **Total 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 and Mollier Diagram is permitted.

1 Solve **Any Four** **20**

a State Perpetual Motion Machine (PMM) - I & II.

b State the similarities and dissimilarities between heat and work transfer.

c Define the following term,
(i) Saturation temperature (ii) Sensible heat
(iii) Critical point (iv) Triple point

d Draw P-V and T-S diagram of Otto cycle and Brayton cycle.

e Discuss the Mach number corresponding to
(i) Subsonic flow
(ii) Sonic Flow
(iii) Supersonic flow

2 a In a gas turbine, the gases flow at the rate of 5 kg/s. The gases enter the turbine at a pressure 7 bar with a velocity 120 m/s. The turbine is insulated. The exit pressure and velocity are 2 bar and 250 m/s. If the enthalpy of the gas at the inlet is 900 kJ/kg and at the outlet is 600 kJ/kg, determine the capacity of the turbine. **10**

b Discuss generation of steam from ice at – 5°C at 1 atm with the help of T–S and P–V diagrams. **10**

3 a A heat pump working on a Carnot cycle takes in heat from a reservoir at 5 °C and delivers heat to a reservoir at 60 °C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir 840 °C and reject heat to a reservoir at 60 °C. The reversible heat engine also drives a machine that absorbs 30 kW. If the pump extracts 17 KJ/s from the 5 °C reservoir, Determine **10**

(i) the rate of heat supply from 840 °C source and

(ii) the rate of heat rejection to the 60 °C sink.

	b	Explain the concept of available and unavailable energy. When does the system become dead state?	05
	c	Describe reheat cycle and compare it with simple Rankine cycle.	05
4	a	Derive the Clausius theorem.	10
	b	Write the equations of Maxwell's Relations.	05
	c	During a thermodynamic cycle of processes (A-B-C-D-A), the heat transferred during each process are: 120 kJ, −16 kJ, −48 kJ and 12 kJ respectively. Estimate network transferred during the thermodynamic cycle, direction of work transfer, change in internal energy using the first law of Thermodynamics.	05
5	a	Derive the expression of efficiency of Diesel cycle and state the assumptions.	10
	b	Steam turbine working on Rankine cycle is supplied with dry saturated steam at 20 bar and the exhaust takes place at 0.3 bar. For a steam flow rate of 10 kg/s. Determine the quality of steam at end of expansion and Rankine efficiency,	10
6	a	An aeroplane is flying at 1000 km/h through still air having a pressure of 78.5 kN/m^2 (abs.) and temperature – 8°C. Calculate on the stagnation point on the nose of the plane : (i) Stagnation pressure, (ii) Stagnation temperature, (Take for air : R = 287 J/kg K and $\gamma = 1.4$)	10
	b	In an air standard diesel cycle, the compression ratio is 15 and the properties at the beginning of compression are 100 kPa and 300 K. For a peak temperature of 1600 K, Calculate the percentage of stroke at which cut- off occurs and the cycle efficiency	10

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