(3 Hours) **Total Marks :80**

Note: 1) Question No.1 is compulsory

2) Attempt any Three from the remaining

Q1

a) Find L[$sinh^5 t$] **5**

b) Find a , b , c, d ,e if
f(z)= (ax^3 +by^2x + $3x^2$ +cy^2 +x)+i(d x^2y - $2y^3$ +exy +y) is analytic **5**

c) Find half range sine series of f(x) = x(π – x) in (0 , π) **5**

d) If $A = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$ Find eigenvalue of Adj(A) **5**

Q2

a) If L[f(t)] = $\frac{9s}{9s^2-3s+6}$ then find L[e^t f(3t)] **6**

b) Find Fourier series for f(x)= x^2 ; $-\pi < x < \pi$ and f(x+ 2π) = f(x) **6**

c) Find analytic function f(z)=u+iv in terms of z where
u + v = e^x (cosy + siny) **8**

Q3

a) A string is stretched and fastened to two points distance l apart. Motion is started by displacing the string in the form 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 **6**

$$y = a \sin\left(\frac{\pi x}{l}\right) \cos\left(\frac{\pi ct}{l}\right)$$

b) Prove that u=x^2 -y^2 -2xy +2x -3y is harmonic function hence find it's harmonic conjugate function. **6**

c) Find the Fourier series to represent f(x) = $\begin{cases} x\ , & 0 < x < \pi \\ 2\pi - x\ , & \pi < x < 2\pi \end{cases}$ in (0 , 2π) **8**

Q4

a) Evaluate $\int_0^\infty e^{-t}\left[\frac{\cos 6t-\cos 4t}{t}\right]dt$ **6**

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

c) Is the matrix $A=\begin{bmatrix}2 & 0 & 2\\ 0 & 2 & 1\\ 0 & 0 & 1\end{bmatrix}$ diagonalizable ? If so find the Diagonal form of A and transforming matrix of A **8**

Q5

Using Cayley Hamilton Theorem find $A^9-6A^8+10A^7-3A^6+A+I$

a) where $A=\begin{bmatrix}1 & 2 & 3\\ -1 & 3 & 1\\ 1 & 0 & 2\end{bmatrix}$ **6**

b) Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2}-\frac{\partial u}{\partial t}=0$, $0\le x\le 1$ subject to the condition $u(0,t)=0, u(1,t)=100$, $u(x,0)=100\,(x-x^2)$ & h=0.25 for one time step **6**

c) Find the inverse Laplace transform of
(i) $\log[(s^2-4)(s^2-9)]$
(ii) $\frac{s}{(s-5)^2}$ **8**

Q6

a) Find the Laplace Transform of $\int_0^t ucoshusinhudu$ **6**

b) Find the solution of $\frac{\partial^2 u}{\partial x^2}-32\frac{\partial u}{\partial t}=0$, $0<x<1$, $u(x,0)=0$, $u(0,t)=0$, $u(1,t)=10+t$, taking h=0.25, k=0.025 for $0\le t\le 1$ where 'h' is the step length for x axis and 'k' is the step size in time direction using Bender-Schmidt method. **6**

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

(3 Hours) **[Total Marks :80]**

N.B.
1. Question No.1 is compulsory.
2. Answer any three questions from remaining questions.
3. Assume suitable data if required.
4. Figure to the right indicates full marks.

Q1 **Answer any four**. Each question carries same mark **5x4=20**

a For a two-dimensional state of stress What do you mean by principal stresses and maximum shear stress? Explain with example.

b Derive expression for deformation of uniformly tapering circular section bar.

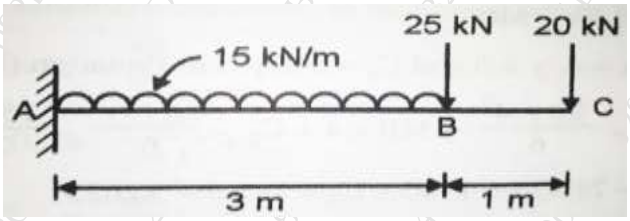
c Write the assumptions made in theory of pure torsion and derive torsional formula.

d What are the different end conditions used in columns?

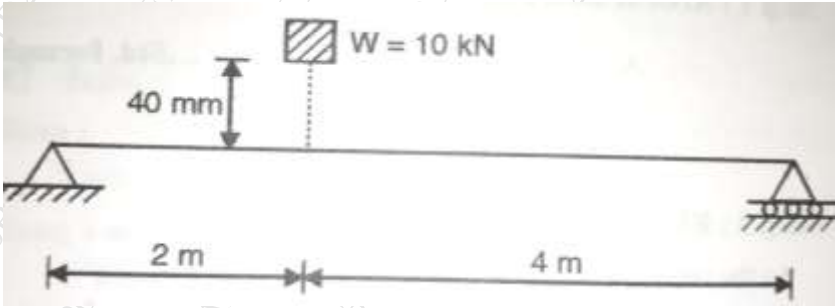
e Explain the stress strain diagram for ductile material.

Q2 a A bar of 25 mm diameter is tested in tension. It is observed that when a load of 60kN is applied, the extension measured over a guage length of 200 mm is 0.12 mm and contraction in diameter is 0.0045 mm. Find Poisson's ratio and elastic constants E, G, K. **10**

b Calculate deflection at point B and C for the beam as shown in figure using any method. Take EI=32000KN.m^2. **10**



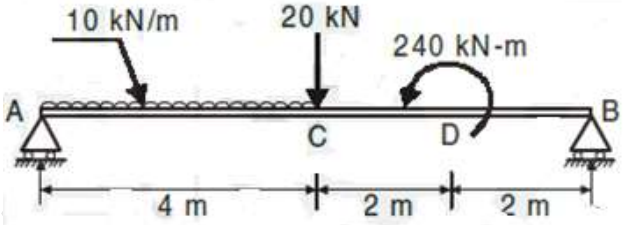
Q3 a A weight of 10 KN is dropped on to a simply supported beam for a height of 40 mm. Assuming the impact to be perfect without any loss of energy, Determine the instantaneous deflection at the impact point. Take EI= constant. **10**



b An I section beam 350mm x 150 mm has a web thickness 10mm and flange thickness 20mm. If the shear force acting on the section is 40 KN find: **10**

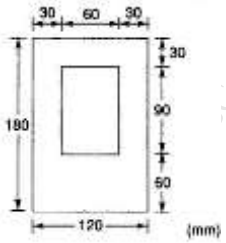
1 Max shear stress developed in the section
2 Sketch the shear stress distribution diagram.
3 The total shear force carried by web.

Q4 a A beam of span 8 m has roller support at A and hinge support at B as shown in Fig. Calculate SF and BM at important points and Draw SF and BM diagrams **10**



b Derive bending equation. Also state the assumption made in the analysis **10**

Q5 a The cross section of the beam is shown in figure. Determine the moment of resistance for both positive and negative of bending moment about horizontal neutral axis. Take tensile and compressive stresses as 24 and 85 *N/mm²* respectively. **10**



b A short hallow cylindrical column of 200 mm external diameter, 100mm internal diameter and 8m long has both ends fixed. It is subjected to axial compression load. Taking FOS as 5, σ_c=450 MPa & α = 1/1600. Determine safe Rankine's load. **10**

Q6 a A cylindrical shell is 150 cm long, 22cm internal diameter of 8mm thick plates is subjected to internal pressure 15 N/mm^2, E=2.1 X 10^5 N/mm^2, Bulk modulus of water is 200 N/mm^2 and 1/m=0.28. Find the change in volume of the shell. **10**

b A bar of brass 20 mm is enclosed in a steel tube of 40 mm external diameter and 20 mm internal diameter. The bar and the tubes are initially 1.2 m long and are rigidly fastened at both ends using 20 mm diameter pins. If the temperature is raised by 60°C, find the stresses induced in the bar, tube and pins. **10**

Es = 2 × 10^5 N/mm^2
Eb = 1 × 10^5 N/mm^2
α s = 11.6 × 10^{-6}/°C
α b = 18.7 × 10^{-6}/°C.

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

NB: 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 types of gates .
b) Differentiate between soldering and brazing.
c) Explain selection of grinding wheel.
d) Explain Internet of Things.
e) Discuss Electro-chemical machining.
f) Various steps involved in powder metallurgy.

Q. 2 a) Draw and explain Geometry of a Single Point Cutting Tool. **10**
b) Draw and explain screw type injection moulding process with its advantages, Limitations and applications. **10**

Q. 3 a) Explain working, advantages and limitations of ultrasonic machining. **10**
b) Draw and explain significance of various elements of gating system in sand casting. **10**

Q. 4 a) Draw and explain in brief the various welding defects their causes and remedies. **10**
b) Describe the types of drilling machine and their application. **10**

Q. 5 a) Explain working of Submerged Arc Welding with its applications, advantages. and limitations. **10**
b) Draw and explain in brief the various rolling defects their causes and remedies. **10**

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

a) Compare wood and metal as pattern materials.
b) Classify Production Processes..
c) Quick return mechanism on shaper.
d) Open die and Closed die forging.
e) CO2 Shell Moulding Process.
f) Cloud manufacturing.

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.
4) Figures to the right indicate full marks.
5) Answers to the questions should be grouped and written together.

Q1. Write notes on any FOUR **[20]**
- (a) Critical Resolved Shear Stress (C.R.S.S.)
- (b) Fracture toughness
- (c) Tool steels
- (d) Creep curve
- (e) Shape Memory Alloys

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

(b) Draw fully labeled neat sketch Fe-Fe_3C equilibrium diagram. Also write invariant reactions in it. **[10]**

Q3. (a) What is recrystalliztion annealing? Discuss the various stages of recrystallization annealing with neat sketch. **[10]**

(b) What is Hardenability of steel? Explain Jomny End Quench test. **[10]**

Q4. (a) What is the need of heat treatment process? Differentiate between annealing and normalizing process. **[10]**

(b) Derive an expression for Griffith's theory of brittle materials failure. **[10]**

Q5. (a) Explain induction hardening process with neat sketch. Also discuss its advantages, disadvantages and applications. **[8]**

(b) Explain the processing of ceramics through injection moulding operation. **[6]**

(c) Define nano materials. Discuss their applications. **[6]**

Q6. (a) Classify composite materials? Discuss their properties and applications **[8]**

(b) What is mean by endurance limit? Draw and discuss S-N curve for ferrous and non ferrous materials. **[6]**

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

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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 and Mollier Diagram is permitted.

1 Attempt any **FOUR** **[20]**

a Differentiate between Intensive & Extensive properties.

b Explain principle of increase of entropy.

c Define a thermodynamic system. Differentiate between open system, closed system and isolated system

d Draw P-V & T-S diagram for Atkinson cycle and Lenoir cycle.

e Define a) Availability, b) Unavailability, c) Dead state,d) Jouls Thomson Coefficient

f Define the terms a) Sonic Velocity and Mach Number b) Stagnation temperature and Stagnation pressure.

2 a 3 kg of air at 150 Kpa pressure and 360 K temperature is compressed polytropically to pressure 750 Kpa according to the law $pv^{1.2}$= C. Subsequently the air is cooled to initial temperature at constant pressure. This is followed by expansion at constant temperature till the original pressure of 150 Kpa is reached. Sketch the cycle on P-v and T-s plots and determine the work done, heat transfer and entropy change for each process. Take Cv = 0.718 kJ/kg K Cp = 1.005 kJ/kg K and R = 0.287 kJ/kg K. **[10]**

b Define Thermal Reservoir. Difference between heat engine, refrigerator, heat pump. State and explain the Kelvin plank and Clausius statements of the second law of thermodynamics **[10]**

3	**a**	Prove that Steady flow energy equation. Apply to it compressor and Turbine.	**[10]**
	b	(i) State and prove the Clausis theorem.	**[05]**
		(ii) Explain (a) Wet Steam (b) Dry Steam (c) Superheated Steam (d) Degree of Subcooling (e) Saturation Temperature	**[05]**
4	**a**	Steam at 15 bar and 300^0C is throttled to 10 bar before supplying to steam turbine. It then undergoes isentropic expansion to 1 bar in the turbine. Determine isentropic heat drop and the condition of steam at exit from the turbine. Use enthalpy-entropy chart.	**[06]**
	b	(i) Explain the Rankine Cycle with schematic, P-v and T-s Diagram.	**[08]**
		(ii)State limitations of Carnot Vapour Power Cycle	**[06]**
5	**a**	What is Brayton Cycle? Represent this on (p-v) and (T-S) diagram. Derive an expression for cycle efficiency	**[08]**
	b	A steam turbine working on Rankine cycle is supplied with dry saturated steam at 25 bar and the exhaust takes place at 0.2 bar. For a steam flow rate of 10kg/s, determine 1) quality steam at end of expansion, 2) turbine shaft work, 3) power required to drive the pump, 4) work ratio,5) Rankine efficiency.	**[12]**
6	**a**	(i) Explain Stagnation Pressure and Stagnation Temperature	**[05]**
		(ii)State assumptions of air standard cycle.	**[05]**
	b	In a diesel cycle, air 0.1 MPa and 300K is compressed adiabatically until the pressure rises to5 MPa. If 700 KJ/kg of energy in the form of heat is supplied at constant pressure, determine the compression ratio, cut off ratio, thermal efficiency and mean effective pressure. Cp = 1.005 kJ/kg	**[10]**

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