Time: 3 Hour Max. Marks: 80

==========

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

Q1.		Write short notes on any FOUR	[20]
	(a)	Classification of Engineering Materials	
	(b)	Allotropic form of iron	
	(c)	Full annealing	
	(d)	Ductile to Brittle Transition Temperature (DBTT)	
	(e)	Shape Memory alloy	
Q2.	(a)	Classify crystal imperfections. Distinguish between edge and screw dislocation.	[10]
	(b)	Draw the Iron-Iron carbide equilibrium diagram and write the important transformation seen in the diagram.	[10]
Q3.	(a)	What is Hardenability? What are the factors affecting it? Explain the Jomny End Quench test.	[10]
	(b)	Define Creep. Draw a Classical Creep Curve. Explain different stages of Creep.	[10]
Q4.	(a)	Explain annealing and its types with appropriate examples.	[10]
	(b)	What is Fatigue of Metals? Explain fatigue testing and interpretation of S-N curve for ferrous and non –ferrous metals.	[10]
Q5.	(a)	State and explain Griffith's theory for brittle material with derivation.	[10]
	(b)	Write a short note on Smart material.	[6]
	(c)	How dislocations are generated at Frank Reed Source?	[4]
Q6.	(a)	What is ceramics and explain the processing of it with a diagram?	[8]
	(b)	Explain Magnetic Particle Testing with neat sketch	[8]
	(c)	Write a note on composites and its applications.	[4]

****

(3 Hours) **Total 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.

Q1. a) Find $L[te^{3t}sint]$ **5**

b) Find a , b , c, d if $f(z) = x^2 + 2axy + by^2 + i(cx^2 + 2dxy + y^2)$ is analytic. **5**

c) Find the Fourier expansion of $f(x) = x^2, -\pi \le x \le \pi$ **5**

d) Find the eigen values of $A^2 - 5A + 4I$ if $A = \begin{bmatrix} -1 & 0 & 0 \\ 2 & -3 & 0 \\ 1 & 4 & 2 \end{bmatrix}$ **5**

Q2. a) i) If $L\{f(t)\} = \frac{s}{s^2+s+4}$, find $L\{e^{-2t} f(2t)\}$ **3**

ii) Find $L(t^2 sinat)$ **3**

b) Determine the Half Range Sine Series for $f(x) = \frac{x(\pi^2 - x^2)}{12}$, where $0 < x < \pi$. **6**

c) Find analytic function *f(z)* whose imaginary part is $e^x cosy + x^3 - 3xy^2$ **8**

Q3. a) Solve $\frac{\partial^2 u}{\partial x^2} - 32\frac{\partial u}{\partial t} = 0$ by Bender-Schmidt method subjected to the conditions $u(0,t) = 0, u(x,0) = 0, u(1,t) = t,$ taking h =0.25, $0 < x < 1$, upto $t = 5$. **6**

b) Determine the Harmonic Conjugate of u if u + iv is analytic
$3x^2y - y^3 = u$ **6**

c) Determine the Fourier Series $f(x) = \left(\frac{\pi - x}{2}\right)^2$ over $[0, 2\pi]$. Hence show that $\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} + ... = \frac{\pi^2}{6}$ **8**

Q4. a) Evaluate the following Integral using Laplace Transforms. **6**
$$I = \int_0^\infty e^{-t}\left(\int_0^t u.cos^2u\, du\right)dt$$

b) Determine inverse Laplace Transform of $\frac{s}{(s^2+1)(s^2+4)}$, using Convolution theorem. **6**

c) *Is the matrix* $A = \begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$ diagonalizable? If so find the diagonal form of A and transforming matrix of A. **8**

Q5. a) Find the Eigen value and the eigen vector of **6**

$$\begin{bmatrix} 1 & 2 & 0 \\ 2 & 1 & -6 \\ 2 & 2 & 2 \end{bmatrix}$$

b) Determine the Inverse Laplace Transform of $\log\left[\frac{s^2+a^2}{(s+b)^2}\right]$ **6**

c) Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$,by Crank-Nicholson simplified formula, where $u(0,t) = 0, u(4,t) = 0, u(x,0) = \frac{x}{3}(16 - x^2)$, find u_{ij} , for $i = 0,1,2,3,4\ and\ j = 0,1,2$ taking $h = 1$. **8**

Q6. a) Find the Laplace Transform of $f(t) = \frac{\cos at - \cos bt}{t}$ **6**

b) A tightly stretched string with fixed end points $x = 0$,and $x = l$, in the shape defined by $y = kx(l - x)$, where k is a constant, is released from this position of rest. Find $y(x,t)$the vertical displacement if $\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$ **6**

c) Determine the Inverse Laplace Transform of i) $\frac{s+2}{s^2-4s+13}$ **4**

ii) $tan^{-1}(s)$ **4**

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 Solve **any four** **20**

a State the second law of thermodynamics with the block diagram.

b Classify types of systems with the suitable example.

c Define the following,

(i) Dryness fraction (ii) Latent heat of vaporization

(iii) Critical point (iv) Triple point

d Draw P-V and T-S diagram of Diesel and Dual cycle.

e Define the following,

(i) Sonic Velocity (ii) Stagnation temperature

(iii) Stagnation Pressure (iv) Mach number

2 a Steam is supplied to a fully loaded 1100 kW turbine at 15 bar with an internal energy of 2395 kJ/kg, specific volume of 0.16 m^3/kg and velocity of 1100 m/s. Exhaust takes place at 0.05 bar with internal energy of 1885 kJ/kg, specific volume of 0.26 m^3/kg and velocity of 300 m/sec. Heat loss from the steam turbine is 21 kJ/kg. Potential energy change is negligible. Determine: **10**

(i) Shaft work output per kg, and

(ii) Steam flow rate in kg/hr.

b Derive the Steady Flow Energy Equation (SFEE) and apply it to Turbine and Nozzle. **10**

3 a Three Carnot heat engines are connected in series. The first engine receives 4000 kJ of heat from a source of at 2000 K and delivers 1800 kJ of work, the second and third engine delivers 1200 kJ and 500 kJ of work respectively. Determine the exhaust temperature of second and third Carnot engines. **10**

	b	Describe the Phase conversion of water with the help of Temperature vs Enthalpy (T-h) curve. State the Maxwell's relation.	**5**
	c	Explain the Rankine Reheat cycle with the help of T-S diagram.	**5**
4	a	Derive the Clausius Inequality.	**8**
	b	Explain various components of a simple steam power plant with sketch	**6**
	c	A certain gas occupies a space of 0.3 m^3 at a pressure of 2 bar and temperature of $77°C$. It is heated at a constant volume, until the pressure is 7 bar. Determine change in internal energy and enthalpy. Take C_p = 1.005 kJ/kgK, C_v = 0.716 kJ/kgK, and R = 0.287 kJ/kgK.	**6**
5	a	Derive the expression of efficiency of Otto cycle and state the assumptions.	**10**
	b	In an air standard diesel cycle with the compression ratio of 14, the condition of air at the start of compression stroke are 1 bar and 300 K. The temperature rises to 2775 K at the end of heat addition process. Determine the thermal efficiency of the cycle and net work done per kg of air.	**10**
6	a	Derive an expression for the area velocity relationship for a compressible fluid flow in the form $\frac{dA}{A} = -\frac{dV}{V}(1-M)^2$	**10**
	b	A steam turbine working on a Rankine cycle is supplied with dry saturated steam at 20 bar and exhaust pressure is 0.3 bar. Determine the work done and Rankine efficiency.	**10**

Time: 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.

I Answer any four of the following:

a. Draw stress-strain diagram for ductile material and explain its salient points. **(05)**

b. A simply supported beam of length 3m and cross section 100mm (width)×200mm (depth) carrying a uniformly distributed load of 4kN/m. Neglecting weight of beam. Determine maximum bending stress and maximum shear stress in beam. **(05)**

c. State the assumptions made in bending. Also state bending formula. **(05)**

d. Determine the maximum shear stress developed in a hollow circular shaft with internal diameter 50mm and external diameter 80mm, which transmits power of 15kW at a speed of 300rpm. **(05)**

e. Determine moment of inertia of the shaded area of the section given below (Fig.1) about centroidal x-x axis. **(05)**

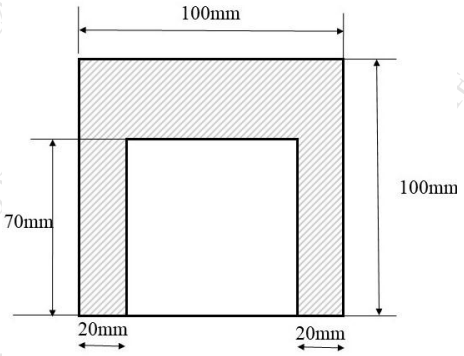

Fig.1

f. State the assumptions made in Euler's theory made in analysis of columns with its limitation. **(05)**

II a) A hollow steel shaft 150mm internal diameter and 300mm external diameter, it is to be replaced by solid shaft. If polar section modulus has the same value for both shafts, calculate: the diameter of solid shaft and ratio of torsional rigidities. Modulus of rigidity (G) for hollow shaft is two times modulus rigidity (G) of solid shaft. Assume same length for both shafts. **(10)**

II b) A steel bar (shown in fig.2) consists of two equal portions each 1m long, the respective diameters of each portion being 30mm and 50mm. Find the total strain energy of the bar when it is subjected to an axial pull of 150KN. Take E=200×10^3 N/mm^2 for steel. **(10)**

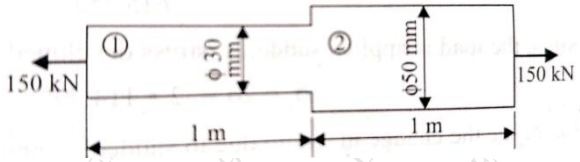

Fig.2

III a) A simply supported beam carries uniformly distributed load over a span of 5m with intensity of 2.5kN/m, with X-section is T-section having flange 125mm×25mm and web 25mm×175mm. Determine shear stress for various section of beam also draw shear stress distribution for given section. **(10)**

III b) Draw shear force and bending moment diagram for beam shown in fig. 3 and locate point of contra-flexure. **(10)**

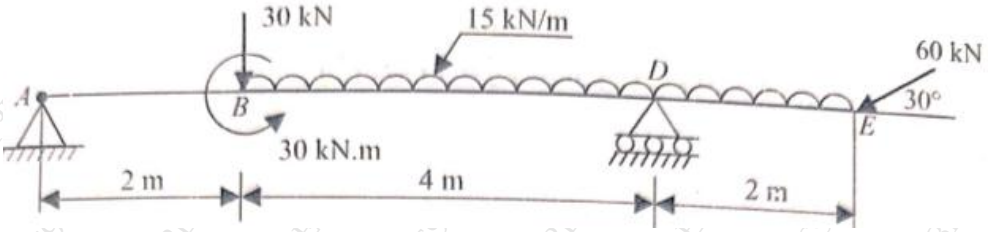

Fig.3

IV a) A composite bar made up of Aluminium and Steel which is held between two supports shown in fig. 4. The bars are stress free at a temperature of 38°C. Determine the stresses in two bars when temperature reaches to 21°C if i) The supports are unyielding and ii) The supports come nearer to each other by 0.1mm. Take Es= 210GPa E_{Al} = 74GPa, $\alpha_s = 11.7\times10^{-6}$/°C, $\alpha_{Al} = 23.4\times10^{-6}$/°C. **(10)**

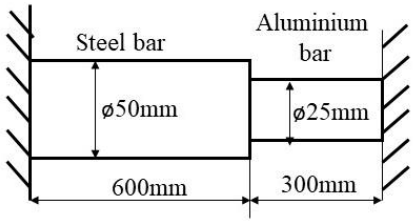

Fig.4

IV b) Find the slope deflection at a point C for the beam loaded shown in fig.5. Assume moment of inertia and modulus of elasticity as I and E. **(10)**

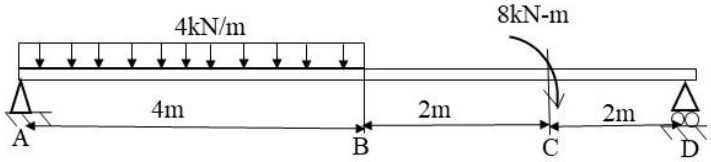

Fig. 5

V a) Two mutually perpendicular plane of an element subjected to σ_x =105MPa (tensile) and σ_y =35MPa (compressive). Locate the principal planes and determine the principal stresses, maximum shear stresses using Mohr's circle verify answers with analytical method. **(10)**

V b) Determine the outside diameter of a hollow cylindrical column 6m long with ends firmly fixed. The ratio of external to internal diameter is 1.3 and carries on an axial load of 500kN. Consider factor of safety as 6. Take σ_c= 500N/mm^2, and Rankine constant = $\frac{1}{1600}$ **(10)**

VI a) Find the load per meter run which can carry over a span of 4m by simple supported beam for cross section shown in fig.6, if the maximum permissible stresses are 90MPa in compression and 40MPa in tension. **(10)**

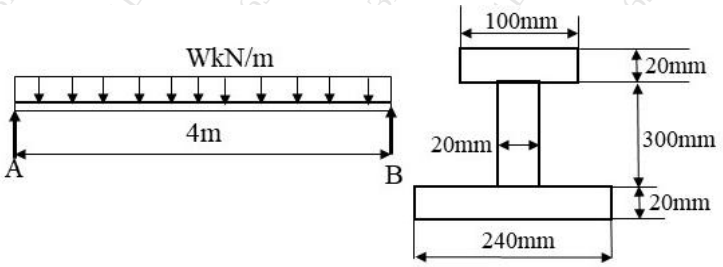

Fig. 6

VI b) A thin cylindrical shell, 3m long and 1m in diameter, is subjected to an internal pressure of 1N/mm^2. If thickness of shell is 12mm, find the circumferential and longitudinal stresses. Also find maximum shear stress and change in dimension of shell. Take E= 2×10^5 N/mm^2 and Poisson's ratio =0.3 **(10)**