Duration: 3 hours **Max. Marks: 80**

N.B. (1) Question No. 1 is **COMPULSORY**.

(2) Answer **ANY THREE** questions from Q.2 to Q.6.

(3) Use of Statistical Tables permitted.

(4) Figures to right indicate full marks.

Que. 1 a. Find Laplace Transform of $sinh3t.sin3t.cos5t$ 5

b. Find Fourier series expansion of $f(x) = x^2 \ \ in \ (-\pi, \pi)$ 5

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

d. If A= $\begin{bmatrix} 2 & 3 & 4 \\ 0 & 4 & 2 \\ 0 & 0 & 3 \end{bmatrix}$ find eigenvalues of A^2 -2A+I & eigen values of adjA 5

Que. 2 a. Obtain Fourier series expansion for f (x) = x | x| in (-1, 1) 6

b. By using convolution theorem, find the inverse Laplace transform of $\frac{s}{(s^2+9)(s^2+16)}$ 6

c. Find the eigenvalues and the eigenvectors of the matrix 8

A= $\begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$

Que. 3 a. Find the analytic function whose real part is $u = e^{2x}(x\cos 2y - y\sin 2y)$ 6

b. Find the Laplace transform of $sin^5 t$ 6

c. By using Green theorem, evaluate $\oint_C \bar{F}.\overline{dr}$ where C is the curve enclosing the region bounded by $y^2 = 4ax$, x=a in xy plane and 8

$$\bar{F} = (2x^2y + 3z^2)i + (x^2 + 4yz)j + (2y^2 + 6xy)$$

Que. 4 a. Verify Cayley-Hamilton theorem for A= $\begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$ and hence find A^{-1} 6

b. Find the harmonic conjugate of the function $v = 3x^2y + 6xy - y^3$ and the corresponding analytic function $f(z) = u + iv$ in terms of z 6

c. Obtain the half range cosine series of $f(x) = \pi x - x^2 \ in \ (0, \pi)$, hence deduce that $\sum_{n=1}^{\infty} \frac{1}{n^4} = \frac{\pi^4}{90}$ 8

Que. 5

a. Find the analytic function $f(z) = u + iv$, in terms of z , if $u + v = \frac{2 \sin 2x}{e^{2y} + e^{-2y} - 2\cos 2x}$ 6

b. Show that $\bar{F} = (y^2 cosx + z^3)i + (2ysinx - 4)j + (3xz^2 + 2)k$ is conservative. Find its corresponding scalar potential ∅. 6

c. Find inverse Laplace transform of the following functions 8

i. $tan^{-1}\left(\frac{s}{2}\right)$ ii. $\frac{e^{-3s}}{s^2-4s+5}$

Que. 6

a. By using stokes theorem, evaluate $\oint_C \bar{F}.\overline{dr}$ where $\bar{F} = x^2 i + xyj$ where 'C' is the boundary of the rectangle x=0, y=0, x=a, y=b 6

b. By using Laplace transform, evaluate, $\int_0^{\infty} \frac{cos2t - cos3t}{t} dt$ 6

c. Determine if the matrix $A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$ diagonalizable, hence find it's diagonal matrix D and modal matrix 8

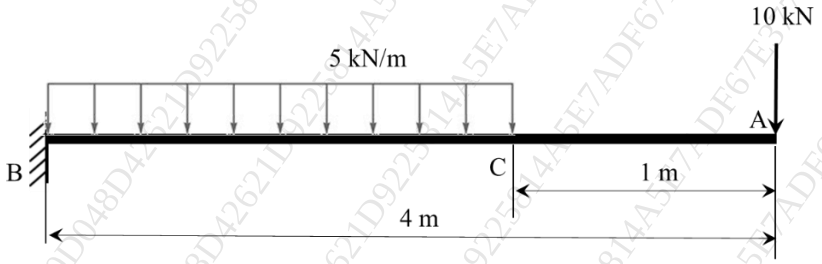
(3 Hours) **[Total Marks : 80**

NB: 1. Question no. 1 is compulsory
2. Attempt any three questions from Q2 to Q6
3. Figures to the right indicates maximum marks

Q1 Attempt any **four** of the following (20M)

(a) For a given material the modulus of rigidity is 80E3 N/mm^2. The poisons ratio is 0.35. Calculate the bulk modulus.

(b) For the beam loaded as shown in figure below draw Shear force diagram.

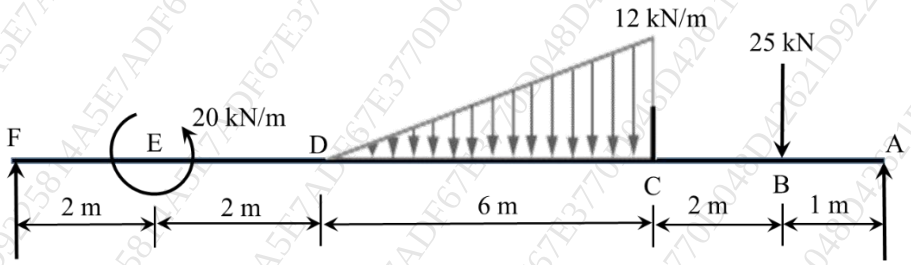


(c) Draw the shear stress distribution diagram for T and H section.

(d) Derive torsion formula.

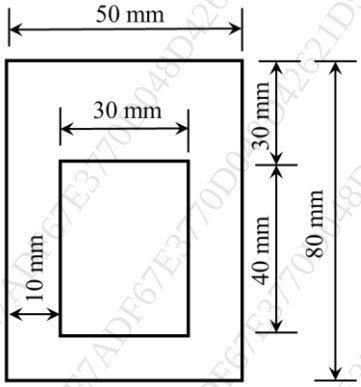
(e) State limitations of Eulers column theory.

Q2 (a) For the beam loaded as shown in figure below draw shear force and bending moment diagram. (10M)

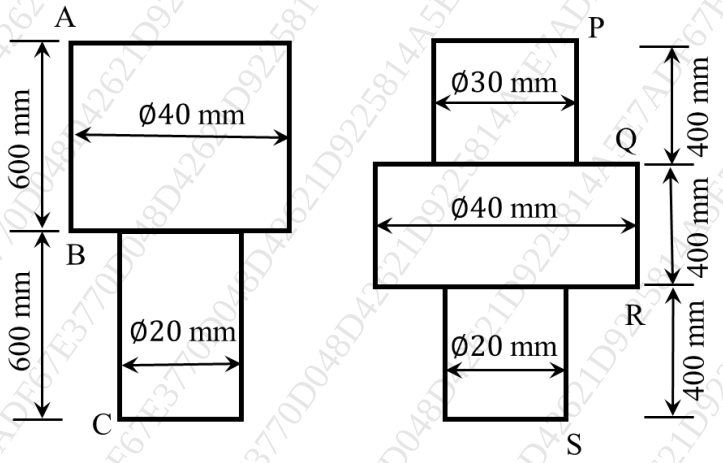


(b) A solid shaft is required to transmit 300 kW at 100 RPM. The maximum torque is 20% greater than the mean torque. Find the diameter of the shaft if the shear stress is not to exceed 80 N/mm^2. If the above shaft is to be replaced by hollow shaft with 3:5 diameter ratio and no change in maximum shear stress and torque, calculate the inner and outer diameters of hollow shaft. (10M)

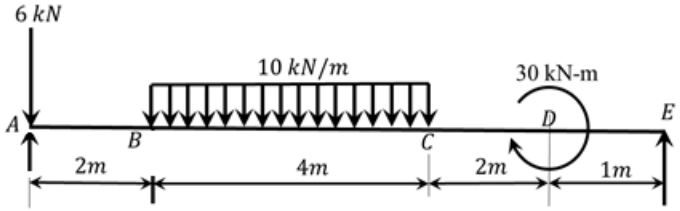
Q3 (a) A beam of hollow rectangular section shown below is acted upon by highest sagging bending moment of 30 kN-m. Draw the bending stress distribution diagram. (10M)



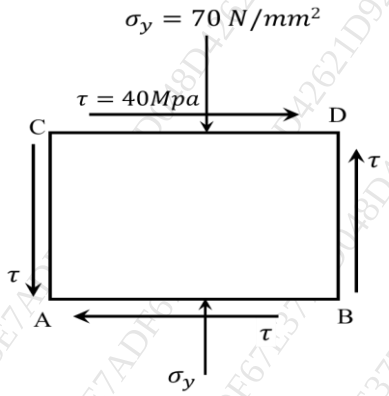
(b) Both machine components AC and PS are acted upon by a tensile load of 50 kN. Find the ratio of their strain energies. Take E = 2E5 N/mm^2. (10M)



Q4 (a) For the beam with supports at A and E, loaded as shown in figure find the slope at point A and deflection at point C. Assume EI = Constant. (10M)

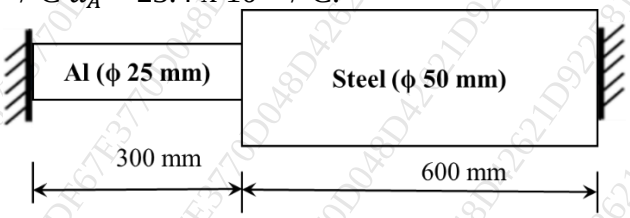


(b) At a point in a material is acted upon by compressive stress of 70 MPa intensity in Y direction accompanied by shear stress of 40 MPa as shown in figure. Determine the principal stresses. Also determine values of normal and tangential stresses at a plane 20 degrees to the plane DB. (10M)



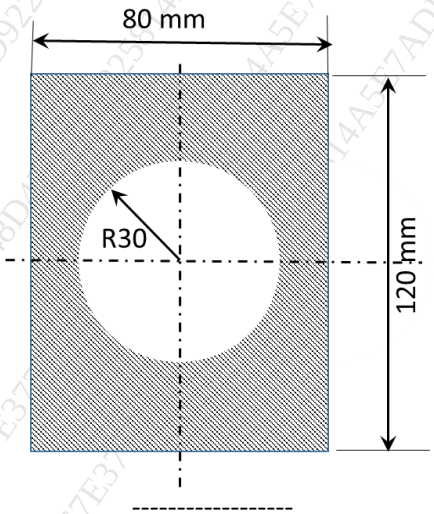
Q5 (a) A cylindrical shell is of 3 m length, 1 m diameter and 10 mm thickness. The shell is subjected to an internal pressure of 1.5 MPa. Find circumferential, longitudinal and shear stresses. Also find change in diameter, length and volume. Take E = 200 GPa and 1/m = 0.3 (10M)

(b) A composite bar made up of aluminium and steel is held between supports. The bars are stress free at 40^{O}C. What will be the stresses in the bars if the temperature is dropped down to 20^{O}C if (i) the supports are non-yielding and (ii) the supports can come closer by 0.1 mm. Take E_S= 210 GPa, E_A= 74 GPa, α_S= 11.7 x 10^{-6} /^{0}C α_A = 23.4 x 10^{-6} /^{0}C. (10M)



Q6 (a) Find the Euler's crippling load for the hollow circular cylindrical column of 50 mm OD and 5 mm thickness. Both ends of the column are hinged and length of the column is 2.5 m. Also determine the Rankine's crippling load for the same column. Take E=2E5 MPa, $\sigma_C = 350$ MPa and $1/\alpha = 1600$ (10M)

(b) For the beam of cross section as shown in figure, draw the shear stress distribution diagram, if acted upon by shear stress of 50 kN (10M)



Total Marks- 80

Duration: 3 Hours

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) Differentiate between Hot working and Cold working.
b) Discuss the different types of flames in gas welding.
c) Explain gear hobbing process.
d) Explain Internet of Things.
e) Discuss electric discharge machining.
f) Classify Production Processes.

Q. 2 a) In a cutting test with 0.3mm flank wear as tool failure criterion, a tool life of 10 min was obtained at a cutting velocity of 20 m/min taking tool life exponent as 0.25, tool life in min at 40 m/min find cutting velocity. **08**

b) Draw and explain plunger type injection moulding process with its advantages, Limitations and applications. **12**

Q. 3 a) Explain working, advantages and limitations of laser beam 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) Draw and explain various operations perform on lathe machine. **10**

Q. 5 a) Differentiate between TIG and MIG welding. **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) Various pattern allowances.
b) Various steps involved in powder metallurgy.
c) Knee type horizontal milling machine.
d) Open die and Closed die forging.
e) Investment Casting.
f) Cloud manufacturing.

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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) Allotropic forms of iron
(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) Define critical cooling. Describe various cooling curves on TTT diagram for eutectoid steels and discuss the transformations. **[10]**

Q4. (a) What is the need of heat treatment process? Differentiate between annealing and normalizing process. **[8]**

(b) Derive an expression for Griffith's theory of brittle materials failure. **[8]**

(c) Discuss the advantages of polymers over metallic materials. **[4]**

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) Explain ultrasonic testing of materials **[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.

Q.1 Attempt any four. **[20]**

a State Zeroth law of Thermodynamics and its significance.

b State and prove the Clausis inequality.

c Define Joule Thomson coefficient and State its significance.

d Draw P-V & T-S diagram for Stirling cycle and Ericsson cycle.

e Explain the effect of varying back pressure on nozzle performance.

Q.2 a 3 kg of air at a pressure of 150 kPa and temperature 360 K is compressed polytropically to 750 kPa according to law $P V^{1.25} = C$. The gas is then cooled to initial temperature at constant pressure. The air is then expanded at constant temperature till it reaches the original pressure of 150 kPa. Draw the cycle on a P-V diagram and determine net work and heat transfer. **[10]**

b A carnot heat engine which operates between temperature levels of 927°C and 33°C rejects 30 kJ to the low temperature sink. The engine drives a heat pump which receives 270 kJ of heat from a low temperature reservoir and rejects it to the surrounding at 33°C. Determine the temperature of the reservoir from which the heat pump receives the heat. **[10]**

Q.3 a In a steady flow process, the fluid flows through a machine at the rate of 15 kg/min. The entrance and exit parameters of the machine are velocity 5 m/s and 8 m/s, Pressure 100 kPa and 700 kPa, Specific volume 0.45 m^3/kg and 0.125 m^3/kg respectively. The working fluid leaves the machine with internal energy 160 kJ/Kg greater than at the entrance and during the process 7200 kJ/min of heat is lost to the surrounding. Assuming the entrance and exit pipe to be at the same level, calculate the shaft work. **[10]**

b (i) Prove that Entropy is property of the system. **[10]**

(ii) Draw & Explain T-S diagram of Water.

Q.4 a Air enters a compressor in a steady flow at 140 kPa, 17°C & 70 m/s and leaves at 350 kPa, 127°C & 110m/s. The environment is at 100 kPa, 7°C. Calculate per kg of air (i) The actual amount of work required (ii) The minimum work required (iii) The irreversibility of the process. **[10]**

b (i) Define (a) Dryness fraction (b) Critical point (c) Triple point (d) Degree of superheat. **[10]**

(ii)Write a short note on the Reheat Rankine cycle.

Q.5 a In an air standard diesel cycle, the compression ratio is 16. At the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of constant pressure process is 1480 °C. Calculate the cycle efficiency & Mean Effective Pressure. **[10]**

b (i) Air at 320 kPa, 300 K and Mach Number = 0.6 flows through a duct. Determine the velocity, stagnation temperature & pressure. **[10]**

(ii) Explain the principle of increase of entropy.

Q.6 a In a Rankine cycle the steam at the inlet to the turbine is at 100 bar and 500°C. If the exhaust pressure is 0.5 bar. Determine Rankine efficiency. **[10]**

b (i) Explain Sonic velocity and Mach number. **[10]**

(ii)Compare the Otto and Diesel cycle for the same compression ratio.

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