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SMT. INDIRA GANDHI COLLEGE OF ENGINEERING

An Autonomous Institute with NAAC 'A' Grade
Approved by AICTE, Affiliated to the University of Mumbai.

END SEMESTER EXAMINATION (SIGCE NEP 2020)

QP Code: 2632113

Subject Name: Engineering Mathematics - III

Date: 20/12/25

Subject Code: 2403111 Branch: MECH

Sem: III

Duration: 2.30 hours

Max Marks: 60

Note:

1) Attempt all questions
2) Assume suitable data wherever necessary.
3) Figures to the right indicate full marks

		CO	Marks
Q.1	**Answer the following (any two)**		**10**
a.	Find L $[e^{4t}sin^3t]$	1	05
b.	Find L.T of $\frac{sinat}{t}$. Does L.T. of $\frac{cosat}{t}$ exist?	1	05
c.	Evaluate $\int_0^\infty e^{-t}\left[\int_0^t u^2 sinhu.\,coshu.\,du\right]$dt.	1	05
Q.2	**Answer the following (any two)**		**10**
a.	Find $L^{-1}\frac{s+29}{(s+4)(s^2+9)}$	2	05
b.	Find L^{-1} by Convolution theorem. $\frac{s}{(s^2+1)(s^2+4)}$	2	05
c.	Find Inverse Laplace Transform of $log\left(\frac{s+a}{s+b}\right)$	2	05
Q.3	**Answer the following (any two)**		**10**
a.	Find Fourier series represent $f(x) = x^2$ in $(0,2\pi)$	3	05
b.	Obtain Fourier series of x.cosx in $(-\pi, \pi)$	3	05
c.	Find the half range sine series $f(x) = x(\pi - x)$ in $(0, \pi)$	3	05

Continued...

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Q.4 Answer the following (any two) **08**

a. Determine the constants a, b, c, d if **4** **04**

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

b. Find the imaginary part of the analytic function on whose real part is e^{2x} (xcos2y-- ysin2y) **4** **04**

c. Show that the following function Laplace equation find it corresponding **4** **04**

analytic function & the harmonic conjugate $u = \frac{1}{2}\log(x^2 + y^2)$

Q.5 Answer the following (any two) **10**

a. Find the Eigen value of A^2+ I. If $A = \begin{bmatrix} 2 & -1 & 1 \\ 1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ **5** **05**

b. Verify and state Cayley – Hamilton theorem for the matrix A and hence, **5** **05**

Find A^{-1} . *where* $A = \begin{bmatrix} 1 & 2 & -2 \\ -1 & 3 & 0 \\ 0 & -2 & 1 \end{bmatrix}$

c. Is the matrix. $A = \begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$ is diagonalisable? **5** **05**

Find the transforming matrix and the diagonal matrix.

Q.6 Answer the following (any two) **12**

a. An elastic string stretched between the fixed point (0 ,0) and (1 ,0) initially in the position **6** **06**

y = A sin(πx) and released from the rest. Find the displacement y (x, t)

b. Solve by the Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2} - 16\frac{\partial u}{\partial t} = 0$, **6** **06**

$0 \le x \le 1, t \ge 0$. Subject to the condition u (0 , t)= 0, u(1 , t)=100t , u(x , 0)= 0,

$h = \frac{1}{4}$ for the one-time step.

c. Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$, by Bender-Schmidt method given u(0 , t)= 0, u(4 , t)= 0 , **6** **06**

$u(x , 0)= x^2(16 - x^2)$. Assume h = 1 up to t = 1sec.

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END SEMESTER EXAMINATION OCT / NOV (SIGCE NEP 2020)

QP Code: 2632133

Subject Name: Thermodynamics
Subject Code: 2403113
Branch: Mechanical
Duration: 2 and Half Hours

Date: 26/12/25
Sem: III
Max Marks: 60

Note:

1) Attempt all questions
2) Assume suitable data wherever necessary.
3) Figures to the right indicate full marks

		CO	Marks
Q.1	Answer the following		
a.	Differentiate between Intensive & Extensive properties.	1	9
	OR		4
a.	A gas undergoes a reversible non-flow process according to the relation $p = (-3V + 15)$ where V is the volume in m^3 and p is the pressure in bar. Determine work done when the volume changes from 3 to 6 m^3.		4
b.	0.2 m3 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. Take Cp = 1.005 kJ/kgK, Cv = 0.716 kJ/kgK, and R = 0.287 kJ/kgK.		5
Q.2	Answer the following		
a.	Define Thermal Reservoir. Difference between Heat Engine, Heat pump, Refrigerator Drive the COP of heat pump is greater than one.	2	12
	OR		5
a.	Define Entropy. Prove that Entropy is property of the system.		5
b.	A household refrigerator absorbs heat at 2°C and rejects heat to the surrounding at 50°C. Its compressor is driven by a 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.		7
Q.3	Answer the following		
a.	Explain the concept of available and unavailable energy. When does the system become dead state?.	3	7
	OR		3
a.	Write short notes on Helmholtz and Gibbs functions and their significance.		3
b.	A heat interaction of 750 kJ occurs reversibly between reservoirs at 850 K and 300 K. Determine net entropy generation and loss of available energy.		4
Q.4	Answer the following		
a.	Define: (a) wet steam, (b) superheated steam, (c) dryness fraction, (d) saturated temperature, (e) critical point.	4	11
	OR		5

a. What is Brayton Cycle? Represent this on (p-v) and (T-S) diagrams. Derive an expression for cycle efficiency. 5

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 10 kg/s, determine quality steam at end of expansion and turbine shaft work. 6

Q.5 Answer the following 5 9

a. Draw and explain the p-v and T-s diagrams for Otto, Diesel, and Dual cycles. 3

OR

a. What is cut off ratio? What are assumptions of air standard cycle? 3

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. 6

Q.6 Answer the following 12

a. Define Mach number and explain stagnation properties for isentropic flow. 6

OR

a. Derive an expression for the area velocity relationship for a compressible fluid flow in the form 6

$$\frac{dA}{A} = -\frac{dV}{V}(1 - M^2)$$

b. An aeroplane is flying at 1000 km/h through still air having a pressure of 78.5 kN/m² (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 $\gamma = 1.4$) 6

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END SEMESTER EXAMINATION (SIGCE NEP 2020)

QP Code: 2632121

Date: 31/10/2025

Subject Name: Strength of Materials
Subject Code: 2403112 Branch: ME
Duration: 2.5 Hours

Sem: III
Max Marks: 60

Note:
1) Attempt all questions
2) Assume suitable data wherever necessary.
3) Figures to the right indicate full marks

		CO	Marks
Q.1	**Answer the following (any three)**		**12**
a.	Explain the stress strain diagram for ductile material.	CO1	04
b.	Define stress and strain. A steel rod of 25 mm diameter and 1.2 m length is subjected to a tensile load of 40 kN. Determine the stress, strain and elongation (E = 200 GPa).	CO1	04
c.	A brass and steel rod are connected in parallel and carry a load of 50 kN. The cross-sectional areas are 300 mm² (brass) and 200 mm² (steel). Determine the load carried by each if E_{steel} = 200 GPa and E_{brass} = 100 GPa	CO1	04
d.	Rails are laid such that there is no stress in them at 24 °C. If the rails are 32 m long. Determine: (i) The stress in the rails at 80 °C, when there is no allowance for expansion. (ii) The stress in the rails at 80 °C, when there is an expansion allowance of 8 mm per rail.	CO1	04
Q.2	**Answer the following (any two)**		**16**
a.	State assumption in the theory of pure torsion. Derive Torsion Formula.	CO2	08
b.	For power transmission, a solid shaft is to carry 300 kW at 100 rpm. The maximum shear stress in the material is limited to 80 N/mm². (i) Determine the diameter of the shaft. (ii) If a hollow shaft (internal diameter = 0.6 × external diameter) is used instead, find the percentage saving in material, assuming identical length, material, and allowable stress.	CO2	08
c.	An unknown weight falls through 8 mm on a collar rigidly attached to the lower end of a vertical bar, 4000 mm long and 40 mm X 10 mm in section. If maximum instantaneous extension is 3 mm what is the corresponding stress and value of unknown weight? Take E = 2 x 10^5 N/mm²	CO2	08
Q.3	**Answer the following (any two)**		**08**
a.	For a simply supported beam of 6 m span carrying a UDL of 4 kN/m, draw the S.F. and B.M. diagrams and find the maximum bending moment.	CO3	04
b.	Define shear force and bending moment. Draw the SFD and BMD for a simply supported beam with a point load at midspan.	CO3	04
c.	Explain the relationship between load, shear force and bending moment with sketches.	CO3	04

Q.4	**Answer the following (any two)**			**08**
a.	A rectangular beam 300 mm 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 X 10 mm^4.	CO4	04	
b.	Derive an expression for the maximum shear stress in a rectangular beam of width b and depth d carrying a transverse shear force V. Start from the general shear formula, show all steps and clearly state the location where the shear stress is maximum.	CO4	04	
c.	A thin cylindrical tube of 200mm internal diameter and 600mm in length is 6mm thick. The tube is filled with water at 8 N/mm^2. Assuming E = 210 X 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	CO4	04	
Q.5	**Answer the following (any two)**			**08**
a.	Explain the double integration method for finding the deflection of beams.	CO5	04	
b.	State Macauley's method and its application in beam deflection problems.	CO5	04	
c.	Calculate the maximum deflection and maximum slope of a simply supported beam of span 5 m carrying a uniformly distributed load of 3 kN/m. Take E = 200 GPa, I = 8 x 10^6 mm^4.	CO5	04	
Q.6	**Answer the following (any two)**			**08**
a.	State the assumptions made in Euler's column theory and its limitations.	CO6	04	
b.	Explain the Rankine formula for columns.	CO6	04	
c.	A steel column of 3 m length and 100 mm diameter is fixed at both ends. Calculate the critical buckling load using Euler's formula. Take E = 210 GPa.	CO6	04	

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END SEMESTER EXAMINATION (SIGCE NEP 2020)

QP Code: 2632153

Subject Name: Leadership Management

Date: 10/11/2025

Subject Code: 2403311 **Branch: Mechanical Engineering**

Sem: III

Duration: 2:30 Hours

Max Marks: 60

Note:

1) **Attempt all questions**
2) **Assume suitable data wherever necessary.**
3) **Figures to the right indicate full marks**

		CO	Marks
Q.1	**Answer the following (any three)**		
a.	Explain the key principles and approaches of leadership in the context of engineering management.	CO1	10
b.	Discuss the main theories of motivation relevant for team management in manufacturing organizations.	CO1	10
c.	Illustrate with examples how leadership skills contribute to effective project planning and execution.	CO1	10
d.	Explain transactional and transformational leadership in detail.	CO1	10
Q.2	**Answer the following (any three)**		
a.	Describe four "I" components in transformational leadership with examples	CO2	10
b.	Analyze the importance of communication in leadership and suggest methods to improve communication efficiency in industrial settings.	CO2	10
c.	Explain women as leaders with examples.	CO2	10
d.	Explain great man theory with its pros and cons with examples.	CO2	10

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END SEMESTER EXAMINATION (SIGCE NEP 2020)

QP Code: 2632142

Date: 07/11/2025

Subject Name: Material Science
Subject Code: 2403114 Branch: Mechanical Engineering
Duration: 2:30 hours
Sem: III
Max Marks: 60

Note:
1) Attempt all questions
2) Assume suitable data wherever necessary.
3) Figures to the right indicate full marks

		CO	Marks
Q.1	**Answer the following (any three)**	1	12
a.	Write a short note on Berger vector.		04
b.	Distinguish between edge and screw dislocation.		04
c.	Write a short note on Properties of engineering material.		04
d.	Distinguish between elastic and plastic deformation.		04
Q.2	**Answer the following (any two)**	2	08
a.	Write mechanism and effects of hot working.		04
b.	Write a short note on Recrystallization annealing.		04
c.	Write mechanism and effects of cold working.		04
Q.3	**Answer the following (any two)**	3	10
a.	Write a solidification process of pure metal.		05
b.	Classify alloys based on phases.		05
c.	Explain with a neat sketch eutectic phase diagram.		05
Q.4	**Answer the following (any two)**	4	12
a.	Draw Iron- Iron carbide equilibrium diagram.		06
b.	What is hardenability ? What are the factors affecting it?		06
c.	Define critical cooling rate. Draw various cooling curves.		06
Q.5	**Answer the following (any two)**	5	10
a.	Explain purpose and process of normalising.		05
b.	Explain austempering and martempering.		05
c.	Distinguish between carburizing and nitriding.		05
Q.6	**Answer the following (any two)**	6	08
a.	Distinguish between ductile and brittle fracture.		04
b.	What is meant by endurance limit & draw S-N curve for ferrous material.		04
c.	Write a short note on the mechanism of creep.		04

QPcode; 10083837

SE Sem IIIrd R-Mechanical R-19 cscheme

Duration: 3hrs **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 Steam Table.

1 Attempt any Five [20]

a) Define a thermodynamic system. Distinguish between open and closed systems with examples.

b) Define Thermal Reservoir. Difference between Heat Engine, Heat pump, Refrigerator Drive the COP of heat pump is greater than one

c) Define Joule Thomson coefficient and state its significance

d) Prove that Entropy is property of the system

e) Define a) Mach number b) Stagnation temperature c) Stagnation Pressure d) Sonic flow.

f) A gas undergoes a reversible non-flow process according to the relation $p = (-3v + 15)$ where V is the volume in m^3 and p is the pressure in bar. Determine work done when the volume changes from 3 to 6 m^3.

2 a) Write two major statements of second law of thermodynamics and explain how the concept of thermal efficiency and coefficient of performance are generated by this law. [08]

b) 2 kg of an ideal gas occupies a volume of $0.3m^3$ at 10 bar pressure and 500K temperature when this gas expands polytropically $PV^{1.2} = C$ the internal energy decreases by 300KJ. and $\gamma = 1.4$ Determine a) Specific gas constant b) Final temperature, pressure and volume c) Heat and work interaction across the system boundary. [12]

3 a) What do you mean by availability? A system at 450 K receives 225 kJ/s of heat energy from a source at 1500K, and the temperature of both the system and source remain constant during the heat transfer process. Determine net change in entropy, available energy of heat sources and system, and decrease in available energy Take atmospheric temperature equal to 300 K. [10]

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

c) Define and explain the terms Available energy, Un-available energy, irreversibility and Dead state. [04]

4 a) Sketch and explain the Rankine cycle on p-v and T-s plots. [08]

b) Define a) wet steam b) Superheated steam c) Dryness fraction d) Saturation temperature. Steam initially at 0.95 dry and 12 bar expands isentropic ally in a non-flow process in a final dryness fraction of 0.8. What is the final pressure of steam and enthalpy change during the process? [12]

5 a) In a thermal power plant operating on an ideal Rankine cycle, superheated steam produced at 5MPa and 500°C is fed to a turbine where it expands to the condenser pressure of 10kPa. If the net power output of the plant is to be 20MW, evaluate: [12]

i) Heat added in the boiler in kJ/k ii) The thermal efficiency.

iii) The mass flow rate of steam in kg/sec

b) What is cut off ratio? What are assumptions of air standard cycle? [08]

For same compression ratio and heat supplied, compare Otto and Diesel cycle with the help of P-V and T-S Diagram.

6 a) An oil engine takes in air at 1.01 bar. 20°C and the maximum cycle pressure is 69 bar. The compression ratio is 18. Calculate the air standard thermal efficiency based on the dual combustion cycle. Assume that the heat added at constant volume is equal to the heat added at constant pressure. [12]

b) Explain the effect of variation in back pressure on C-D nozzle performance [08]

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 Bcode: 10087080

SE Sem IIIrd Mechanical R-19 Cscheme

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 notes on any FOUR [20]
- (a) Hume-Rothary conditions
- (b) Cooling curve of pure iron
- (c) Normalizing
- (d) Critical Resolved Shear Stress (C.R.S.S.)
- (e) Nano composites

Q2. (a) What is plastic deformation? Explain slip mechanism with a neat sketch. [10]
(b) Define fatigue failure. Discuss fatigue testing. Explain interpretation of S-N curve for ferrous and non –ferrous metals. [10]

Q3. (a) Classify various types of crystal defects? Discuss any one defect in details. [10]
(b) Draw the iron -iron carbide equilibrium diagram and write the important transformation seen in the diagram. [10]

Q4. (a) What is flame hardening process? Discuss advantages, disadvantages and applications of it. [8]
(b) Discuss the properties of polymer materials. [4]
(c) Derive an expression for Griffith's theory of brittle materials failure. [8]

Q5. (a) Draw and explain pack carburizing process. Discuss its applications. [8]
(b) Explain the processing of ceramics materials through injection moulding operation. [7]
(c) Define Shape Memory Alloys (SPA). Discuss their properties and applications. [5]

Q6. (a) Draw and explain Isomorphous and Eutectoid phase diagram. [6]
(b) Discuss working principle of ultrasonic testing machine with neat sketch. [8]
(c) Define nanotechnology? Discuss its applications in various fields. [6]

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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	Friction welding	
	c	Rolling defects	
	d	Gear shaping	
	e	Industrial revolutions	
Q.2	a	Explain the desirables properties of molding sands, also explain different types molding sands used in the foundry	**10**
	b	Classify welding and compare soldering and brazing	**10**
Q.3	a	Describe different types of dies with neat sketches	**10**
	b	Write short not on column and knee type milling machine	**10**
Q.4	a	What are various methods of taper turning on lathe machine. explain any one type in detail with neat sketch	**10**
	b	Explain stepwise procedure of powder metallurgy.	**10**
Q.5	a	Describe the investment casting process with neat sketches.	**10**
	b	Write short note on thermit welding with their advantages, disadvantages applications.	**10**
Q.6	a	Compare the following 1. Shaper and planer 2. Hot chamber and cold chamber die casting	**10**
	b	List various nontraditional machining methods and explain electro-chemical machining in detail	**10**

QP code : 10083689

SE sem-III Mechanical R-19 C scheme

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

Note: 1) Question No.1 is **compulsory.**
2) Attempt **any THREE** from the remaining.
3) Figures to the right indicate full marks.

Q.1 **A)** Find the values of constants a,b,c and d if $f(z) = (x^2 + 2axy + by^2) + i(cx^2 + 2dxy + y^2)$ is analytic **5**

B) Find the Eigen Value of $A^3 - 3A^2$ **5**

Where $A = \begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -4 & -3 \end{bmatrix}$

C) Find the Laplace Transform of t sin at **5**

D) Find the Fourier series expansion for f(x) = x defined in (-1,1) **5**

Q.2 **A)** If $L[f(t)] = \frac{s}{s^2+s+4}$ find $L[e^{-3t}f(2t)]$ **6**

B) Find the Fourier series expansion for f(x) = x defined in $(-\pi, \pi)$ with period 2π **6**

C) Find the analytic function f(z) with the real part $u = x^3 - 3xy^2 + 3x^2 - 3y^2 + 1$ **8**

Q.3 **A)** Show that the function $u = x^3 - 3xy^2$ is harmonic function. **6**
Hence find the corresponding analytic function and harmonic conjugate.

B) A string is stretched and fastened to two points distance L apart motion is started by displacing the string in the form $u = \alpha \sin(\frac{\pi x}{L})$ 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 $u(x,t) = \alpha \sin\left(\frac{\pi x}{L}\right) \cos(\frac{\pi ct}{L})$ **6**

C) Obtain the Fourier series expansion of $f(x) = |x|$ where $-\pi \leq x \leq \pi$ **8**

Q.4 **A)** Find Laplace transform of $e^{-4t} \int_0^t usin3u\, du$ **6**

B) Find Inverse Laplace transform of $\frac{2s+3}{s^2+2s+2}$ **6**

C) Verify Cayley – Hamilton theorem for the matrix A and hence find A^{-1} & A^4 **8**

where $A = \begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$

Q.5 **A)** Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2} - 16\frac{\partial}{}$ $= 0$,$0 \leq x \leq 1$ **6**
subject to the condition u(0,t) = 0,u(1,t) = 100t , u(x,0) = 0, $h = \frac{1}{4}$
for one –time step.

B) Find the inverse Laplace transform of $\log\left(\frac{s+a}{s+b}\right)$ **6**

C) Show that the matrix $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 7 \end{bmatrix}$ is diagonalizable. **8**
Find transforming matrix and diagonal Matrix.

Q.6 **A)** Evaluate $\int_0^\infty e^{-3t}\, t\, sint\, dt$ using Laplace transform. **6**

B) Find the solution $u_t = u_{xx}$ subject to u(0,t) = 0,u (5,t) = 0,u (x,0) = x^2 $(25 - x^2)$ **6**
using Schmidt method taking h = 1 up to 3 seconds.

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

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SE/sem III/ R-19 C-scheme / SOM / Mechanical

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. A brass bar with a cross section area of 1000 mm^2 (area of entire bar) is subjected to axial force as shown in Fig. 1. Determine total elongation of the bar. Take E =1.05×10^5 N/mm^2. **(05)**

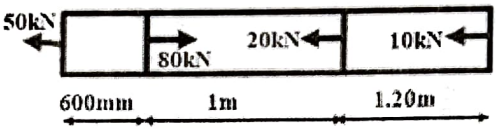

Fig.1

b. A rectangular beam of 200 mm wide and 250 mm deep, is subjected to maximum shear of 50 kN. Determine 1) Average shear stress 2) Maximum shear stress. **(05)**

c. Determine the maximum power transmitted by a shaft of 60 mm diameter rotating at 300 rpm, given that maximum permissible shear stress is 80 N/mm^2. **(05)**

d. What are the assumption made in theory of bending. **(05)**

e. Differentiate between column and struts. State different end conditions for columns with equation **(05)**

f. Differentiate between thick cylinder and thin cylinder. Define hoop stress and Longitudinal Stress. **(05)**

II a) T-shaped cross section of a beam is subjected to a vertical shear force of 30 kN as shown in Fig. 2. Determine the shear stress at the neutral axis and at the junction of web and flange. Draw shear distribution for figure no.2. Assume the moment of Inertia about horizontal neutral axis is 29.56 × 10^6 mm^4 **(10)**

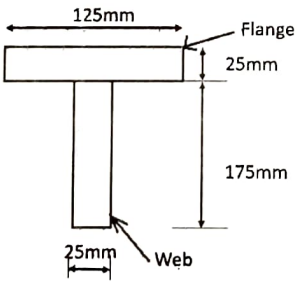

Fig. 2

II b) A 10 m long overhanging beam is loaded as shown in Fig. 3. Determine the shear force and bending moment with SFD and BMD diagram at various salient point. **(10)**

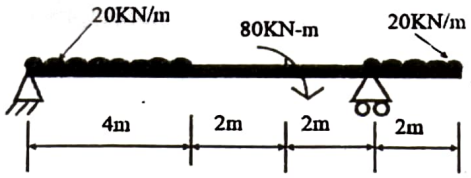

Fig.3

III a) A column of timber, with a section of 10 cm x 15 cm and length of 5 m has both ends fixed. If theYoung's modulus for timber = 17.5 kN/mm^2. Determine, i) Crippling load ii) Safe load for column if factor of safety is 3. **(10)**

III b) A simply supported beam of span 10 m, carries loads as shown in Fig. 4, with a hinge support at A and roller support at B. Determine the slope at the ends and deflection at point D, consider EI is constant. **(10)**

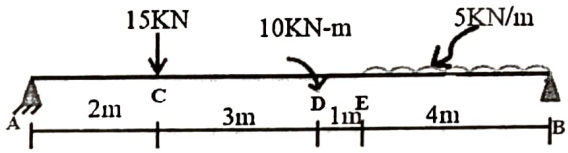

Fig. 4

IV a) At a certain point in a strained material, the stresses on the two planes at right angles to each other are 40 N/mm^2 and 20 N/mm^2 respectively (both tensile). They are accompanied by the shear stress of magnitude 20 N/mm^2. Determine the principal stresses and location of principal planes using Mohr circle and analytical method. **(10)**

IV b) A water main of 90 cm diameter contains water at a pressure head of 110 m. If the weight density of water is 9810 mm^3, determine the thickness of the metal required for the water main. Given the permissible stress as 22 N/mm^2. **(10)**

V a) A steel tube of 30 mm external diameter and 25 mm internal diameter encloses a gun metal rod of 20 mm diameter to which it is rigidly joined at each end. The temperature of the whole assembly is 140°C and the nuts on the rod are then screwed lightly on the ends of the tube. Calculate the intensity of stress in the rod when the common temperature has fallen to 30°C. The value of E for steel and gun metal is 2.1 x 10^5 N/mm^2 and 1 x 10^5 N/mm^2. The linear co-efficient of expansion for steel and gun metal is 12 x 10^{-6} per °C and 20 x 10^{-6} per °C. **(10)**

V b) A cast iron bracket, subjected to bending, has a cross-section of an 'I' shape with unequal flanges. If the compressive stress in top flange is not to exceed 17.5 N/mm^2, determine bending moment the section can withstand. Take dimensions of I section as: Top flange: 250 mm × 50 mm, web: 50 mm × 250 mm and bottom flange: 150 mm × 50 mm. **(10)**

VI a) A hollow circular shaft has inside diameter 60% as that of outside diameter. The solid shaft is replaced by a hollow shaft with same power and at the same speed. Determine percentage saving in material, if the same material to be used. **(10)**

VI b) Determine the instantaneous stress produced in a bar with a cross-sectional area of 10 cm^2 and a length of 4 m by the sudden application of the tensile load of unknown magnitude. Extension of the bar due to suddenly applied load is 1.35 mm. Also determine the magnitude of suddenly applied load. Take E= 2 x 10^5 N/mm^2. **(10)**

SE sem III Mechanical R-19 C scheme

QP code : 10096312

(3 Hours) Total Marks :80

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

Q.1.

A) Find $L\left\{\int_0^t u^n e^{6u} du\right\}$ **5**

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

C) Find half range sine series of $f(x) = x^2$ in $(0, \pi)$ **5**

D) If $A=\begin{bmatrix}1 & 1 & 1\\ 0 & 2 & 1\\ 0 & 0 & 3\end{bmatrix}$ then Find an eigen value of **5**

i) A
ii) Adj(A)
iii) $A^2 - 2A + I$

Q.2.

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

B) Find Fourier series for $f(x) = x^3$, $if\ 0 < x < 2\pi$ and $f(x + 2\pi) = f(x)$ **6**

C) Find analytic function f(z) in terms of z where $u = x^2 + y^2 + 5x + y + 2$ **8**

Q.3.

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 y = a sin(πx/ l) cos (πct / l) **6**

B) Prove that $u = y^3 - 3x^2y$ is harmonic function hence find it's harmonic conjugate function **6**

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

Q.4.

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

B) Find Inverse Laplace transform of $\frac{s}{(s-1)(s-2)(s-3)}$ **6**

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

Q.5.

A) If $A=\begin{bmatrix}1 & 2 & 3\\ 2 & -1 & 4\\ 3 & 1 & -1\end{bmatrix}$ then verify Caley Hamilton theorem and hence **6**

Compute: $A^5 + A^4 - 18A^3 - 40A^2$

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

$0 \le x \le 1$ 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 $(i)\ log\left[\frac{s+1}{s+5}\right]$ $(ii)\ \frac{s-4}{(s+6)^2}$ **8**

Q.6.

A) Find the Laplace Transform of $e^{-t}\int_0^t \sin(u)\cos(u)du$ **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 $h = 1, k = \frac{1}{8}$ $for\ 0 \le t \le 4/8$

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 $\frac{1}{(s^2+16)(s^2+25)}$ using convolution theorem **8**

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QP code : 10095465

SE sem-III Mechanical R-19 cscheme

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

- Question-1 is compulsory. Answer any three from remaining questions.
- Assume any suitable data wherever required, but justify the same. Assumptions made should be clearly stated. Illustrate answers with sketches wherever required.
- Figures to the right indicate marks
- Students should sit for at least 30 minutes

I Answer any four of the following:

a. A round bar of 50 mm diameter and 2.5 m long of a certain material has Young's modulus of 1.1 x 10^5 N/mm^2 and modulus of rigidity of 4.5 x 10^4 N/mm^2. Find the bulk modulus of the bar **05**

b. Derive the relationship between the rate of loading, shear force and bending moment in a beam. **05**

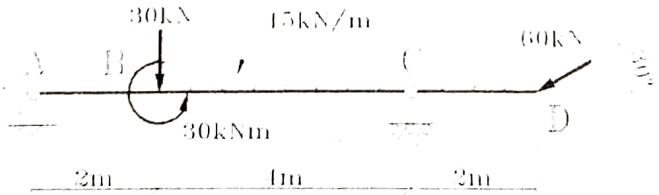
c. Prove the relationship between maximum and average shear stress for a circular section with neat sketches **05**

d. A steel bar of 50 mm x 50 mm in section and 3 m in length is subjected to an axial pull of 140 N. Calculate the strain energy stored in the bar. Also, find the extension of the bar. Take E= 200 GPa **05**

e. A simply supported beam of 6 m span carries a UDL of 8 kN/m for the entire span. If EI is constant, find the deflection at the center. **05**

f. Find the maximum power that can be transmitted through a 50 mm diameter shaft at 150 rpm, if the maximum permissible shear stress in the shaft is 80 N/mm^2. **05**

IIa. For the beam shown below, draw A.F, S.F. and B.M. diagrams and mark all important points. **10**



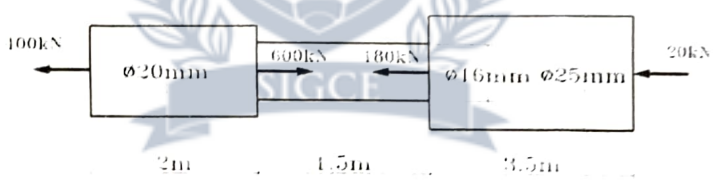
IIb. An elemental cube is subjected to tensile stresses of 30 N/mm^2 and 20 N/mm^2 acting on two mutually perpendicular planes and a shear stress of 10 N/mm^2 on these planes. Draw the Mohr's circle of stresses and hence or otherwise determine the magnitudes and directions of principal stresses and also the greatest shear stress. Verify the values analytically. **10**

IIIa. A simply supported beam, with a span of 1.3 m and a rectangular cross section of 150 mm wide and 250 mm deep, carries a concentrated load of **W** at the centre. If the allowable stresses are 7 N/mm^2 for bending and 1 N/mm^2 for shear, what is the value of the safe load **W**? Also draw bending stress and shear stress distribution diagrams **12**

IIIb. A simply supported beam of span 4 m with EI constant throughout the span is subjected to a load of 24 kN at 3 m from left end support. Find total strain energy of the beam in bending. **08**

IVa. Find the total change in length of the following member for the given loading. **10**

Take E= 2 x 10^5 N/mm^2



IVb. A cylindrical vessel of 1.5 m internal diameter and 4 m long is closed at the ends by rigid plates. It is subjected to an internal pressure of 3 N/mm^2. If maximum circumferential stress is not to exceed 150 N/mm^2, find the thickness of the shell. Find change in diameter, length and volume of the shell. Assume E= 2 x 10^5 N/mm^2 and Poisson's ratio= 0.25. **10**

Va. 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**

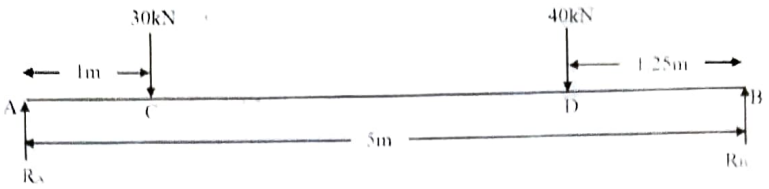
Vb. Figure shows a simply supported beam of span 5 m carrying two point loads. Find **10**

(1) the deflection at the section of the point loads.

(ii) Slope at A,

(iii) maximum deflection of the beam.

Take E=200 GPa, I=7332.9 cm^4.



VIa. A hollow cast iron column of 200 mm external diameter, 150 mm internal diameter and 8 m long has both ends fixed. It is subjected to axial compressive load. Taking factor of safety as 6, $\sigma_c = 560\ N/mm^2$, $\alpha = \frac{1}{1600}$, determine the safe Rankine load. **10**

VIb. A 30 m long steel rail is at a temperature of 24°C. **10**

a) Estimate the elongation when temperature increases to 44°C.

b) Calculate the thermal stress in the rail under the following two conditions:

i. No expansion gap provided.

ii. 4.5 mm gap is provided for expansion.

c) If the stress developed is 60 MPa, what is the gap left between the rails?

Take E = 200 GPa, $\alpha = 12 \times 10^{-6}/°C$

QP code : 10095856

SE sem III Mechanical R-19 C scheme

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 Steam Table.

1 Attempt any Five (each question carries 4 marks) **[20]**

a) Define a thermodynamic property. Distinguish between intensive and extensive property with examples.

b) Define Thermal Reservoir. Difference between Heat Engine, Heat pump, Refrigerator. Derive the COP of heat pump is greater than one.

c) Define Joule Thomson coefficient and state its significance.

d) Prove that Entropy is property of the system.

e) Define a) Mach number b) Stagnation temperature c) Stagnation Pressure d) Sonic flow.

f) A gas undergoes a reversible non-flow process according to the relation $p = (-6v + 15)$ where V is the volume in m^3 and p is the pressure in bar. Determine work done when the volume changes from 3 to 6 m^3.

2 **a)** Write two major statements of second law of thermodynamics and explain how the concept of thermal efficiency and coefficient of performance are generated by this law. **[08]**

b) 2 kg of an ideal gas occupies a volume of 0.3 m^3 at 10 bar pressure and 500 K temperature when this gas expands polytropically $PV^{1.2} = C$ the internal energy decreases by 300 KJ. and $\gamma = 1.4$ Determine **[12]**

i. Specific gas constant
ii. Final temperature, pressure and volume
iii. Heat and work interaction across the system boundary.

3 **a)** What do you mean by availability? A system at 450 K receives 225 kJ/s of heat energy from a source at 1500K, and the temperature of both the system and source remain constant during the heat transfer process. Determine net change in entropy, available energy of heat sources and system, and decrease in available energy Take atmospheric temperature equal to 300 K. **[10]**

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

c) Define and explain the terms Available energy, Un-available energy, irreversibility and Dead state. **[04]**

4 **a)** Sketch and explain the Reheat Rankine cycle on p-v and T-s plots. **[08]**

b) Define a) wet steam b) Superheated steam c) Dryness fraction d) Saturation temperature. Steam initially at 0.95 dry and 12 bar expands isentropic ally in a non-flow process in a final dryness fraction of 0.8. What is the final pressure of steam and enthalpy change during the process? **[12]**

5 a) In a thermal power plant operating on an ideal Rankine cycle, superheated steam produced at 5MPa and 500°C is fed to a turbine where it expands to the condenser pressure of 10kPa. If the net power output of the plant is to be 20MW, evaluate: **[12]**

i) Heat added in the boiler in kJ/k
ii) The thermal efficiency.
iii) The mass flow rate of steam in kg/sec

b) What is cut off ratio? What are assumptions of air standard cycle? For same compression ratio and heat supplied, compare Otto and Diesel cycle with the help of P-V and T-S Diagram. **[08]**

6 a) An oil engine takes in air at 1.01 bar. 20°C and the maximum cycle pressure is 69 bar. The compression ratio is 18. Calculate the air standard thermal efficiency based on the dual combustion cycle. Assume that the heat added at constant volume is equal to the heat added at constant pressure. **[12]**

b) Explain the effect of variation in back pressure on C-D nozzle performance **[08]**

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