University Of Mumbai
Examination Summer 2022

Time: 2.30 hours Max. Marks: 80

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Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	What is the Laplace transform of $\int_0^t \sin 5u \, du$?
Option A:	$\frac{5}{s\left(s^2+25\right)}$
Option B:	$\frac{5}{s\left(s^2-25\right)}$
Option C:	$\frac{1}{s\left(s^2-25\right)}$
Option D:	$\frac{1}{s^2+25}$
2.	Find value of b_n in the Fourier expansion of function $f(x)=\left(2-x^2\right)$ in the interval $(0,2)$.
Option A:	$\frac{2}{n\pi}+\frac{2}{n^3\pi^3}$
Option B:	$\frac{2}{n\pi}$
Option C:	$\frac{4}{n\pi}$
Option D:	$\frac{4}{n^3\pi^3}$
3.	If $f(z)=e^z$ is an analytic function, then real part is given by
Option A:	$e^x \cos y$
Option B:	$\cos y$
Option C:	$-e^x \sin y$
Option D:	$\sin y$
4.	$L^{-1}[\,1/(S+2)^4\,]$
Option A:	$e^{-2t}.t^3/3$
Option B:	$e^{-2t}.t^4/6$
Option C:	$e^{-3t}.t^3/6$
Option D:	$e^{-2t}.t^3/6$
5.	If $f(x)=\cos x$ defined in $(-\pi,\pi)$then the value Fourier coefficient b_n is
Option A:	0
Option B:	π
Option C:	$\frac{\pi}{(n^2-1)}$

Option D:	$\frac{2\pi}{(n^2-1)}[(-1)^n-1]$
6.	A function $u(x,y)$ is harmonic if and only if,
Option A:	$u_{xx}+u_{yy}=0$
Option B:	$u_x+u_y=0$
Option C:	$u_{xy}+u_{yx}=0$
Option D:	$u_x-u_y=0$
7.	Find $L^{-1}\left[\frac{3s+4}{s^2+16}\right]$
Option A:	$4.\sin 4t+\cos 4t$
Option B:	$\cos 4t+\sin 3t$
Option C:	$3.\cos 4t+\sin 4t$
Option D:	$\sin 3t+\cos 4t$
8.	If characteristic equation of matrix A of order 3×3 is λ^3 - 3 λ^2 +3 λ -1 =0. Then by Cayley Hamilton theorem A^{-1} is equal to
Option A:	A^3 - 3 A^2 +3 A -I
Option B:	A^2 - 3 A - 3I
Option C:	3 A^2 - 3 A - I
Option D:	A^2 - 3 A + 3I
9.	The Laplace Transform of $t.e^{at}$
Option A:	$\frac{1}{s}$
Option B:	$\frac{1}{(s-a)^2}$
Option C:	$\frac{1}{(s+a)^2}$
Option D:	$\frac{1}{s^2}$
10.	The equation of one dimensional heat flow is given by
Option A:	$\frac{\partial u}{\partial t}=c^2\frac{\partial^2 u}{\partial x^2}$
Option B:	$\frac{\partial^2 u}{\partial t^2}=c^2\frac{\partial^2 u}{\partial x^2}$
Option C:	$\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}=0$
Option D:	$\frac{\partial u}{\partial t}=c^2\left(\frac{\partial^2 u}{\partial x^2}-\frac{\partial^2 u}{\partial y^2}\right)$

Q2 (20 Marks)	**Solve any Four out of Six5 marks each**
A	Solve $\frac{\partial^2 u}{\partial x^2} - 2\frac{\partial u}{\partial t} = 0$ by Bender-Schmidt method, given $u(0,t) = 0, u(5,t) = 0, u(x,0) = x^2(25 - x^2)$ Assume h=1 & find the values of u up to t=3
B	Using convolution theorem find inverse Laplace transform of $\frac{s}{(s^2+1)(s^2+4)}$
C	Find the Laplace transform of $\cos t.\cos 2t.\cos 3t$
D	Using Cayley-Hamilton theorem, find the matrix represented by $A^8 - 5A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 8A^2 - 2A + I$ where $A = \begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$.
E	Find k such that $\frac{1}{2}\log\left(x^2+y^2\right) + i\tan^{-1}\left(\frac{kx}{y}\right)$ is analytic.
F	Find Fourier expansion of $f(x) = x^2$ in the interval $(0, 2\pi)$.

Q3 (20 Marks)	**Solve any Four out of Six5 marks each**
A	Find $L^{-1}\{\frac{s-2}{(s^2+4s+8)}\}$
B	Find Half Range Cosine Series for f(x)=x; 0<x<2
C	Find the orthogonal trajectories of the curve is $e^x \cos y - xy = c$
D	Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$, under the conditions $u(0,t) = 0;\ u(1,t) = t, u(x,0) = 0$ h=$\frac{1}{4}$ (one –time step) using Crank Nicholson's method
E	Show that $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ is diagonalizable. Determine transforming and diagonal matrix.
F	Find L.T. of the following functions:- $(i)\ te^{-4t}sin3t$ (ii) $\frac{1}{t}[\cos(2t) - \cos(3t)]$

Q4 (20 Marks)	**Solve any Four out of Six5 marks each**
A	Evaluate $\int_0^\infty e^t\ sin\ 2t\ cos\ 3t\ dt$
B	Find Fourier series of $f(x) = x^2$ in the interval $(-\pi, \pi)$. Hence prove that $\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} \ldots\ldots = \frac{\pi^2}{6}$
C	An elastic string stretched between the fixed points (0, 0) and (1, 0) initially in the position y=Asin (πx) and released from rest. Find the displacement y(x,t)
D	If $A = \begin{bmatrix} 3 & 1 \\ 1 & 3 \end{bmatrix}$ Calculate e^A and 5^A
E	Find an analytic function $f(z)$ whose imaginary part is

	$e^{-x}(y\sin y + x\cos y)$
F	Find the inverse Laplace transform of $F(s) = \log\left(\frac{s^2+a^2}{\sqrt{s+b}}\right)$.

University of Mumbai
Examination May -2022

Program: Mechanical Engineering
Curriculum Scheme: Rev2019
Examination: SE Semester III
Course Code: MEC302 and Course Name: Strength of Materials

Time: 2.5 hours Max. Marks: 80

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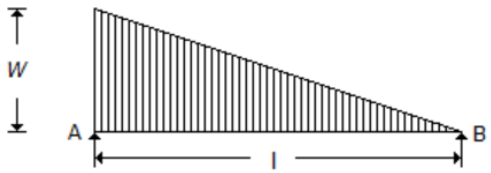
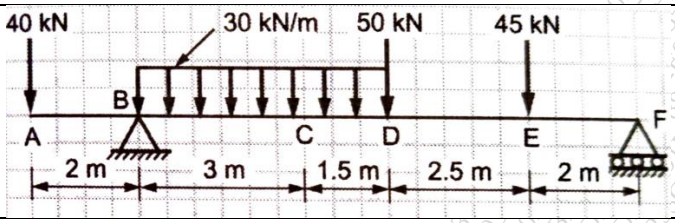
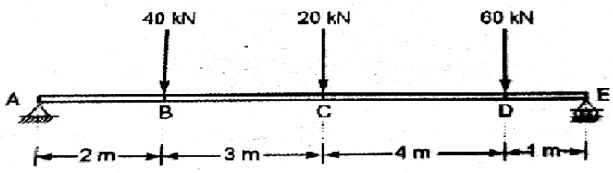
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	Which of the following has no unit
Option A:	Strain
Option B:	Surface tension
Option C:	Bulk modulus
Option D:	Elasticity
2.	A body is subjected to a tensile stress of 1200 MPa on one plane and another tensile stress of 600 MPa on a plane at right angles to the former. It is also subjected to a shear stress of 400 MPa on the same planes. The maximum normal stress will be
Option A:	400 MPa
Option B:	500 MPa
Option C:	900 MPa
Option D:	1400 MPa
3.	If the slenderness ratio for a column is 100, then it is said to be a _____ column.
Option A:	Long
Option B:	Medium
Option C:	Short
Option D:	Intermediate
4.	The extreme bending moment caused by total of UDL (W) on a cantilever beam of span (L) is
Option A:	WL/2
Option B:	WL/8
Option C:	WL/4
Option D:	WL/12
5.	The maximum bending moment for the beam shown in the below figure, lies at a distance of _____ from the end *B*. 
Option A:	L/2
Option B:	L/3
Option C:	L/√2

Option D:	L/√3
6.	Which of the following assumptions are made in torsion theory?
Option A:	Shaft is perfectly straight
Option B:	Material of the shaft is heterogeneous
Option C:	Twist cannot be uniform along the length of the shaft
Option D:	Torsion is not constant along the length
7.	Strain energy stored in a uniform bar is given as _____
Option A:	(σ E/ 2A)
Option B:	(σ L/ 2AE)
Option C:	(σ^2 AL/ 4E)
Option D:	(σ^2 AL/ 2E)
8.	Which of the following is a differential equation for deflection?
Option A:	dy / dx = (M/EI)
Option B:	dy / dx = (MI/E)
Option C:	d^2y / dx^2 = (M/EI)
Option D:	d^2y / dx^2 = (ME/I)
9.	A simply supported beam carries uniformly distributed load of 20 kN/m over the length of 5 m. If flexural rigidity is 30000 kN.m^2, what is the maximum deflection in the beam?
Option A:	5.4 mm
Option B:	1.08 mm
Option C:	6.2 mm
Option D:	8.6 mm
10.	The S.I. unit of torsional rigidity is……
Option A:	Nm
Option B:	N.m^2
Option C:	Nm/ radian
Option D:	Nm^2/ radian

Q2	**Solve any Two Questions out of Three** **10 marks each**
A	A copper bar 50mm in diameter is placed within a steel tube 75mm external diameter and 50 mm internal diameter of exactly the same length. The two pieces are rigidly fixed together by two pins 18mm in diameter, one at each end passing through the bar and tube. Calculate the stresses induced in the copper bar, steel tube and pins if the temperature of the combination is raised by 50°C. Take E_s = 210G Pa; E_c = 105 GPa; Coefficient of thermal expansion of steel = 11.5x 10 $^{-6}$ /^{0} C; Coefficient of thermal expansion of copper = 17x 10 $^{-6}$ /^{0} C.
B	For the beam loaded as shown in figure, Draw S.F. and S.M. diagrams. Also locate point of contraflexure if any.

	
C	A hollow shaft having and internal diameter 40% of its external diameter transmits 562.5 KW power at 100 rpm. Determine the external diameter of the shaft if the shear stress is not to exceed 60 N/mm^2 and twist in the length of 2.5 m should not exceed 1.3 degrees. Assuming maximum torque as 1.25 times the mean torque and modulus of rigidity as 9x10^4 N/mm^2.

Q3.	**Solve any Two Questions out of Three** **10 marks each**
A	Find the deflections of points B and C for the beam shown in figure. Assume EI =constant. Point A is a fixed support and point E is a roller support in the figure. 
B	A T-shaped cross section of a beam having flange of 50x200 mm and web of 200x50 mm, is subjected to a vertical shear force of 100 KN. Calculate the shear stress at important points and draw shear stress distribution diagram. Take Moment of Inertia about horizontal neutral axis is 113.4 x 10^6 mm^4.
C	Find the Euler crushing load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick. If it is 6 m long and hinged at both ends. Take E = 1.2 x 10^6 N/mm^2. Compare the load with crushing load as given by Rankine's formula, take σ_c = 550 N/mm^2 and α = 1/1600.

Q4	**Solve any Two Questions out of Three** **10 marks each**
A	A cylindrical thin drum 800 mm in diameter and 3 m long has a shell thickness of 10 mm. if the drum is subjected to an internal pressure of 2.5 N/mm^2, determine (i) change in diameter, (ii) change in length and (iii) change in volume. Take E = 2 x 10^5 N/mm^2 and Poisson's ratio = 0.25
B	A rod 12.5 mm in diameter is stretched 3.2 mm under a steady load of 10 KN. What stress would be produced in the bar by a weight of 700 N, falling through 75 mm before commencing to stretch, the rod being initially unstressed? Take value of E as 2.1 x 10^5 N/mm^2.
C	At a point within the body subjected to two mutually perpendicular directions, the stresses are 20 N/mm^2 and tensile 10 N/mm^2 tensile. Each of above stress is accomplished by a shear stress of 10 N/mm^2. Determine the principal stresses and principal planes by using Mohr circle method.

University of Mumbai

Examinations Summer 2022

Time: 2 hour 30 minutes Max. Marks: 80

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Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	In case of an edge dislocation the relation between burger vector and dislocation line is
Option A:	Parallel
Option B:	Inclined at 45 degree
Option C:	Inclined at 45 degree
Option D:	Perpendicular
2.	The increase in strength and hardness due to cold working is called as
Option A:	Creep
Option B:	Work Hardening
Option C:	Fatigue
Option D:	Recrystallization
3.	Which of the following can be categorised as an open moulding composite manufacturing process
Option A:	Hand Layup Process
Option B:	Resin Transfer Moulding
Option C:	Vacuum Bagging
Option D:	Sheet Moulding Compounds
4.	The following is not a phase transformation occurring on Fe-Fe3C equilibrium diagram
Option A:	Eutectoid
Option B:	Eutectic
Option C:	Peritectic
Option D:	Peritectoid
5.	The test to determine hardenability of steel is
Option A:	Jominy End Quench Test
Option B:	Fatigue Test
Option C:	Creep Test
Option D:	Tension Test
6.	Which of the following nondestructive test can't be applied to a non-conducting material
Option A:	Die penetrant test
Option B:	Radiographic test
Option C:	Ultrasonic test
Option D:	Magnetic particle test
7.	The heat treatment carried out to reduce brittleness caused by hardening heat treatment is called as
Option A:	Annealing
Option B:	Normalizing
Option C:	Tempering
Option D:	Hardening

8.	Which of the following surface hardening methods is best suited for symmetrical parts
Option A:	Induction Hardening
Option B:	Carburising
Option C:	Nitriding
Option D:	Cyniding
9.	The stress at which the material will not fail for an infinite number of cycles of fatigue load is called as
Option A:	Endurance limit
Option B:	Fatigue strength
Option C:	Fatigue life
Option D:	Tensile fatigue
10.	The creep rate remains almost constant during
Option A:	Primary Creep
Option B:	Secondary creep
Option C:	Tertiary creep
Option D:	It never remains constant

Q2 (20 Marks)	
A	**Solve any Two** **5 marks each**
i.	Classify defects in materials and explain point defects in detail.
ii.	Classify nondestructive testing of materials. Explain Magnetic particle test in detail.
iii.	What are the stages of creep in material? Explain with the help of a neat sketch.
B	**Solve any One** **10 marks each**
i.	Derive an expression for Griffiths Theory of Brittle fracture.
ii.	Explain slow cooling of steel of hypo eutectoid composition.
Q3 (20 Marks)	
A	**Solve any Two** **5 marks each**
i.	What is the difference between slip and twining? Explain the deformation of material by slip in detail.
ii.	Explain flame hardening process in details.
iii.	What are polymers? Explain their advantages over metallic materials.
B	**Solve any One** **10 marks each**
i.	What is strain hardening? Explain the steps of recrystallization annealing clearly showing the changes that are observed in ductility and tensile strength of the material during each step.
ii.	State various processing methods of composite materials.
Q4 (20 Marks)	
A	**Solve any Two** **5 marks each**
i.	State the process for synthesis of nano materials in detail.
ii.	Explain solid carburizing process with the help of a neat sketch.
iii.	What are alloy steels? Give their brief classification.
B	**Solve any One** **10 marks each**
i.	Draw Fe-Fe3C equilibrium diagram and locate all the important temperatures, compositions and phases on it.
ii.	What is Fatigue of material? Explain the procedure for plotting SN curve of a given material using fatigue test. State endurance limit, fatigue strength and fatigue life through SN curve.

University of Mumbai

Examination Summer 2022

Program: Mechanical Engineering **Curriculum Scheme:** REV- 2019 'C' Scheme

Examination: SE **Semester:** III

Course Code: MEC305 **Course Name:** Thermodynamics

Time: 2 hour 30 Minutes **Max. Marks:** 80

N. B. :
1. All questions are **compulsory.**
2. Assume suitable data if required and state it clearly.
3. Use of Steam Table and Mollier diagram is permitted.

Q 1	**Choose the correct option for following questions. All questions are compulsory and carry equal marks. 2 marks each**
1	In case of a closed system
Option A	Neither mass nor energy can enter or leave system
Option B	both mass & energy can enter or leave system
Option C	mass cannot enter or leave but energy can enter or leave system
Option D	mass can enter or leave but energy cannot enter or leave system
2	A system undergoes a process in which heat supplied to system is 100 kJ and work done on the system by surrounding is 20 kJ, the change in internal energy is
Option A	80 kJ
Option B	120 kJ
Option C	-80 kJ
Option D	-120 kJ
3	A refrigerator having COP of 5 removes 10 MJ of heat from a cold body. Work Input required for refrigerator is?
Option A	2 MJ

Option B	0.5 MJ
Option C	50 MJ
Option D	15 MJ
4	300 kJ/s of heat is supplied at a constant fixed temperature of 290° C to a heat engine. 215 kJ/s of heat is rejected at a constant fixed temperature of 8.5 ° C.
Option A	Cycle is impossible
Option B	Cycle is reversible
Option C	Cycle is irreversible
Option D	Insufficient data
5	Which of the following is High Grade Energy?
Option A	Wind Energy
Option B	Nuclear Energy
Option C	Thermal Energy
Option D	Chemical Energy
6	Joule Thompson Coefficient is given by
Option A	$\left(\frac{\partial \square}{\partial \square}\right)_h$
Option B	$\left(\frac{\partial \square}{\partial \square}\right)_h$
Option C	$\left(\frac{\partial \square}{\partial \square}\right)_{\square}$
Option D	$\left(\frac{\partial \square}{\partial \square}\right)_{\square}$
7	Which of the following statement is not true ?

Option A	Dryness fraction(x) of wet steam is greater than zero & less than One
Option B	Point at which saturated liquid line meets saturated vapour line is Critical Point
Option C	Dryness fraction of superheated steam is greater than one
Option D	Point at which all phases exist is Triple Point
8	Reheating the steam before supplying to the steam turbine
Option A	Reduces heat supplied
Option B	Reduces heat rejected in condenser
Option C	Increases Turbine Work
Option D	Reduces Pump Work
9	In Bryton cycle, heat addition & heat rejection takes place at
Option A	Constant Pressure
Option B	Constant Volume
Option C	Constant Pressure & Constant Volume respectively
Option D	Constant Volume & Constant Pressure respectively
10	The discharge from nozzle is maximum and nozzle is said to be choked when
Option A	Mach Number < 1
Option B	Mach Number = 1
Option C	Mach Number > 1
Option D	Mach Number > 5

Q2	
A.	**Solve any Two** **5 Marks Each**
i)	Explain principle of increase of entropy.
ii)	Steam at 15 bar and 300 °C is throttled to 10 bar before supplying to the 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.
iii)	Explain (i) Availability (ii) Irreversibility (iii) Effectiveness (iv) Dead State
B.	**Solve any One** **10 Marks Each**
i)	A mass of air initially at 206°C is at a pressure of 7 bar and has a volume of 0.03 m^3. The air is expanded at constant pressure to 0.09 m^3. A polytropic process with n = 1.5 is then carried out, followed by a constant temperature process which completes the cycle. All the processes are reversible. Sketch the cycle on P-V diagram and find the heat received and heat rejected in the cycle. Take R = 0.287 kJ/kg K, C_v = 0.713 kJ/kg K.
ii)	A reversible heat engine operates between two reservoirs at temperature of 600°C and 60°C. The engine drives the refrigerator which operates between the reservoirs at temperature of 60°C and -30°C. The heat transfer to the engine is 3MJ and the net work output of the combined engine and refrigerator plant is 380 kJ. Find heat transfer to the refrigerator and the net heat transfer to the reservoir at 60°C.

Q3	
A.	**Solve any Two** **5 Marks Each**
i)	Explain limitations of Carnot vapour power cycle
ii)	Air at 320 kPa, 300 K and Mach Number = 0.6 flows through a duct. Determine the velocity, stagnation temperature & pressure.
iii)	State and explain Maxwell relations.
B.	**Solve any One** **10 Marks Each**
i)	Air at 20°C and 1.05 bar occupies 0.025 m^3. The air is heated at constant volume until the pressure is 2 bar and then cooled at constant pressure back to original temperature. Sketch the processes on T-S and P-V diagram and calculate the net entropy change.
ii)	A steam turbine 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 (i) Quality of steam at the end of expansion (ii) Turbine shaft work (iii) Power required to drive the pump (iv) The heat flow in the condenser (v) The Rankine efficiency

Q4	
A.	**Solve any Two** **5 Marks Each**
i)	State and Explain steady flow energy equation.
ii)	Explain the effect of varying back pressure on nozzle performance.

iii)	Explain Lenoir cycle and Atkinson cycle using P-V & T-S Diagram.
B.	**Solve any One** **10 Marks Each**
i)	In an air standard dual cycle, the pressure and temperature are 0.1MPa and 27°C. The compression ratio is 18. The pressure ratio for the constant volume part of the heating process is 1.5 and the volume ratio for the constant pressure part of heating is 1.2 Determine (i) Thermal efficiency (ii) Mean effective pressure.
ii)	Air at the rate of 25kg/min is compressed in centrifugal compressor from 1 bar to 2 bar. The temperature increases from 15°C to 105°C during compression. Determine actual and minimum power required to run the compressor. The surrounding air temperature is 15°C. Neglect the change in K.E and P.E.