University of Mumbai
Examination First Half 2022
Program: BE Mechanical Engineering
Curriculum Scheme: Rev-2019
Examination: TE Semester V
Course Code: MEC501and Course Name: **Mechanical Measurement and Control**
Time:3 hour Max.Marks:80

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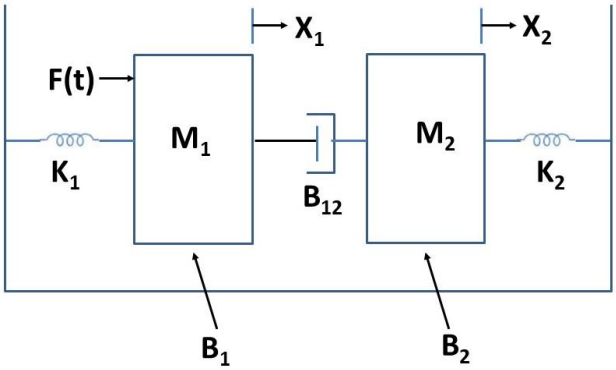
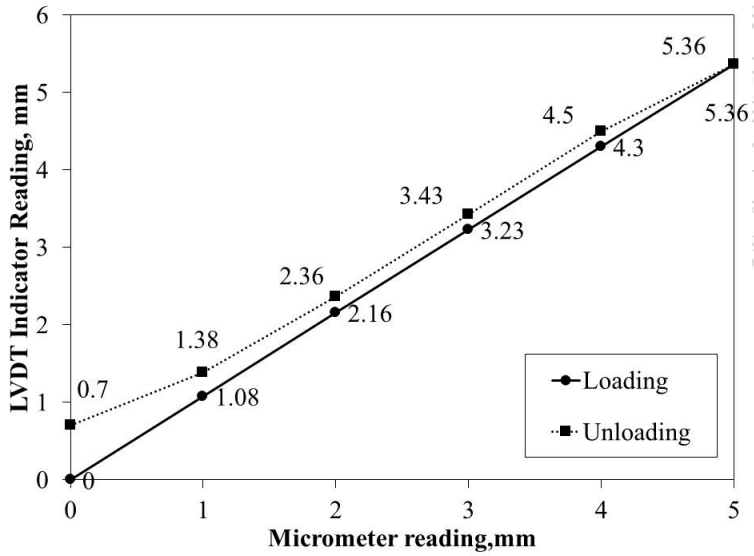
Q.1	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
Q1.	Drift is defined as
Option A:	Variation in input of the instrument with respect to desired input
Option B:	smallest change in input quantity which can be measured with an instrument
Option C:	Variation in output of the instrument from the desired value for given input
Option D:	degree of closeness with which a reading is repeated again and again
Q2.	A voltmeter has a uniform scale with 100 divisions. The full-scale reading is 10 V and could be read upto 1/10 of a scale division with some degree of certainty. It's resolution is
Option A:	0.1 V
Option B:	0.02 V
Option C:	0.001 V
Option D:	0.01 V
Q3.	McLeod gauge
Option A:	can be used for pressure below 0.1×10^{-3} torr
Option B:	gives continuous output
Option C:	is sensitive to condensed vapours that may be present in the sample of the gas whose pressure is being measured
Option D:	can not be used as standard for vacuum measurement
Q4.	NO GO gauges are designed
Option A:	for maximum shaft limit and minimum hole limit
Option B:	for maximum hole limit and minimum shaft limit
Option C:	for maximum hole and shaft limit
Option D:	for minimum hole and shaft limit
Q5.	The average height from a mean line of all ordinates of the surface, regardless of sign, is the
Option A:	RMS value
Option B:	Rz value
Option C:	Ra value
Option D:	Rm value

Q6.	Steady state error is a) $e_{ss} = \lim_{s\to 0} \frac{s\,R(s)}{1 \pm G(s)H(s)}$ b) $e_{ss} = \frac{s\,R(s)}{1 \pm G(s)H(s)}$ c) $e_{ss} = \lim_{s\to 0} \frac{s}{1 \pm G(s)H(s)}$ d) $e_{ss} = \lim_{s\to 0} \frac{s\,R(s)}{G(s)H(s)}$
Option A:	A
Option B:	B
Option C:	C
Option D:	D
Q7.	The transient response of control system is
Option A:	Response is a function of input
Option B:	response is a function of time
Option C:	response remains constant with time
Option D:	Response is zero
Q8.	The analogous electrical component for angular displacement in mechanical system in F-I analogy
Option A:	Charge
Option B:	Flux
Option C:	Resistance
Option D:	capacitance
Q9.	The order of a system is represented by The Routh-Hurwitz criterion cannot be applied when the characteristic equation of the system contains any coefficients which is :
Option A:	Negative real and exponential function
Option B:	Negative real, both exponential and sinusoidal function of s
Option C:	Both exponential and sinusoidal function of s
Option D:	Complex, both exponential and sinusoidal function of s
Q10.	Surface texture depends to a large extent on
Option A:	material composition
Option B:	type of manufacturing operation
Option C:	skill of the operator
Option D:	accuracy of measurement

Q2	**Solve any Two Questions out of Three** **(10 marks each)**
A	Write differential equation for mechanical system as shown in **Fig.1**. Obtain an analogues electrical network based on force-current analogy  **Fig.1**
B	Illustrate the working principle of L.V.D.T with neat sketch for displacement measurement. For the LVDT output in **Fig.2**, determine, accuracy, precision, drift and percentage sensitivity  **Fig.2**
C	Derive necessary expression to calculate the best wire diameter With the help of suitable diagram explain three wire method used in screw thread measurement.

Q3	**Solve any Four out of Six** **(5 marks each)**
A	Explain Principle, construction and working of Parkinson's Gear Tester
B	Explain Laser Interferometer with neat sketch.
C	What do you mean by waviness and roughness
D	With respect to surface roughness parameters explain the following terms i) Ra ii) Rz iii) RMS
E	Define gauge factor for strain gauge and write expression of it
F	Explain routh criterion for stability with example

Q4.	**Solve any Two Questions out of Three** **10 marks each**
A	For a particular unity feedback system $$G(s) = \frac{64(S+2)}{S(S+0.5)(S^2+3.2S+64))}$$ Sketch the Bode Plot, Find ω_{gc}, ω_{pc}, GM and PM. Comment on stability.
B	A unity feedback system characterised by an open loop transfer function $G(s) = \frac{K}{S(S+10)}$ Determine the gain K. so that the system will have a damping ratio of 0.5. for this value of K determine settling time, peak overshoot, and time to peak overshoot for unit –step input.
C	What is encoder? With a neat sketch explain working of an incremental and absolute optical encoder. Explain in detail with example

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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 $F(s) = \log\left(\frac{s^2+a^2}{\sqrt{s+b}}\right)$.

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Examinations Summer 2022

Subject: Thermal Engineering **Sem:V**
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.	Thermal conductivity of pure metals
Option A:	Decreases with increase in temperature
Option B:	Increases with increase in temperature
Option C:	Does not have any effect of temperature
Option D:	Depending on range of temperature
2.	In a diesel engine, the fuel is ignited by
Option A:	spark
Option B:	injected fuel
Option C:	heat resulting from compressing air that is supplied for combustion
Option D:	Ignition
3.	The volumetric efficiency of a well-designed engine is in the range
Option A:	30 to 40%
Option B:	40 to 60%
Option C:	60 to 70%
Option D:	75 to 90%
4.	Which statement is true regarding steady state condition?
Option A:	There is a variation in temperature in the course of time
Option B:	Heat exchange is constant
Option C:	It is a function of space and time coordinates
Option D:	Internal energy of the system changes
5.	The air standard efficiency of an Otto cycle compared to diesel cycle for the given compression ratio is
Option A:	same
Option B:	less
Option C:	more
Option D:	more or less depending on power rating
6.	If the intake air temperature of I.C. engine increases, its efficiency will
Option A:	increase
Option B:	decrease
Option C:	remain same
Option D:	unpredictable
7.	**Absorptive power of perfectly black body is**
Option A:	zero
Option B:	one
Option C:	infinity
Option D:	constant
8.	**Opaque body is**
Option A:	Absorbs all radiation
Option B:	Reflects all radiation
Option C:	Transmit all radiation
Option D:	Some reflect and some absorbs

9.	**The phenomenon of heat transfer is deals with**
Option A:	Temperature transfer
Option B:	Work transfer
Option C:	Energy transfer
Option D:	Mass transfer
10.	**With increase in temperature the thermal conductivity of air**
Option A:	Increases
Option B:	Decreases
Option C:	Remain constant
Option D:	May increase or decrease depending on the temperature

Q2	**Solve any Four Questions out of Six** **5 marks each**
A	Derive an expression for one dimensional steady state heat conduction through plane wall.
B	Discuss the concept and application of steady and unsteady state heat transfer along with the practical example of each.
C	Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500 °C. 1. Monochromatic emissive power at 1.2 µm 2. Wave length at which the emission is maximum Total emissive power of the furnace if it is assumed as real surface with emissivity equal to 0.8
D	Discuss in detail about the effect of engine variables on detonation in Spark ignition engines
E	A cylinder rod of 1 cm diameter and 1 m long is initially mainlined at 300 °C. It is suddenly dropped in oil at 50 °C having convective heat transfer coefficient at 240 W/m^{2}K. Find the time required to cool the rod up to 120 °C. Properties of rod material is as follows: Density = 8000 kg/m^3. C=400 J/kg/K. k= 60 W/mK
F	The following details were noted in a test on a four-cylinder, four-stroke engine, diameter = 100 mm; stroke = 120 mm; speed of the engine = 1600 rpm; fuel consumption = 0.2 kg/min; calorific value of fuel is 44000 kJ/kg; difference in tension on either side of the brake pulley = 40 kg; brake circumference is 300 cm. If the mechanical efficiency is 80%, calculate (i) brake thermal efficiency (ii) indicated thermal efficiency (iii) indicated mean effective pressure and (iv) brake specific fuel consumption

Q3	**Solve any Two Questions out of Three** **10 marks each**
A	Derive an expression for temperature distribution and heat dissipation in a straight fin of rectangular profile for insulated tip.
B	An aluminum rod 2 cm diameter and 10 cm long protrudes from the wall maintained at 300 °C. The rod is exposed to surroundings at 15°C. Heat transfer coefficient between rod surfaces an environment is 20 W/m^{2}K. The thermal conductivity of the material is 200 W/mK. Find 1. Total heat dissipated by rod 2. Temperature of road at 4 cm from the wall 3. Temperature at the end of rod 4. Fin efficiency Assume that the rod end is insulated
C	A four stroke gas engine has a cylinder diameter of 25 cm and stroke 45cm. The effective diameter of the brake is 1.6m. The observations made in the test of the engine were as follows. Duration of the test 40 minute, total number of revolutions = 8080. Total no of explosions = 3230, net load on the brake = 90 kg, mean effective pressure = 5.8 bar, volume of gas used = 7.5 m^3, pressure of gas indicated in meter = 136 mm of water of gauge, atmospheric temperature = 17 °C, calorific value of the gas 19 MJ/m^3 at NTP. Rise in temperature of the jacket cooling water = 45 °C , Cooling Water Supplied 180 Kg. Draw up the heat balance

	sheet and estimate the indicated thermal efficiency and brake thermal efficiency. Assume atmospheric pressure as 760 mm of Hg

Q4	**Solve any Four Questions out of Six** **5 marks each**
A	Draw a neat boiling curve for water and show the different boiling regimes. Explain the phenomenon of condensation
B	Derive an expression for log mean temperature difference in parallel flow heat exchanger. State your assumption.
C	Water(mass flow rate of 1.4 kg/s, Cp= 4.187 kJ/kgK) is heated from 40 °C to 70 °C by an oil (mass flow rate 2kg/s, Cp 1.9 kJ/kgK) entering at 110 °C in a counter flow heat exchanger. If overall heat transfer coefficient is 350W/m^2K, Calculate the surface area required
D	What are the different control methods for engine emissions
E	What is the governing law of diffusion mass transfer?
F	Discuss about valve timing diagram for four stroke petrol engine.

University of Mumbai

Examinations Summer 2022

Program: Mechanical Engineering

Curriculum Scheme: Rev 2016

Examination: TE Semester V

Course Code: MEC502

Course Name: MECHANICAL MEASUREMENT AND CONTROL

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.	Which of the following instruments measure amplitude of a vibrating body?
Option A:	LVDT
Option B:	Tachometer
Option C:	Stroboscope
Option D:	Seismometer
2.	The “dead zone” in a certain pyrometer is 0.125 percent of span. The calibration is 400 ° C, to 1000 ° C. What temperature change might occur before it is detected _____
Option A:	0.65° C
Option B:	0.75° C
Option C:	0.35° C
Option D:	0.86° C
3.	Strain gauge is a
Option A:	Active device and converts mechanical displacement into a change of resistance
Option B:	Passive device and converts electrical displacement into a change of resistance
Option C:	Passive device and converts mechanical displacement into a change of resistance
Option D:	Active device and converts electrical displacement into a change of resistance
4.	A moving coil voltmeter has a uniform scale with 100 divisions, the full scale reading is 200 V and 1/10 of a scale division can be estimated with a fair degree of certainty. The resolution of the instrument in volt is _____
Option A:	0.2 V
Option B:	2 V
Option C:	2.2 V
Option D:	0.4 V
5.	Frequency response means
Option A:	Transient response of a system to a sinusoidal input
Option B:	Steady state response of a system to a sinusoidal input
Option C:	Oscillatory response of a system to a sinusoidal input
Option D:	Oscillatory and transient response of a system to a sinusoidal input
6.	If a pole is located at origin, how does it get represented on the magnitude plot?
Option A:	-10 log (ω) dB
Option B:	-20 log (ω) dB
Option C:	-40 log (ω) dB
Option D:	-60 log (ω) dB

7.	When negative voltage feedback is applied to an amplifier, its voltage gain …….
Option A:	Is increased
Option B:	Is reduced
Option C:	Remains the same
Option D:	Zero
8.	PID controller is known as
Option A:	Two term controller
Option B:	Four term controller
Option C:	Three term controller
Option D:	Proportional controller
9.	The breakaway points of a root locus occur at
Option A:	Imaginary axis
Option B:	Real axis
Option C:	Multiple roots of characteristic equation
Option D:	At zero
10.	The characteristic equation of a system is given as $3s^4+10s^3+5s^2+2=0$. This system is :
Option A:	Stable
Option B:	Marginally stable
Option C:	Unstable
Option D:	Linear

Q2.	**Solve any Four out of Six** **5 marks each**
A	A system is represented by the characteristic equation $P(S) = S^5 + S^4 + 2S^3 + 2S^2 + 3S + 15 = 0$, predict the stability of the system by using Routh's criterion.
B	Explain elements of the generalized measurement system..
C	A unity feedback system has $G(S) = \frac{40\,(S+2)}{S(S+1)(S+4)}$, Determine (i) Type of system , (ii)Static Error Coefficients and (iii) steady state error for a ramp input of magnitude 4.
D	Illustrate with neat diagrams the working principle of ultrasonic flow meter with its applications
E	Define the terms ,Resolution, Threshold, Accuracy , Span, And Range w.r.t static characteristics of measuring instruments.
F	While measuring the speed of a steam turbine with stroboscope single line images were observed for stroboscope setting of 30000, 4000 and 5230 r.p.m. Calculate the speed of the turbine.

Q3.	**Solve any Two Questions out of Three** **10 marks each**
A	For a system having $G(S) = \frac{\mathbf{15}}{(\boldsymbol{S+1})(\boldsymbol{S+3}),}$, H(s)=1. Determine (i) Characteristic equation (ii) ω_n and ζ (iii) Time at which 1st undershoot will occur (iv) Time period of oscillation (v) Number of cycles output will perform before settling down

B	Illustrate with neat diagrams the construction and working principle of (i) McLeod Gauge and (ii) Optical pyrometer with its industrial applications.
C	Draw the root locus and predict the stability of the system having G(S)H(S)= $\frac{K}{S(S+5)(S+10)}$.

Q4.	**Solve the following.**
A	**Solve any Two .** **5 marks each**
i.	A resistance strain gauge with a gauge factor of 1.5 is cemented to a steel member, which is subjected to a strain of 1 x10^{-6}. If the original resistance value of the gauge is 100Ω, calculate the change in resistance.
ii.	Explain the terms signal filtering , and modulation with reference to the Signal conditioning
iii.	Differentiate between open and closed loop control system.
B	**Solve any One .** **10 marks each**
i.	A unity feedback control system has G(S)= $\frac{80}{S(S+2)(S+20)}$. Draw the bode plot. Determine GM, PM, ω_{gc} and ω_{pc}. Comment on the stability.
ii.	Obtain the state-space equation and output equation for the system defined by the equation, $\frac{Y(s)}{U(s)} = \frac{2s^3+s^2+s+2}{s^3+4s^2+5s+2}$

University of Mumbai

Examination Summer 2022

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

Examination: TE **Semester:** V

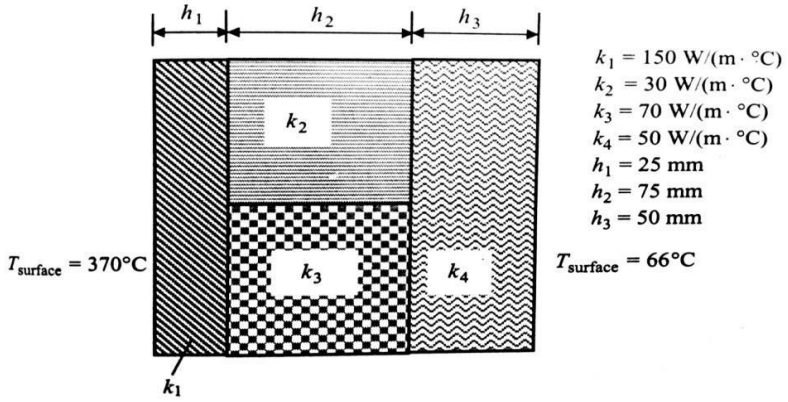
Course Code: MEC504 **Course Name:** Finite Element Analysis

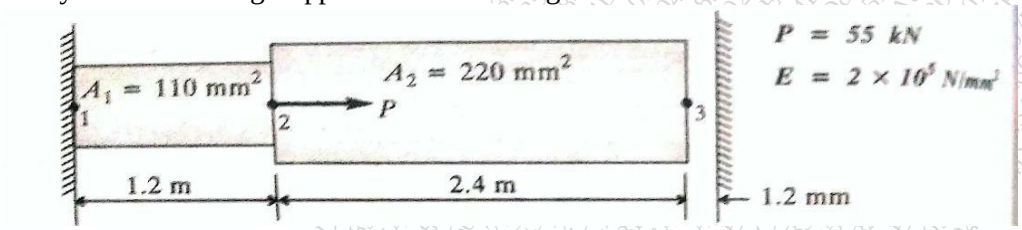
Time: 2 hour 30 Minutes **Max. Marks:** 80

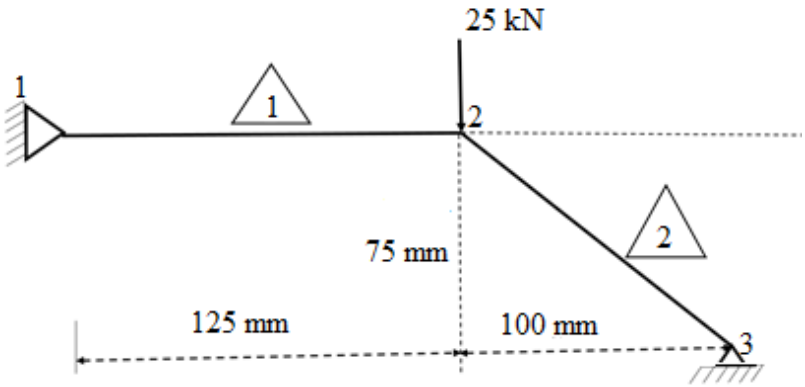
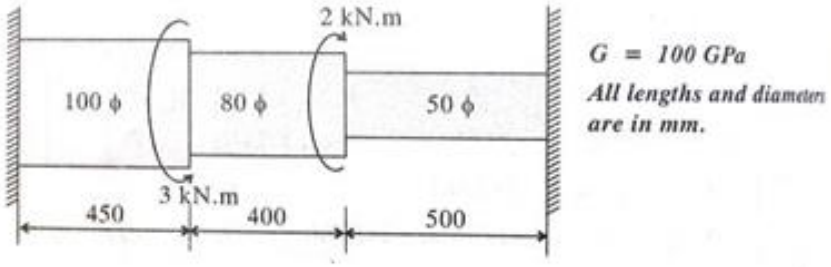
Q.1	**Choose the correct option for following questions. All questions are compulsory and carry equal marks. 2 marks each**
1	What is number of internal nodes of a quadratic element?
Option A:	0
Option B:	2
Option C:	1
Option D:	3
2	What is the order of a 1D linear element?
Option A	1
Option B	2
Option C	3
Option D	4
3	The global stiffness matrix is always ……
Option A	Square, un-symmetric, non-singular and positive definite.
Option B	Square, symmetric, non-singular and negative definite.
Option C	Non-square, non-symmetric, non-singular and positive definite.
Option D	Square, symmetric, singular and positive definite.

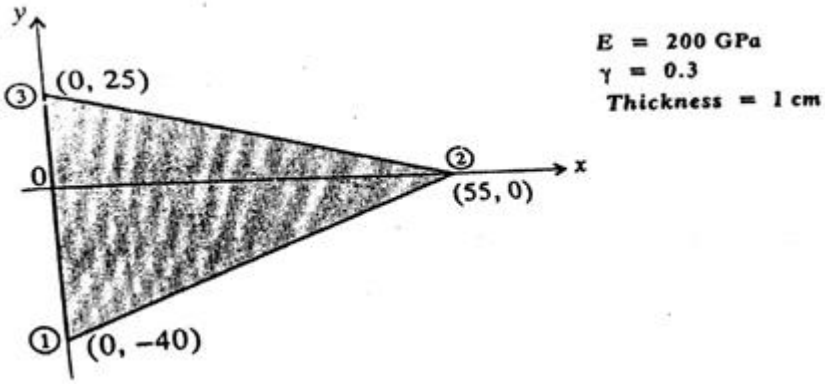
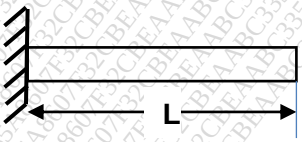
4	The sum of the shape functions over the element is always equal to
Option A	Zero
Option B	Infinity
Option C	Unity
Option D	Half
5	The size of stiffness matrix for 8 node rectangular element is:
Option A	4 x 4
Option B	8 x 8
Option C	16 x 16
Option D	64 x 64
6	The range of natural coordinates is between
Option A	0 to 1
Option B	-1 to +1
Option C	0 to -1
Option D	0 to ∞
7	In FEM , _____ method is used to convert Cartesian coordinate to local coordinate
Option A	Crammer
Option B	Henry
Option C	Jacobian
Option D	Newton
8	The dimension of the Stress-Strain Relation (D) matrix for 2D analysis is

Option A	2x2
Option B	3x3
Option C	4x4
Option D	6x6
9	In iso-parametric element the number of nodes defining geometry as compared to number of nodes defining dependent variable are
Option A	Less
Option B	More
Option C	Same
Option D	Not related
10	The truss element can deform only in the
Option A	Vertical direction
Option B	Horizontal directional
Option C	Inclined direction
Option D	Axial direction

Q.2	**Solve any Two out of Three** **10 Marks Each**
A	Find the heat transfer per unit area through the composite wall as shown. Flow is one dimensional. 

B	Solve the following differential equation and determine y at x=0.5 using Galerkin Method. $\frac{d^2y}{dx^2} - 10x^2 - 5 = 0$ in the domain $0 \le x \le 1$ Boundary conditions are: y(0) = 0 and y(1) = 0.
C	Analyze the following stepped bar shown in fig. 

Q.3	**Solve any Two out of Three**	**10 Marks Each**
A	Derive the shape functions of rectangular element in local coordinate system.	
B	Determine the nodal displacement and stresses in each element. Consider the cross-sectional area of each member of truss as 100 mm² and modulus of elasticity as 100 GPa. 	
C	For three stepped bar shown, determine the displacement at nodes, stresses in three sections and reaction at the ends. 	

Q.4	**Solve any Two out of Three** **10 Marks Each**
A	Find stresses for the CST element shown below. Assume plane stress condition. Nodal displacements are given as: u_1 = 1mm, u_2 = 0.5mm, u_3 = 2mm, v_1 = 1mm, v_2 = 0 mm, & v_3 = 1mm. 
B	A iso parametric four node quadrilateral element ABCD has coordinates A(10,5), B(12,6) , C(15,8) and D(8,4). Determine the Cartesian coordinate of a point P which has natural coordinates as ξ= 0.8 and η= 0.2.
C	Determine the natural frequency of vibration using consistent mass matrix with one bar element. An aluminum bar has a uniform cross-section, length 1 m and made up of a material having E = 70 x 10^9 N/m^2 and ρ = 2700 kg/m^3. 

University of Mumbai

Examinations Summer 2022

1T01435 / / T.E.(Mechanical) Engineering)(SEM-V)(CBCGS) ((R- 19) (C Scheme)

32626 / / Design of Exaperiments

SET-1

Time: 2 hour 30 minutes Max. Marks: 80

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<table>
<tr><td>Q1.</td><td>Choose the correct option for following questions.
All the Questions are compulsory and carry equal marks</td><td>20 marks</td></tr>
<tr><td></td><td>Questions 1,2&3 are based on the following case
A manufacturer of television sets is interested in the effect of tube conductivity of four different types of coating for color picture tubes. The following conductivity data are obtained (Use α=0.05)
<table><tr><td>Coting type</td><td colspan="4">conductivity</td></tr><tr><td>1</td><td>143</td><td>141</td><td>150</td><td>146</td></tr><tr><td>2</td><td>152</td><td>149</td><td>137</td><td>143</td></tr><tr><td>3</td><td>134</td><td>136</td><td>132</td><td>127</td></tr><tr><td>4</td><td>129</td><td>127</td><td>132</td><td>129</td></tr></table></td><td></td></tr>
<tr><td>1.</td><td>The mean square of the model is</td><td></td></tr>
<tr><td>Option A:</td><td>281.56</td><td></td></tr>
<tr><td>Option B:</td><td>844.69</td><td></td></tr>
<tr><td>Option C:</td><td>19.69</td><td></td></tr>
<tr><td>Option D:</td><td>236.25</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>2.</td><td>Degree of freedom of the model is</td><td></td></tr>
<tr><td>Option A:</td><td>12</td><td></td></tr>
<tr><td>Option B:</td><td>3</td><td></td></tr>
<tr><td>Option C:</td><td>13</td><td></td></tr>
<tr><td>Option D:</td><td>4</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>3</td><td>Degree of freedom of the error is</td><td></td></tr>
<tr><td>Option A:</td><td>12</td><td></td></tr>
<tr><td>Option B:</td><td>3</td><td></td></tr>
<tr><td>Option C:</td><td>13</td><td></td></tr>
<tr><td>Option D:</td><td>4</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>4.</td><td>The basic principles of experimental design are</td><td></td></tr>
<tr><td>Option A:</td><td>randomization, repetition, blocking</td><td></td></tr>
<tr><td>Option B:</td><td>repetition, randomization, factorization</td><td></td></tr>
<tr><td>Option C:</td><td>replication, blocking, randomization</td><td></td></tr>
<tr><td>Option D:</td><td>Optimization, blocking, factorization</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>5.</td><td>The analysis procedure used for experimental data with uncontrollable and measurable nuisance factor is</td><td></td></tr>
<tr><td>Option A:</td><td>blocking</td><td></td></tr>
<tr><td>Option B:</td><td>analysis of covariance</td><td></td></tr>
<tr><td>Option C:</td><td>analysis of variance</td><td></td></tr>
</table>

Option D:	none of these	
6.	An independent repeat run of each factor combinations is called	
Option A:	Replication	
Option B:	Randomization	
Option C:	Blocking	
Option D:	Repeated measurement	
7.	ANOVA stands for…..	
Option A:	Analysis of Variance	
Option B:	Analysis of Value	
Option C:	Analysis of Virtue	
Option D:	Analysis of Variety	
8.	A technique of statistical interference used to assist the experimenter in compering two formulations is known as	
Option A:	Hypothesis testing	
Option B:	Factor testing	
Option C:	Variable testing	
Option D:	Level testing	
	Questions 9&10 are based on the following case: A chemist wishes to test the effect of four chemical agents on the strength of a particular type of cloth. Because there might be variability from one bolt to another, the chemist decides to use a randomized block design, with the bolts of cloth considered as blocks. She selects five bolts and applies all four chemicals in random order to each bolt. The resulting tensile strengths as follows (use α=0.05)	

chemical	bolt				
	1	2	3	4	5
1	73	68	74	71	67
2	73	67	75	72	70
3	75	68	78	73	68
4	73	71	75	75	69

9.	Mean square value of block in this experiment is	
Option A:	4.32	
Option B:	1.82	
Option C:	39.25	
Option D:	12.95	
10.	Mean square value of treatment in this experiment is	
Option A:	4.32	
Option B:	1.82	
Option C:	39.25	
Option D:	12.95	
Q.2	**Solve any Four out of Five (5 marks each)**	**20 marks**
A	Write a note on Latin Square Design with example.	
B	Define the Hypothesis in DOE.	

C	Define the Population in DOE.	
D	Define the Sample in DOE	
E	Why is randomization important in an experiment?	
Q.3	**Solve any Two Questions out of Three (10 marks each)**	**20 marks**
A	List Guidelines for Designing Experiments and explain any one	
B	Table presents the effective life (in hours) observed in the battery design example. Do the Analysis of Variance for Battery Life Data and find Sum of Square, Degrees of Freedom, and fill it in tabular format given.	

Material type	Temperature (^{0}F)					
	15		70		125	
1	130	155	34	40	20	70
	74	180	80	75	82	58
2	150	188	136	122	25	70
	159	126	106	115	58	45
3	138	110	174	120	96	104
	168	160	150	139	82	60

The Analysis of Variance Table for the Two-Factor Factorial, Fixed Effects Model

Source of Variation	**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	***F*0**
A treatments				
B treatments				
Interaction				
Error				
Total				

C	Explain in detail Basic Principles of Randomization	
Q.4	**Solve any Two out of Three (10 marks each)**	**20 marks**
A	A soft drink bottler is interested in obtaining more uniform fill heights in the bottles produced by his manufacturing process. The filling machine theoretically fills each bottle to the correct target height, but in practice, there is variation around this target, and the bottler would like to understand the sources of this variability better and eventually reduce it. The process engineer can control three variables during the filling process: the percent carbonation (*A*), the operating pressure in the filler (*B*), and the bottles produced per minute or the line speed (*C*). The pressure and speed are easy to control, but the percent carbonation is more difficult to control during actual manufacturing because it varies with product temperature. However, for purposes of an experiment, the engineer can control carbonation at three levels: 10, 12, and 14 percent. She chooses two levels for pressure (25 and 30 psi) and two levels for line speed (200 and 250 bpm). She decides to run	

	two replicates of a factorial design in these three factors, with all 24 runs taken in random order. The response variable observed is the average deviation from the target fill height observed in a production run of bottles at each set of conditions. The data that resulted from this experiment are shown in Table Positive deviations are fill heights above the target, whereas negative deviations are fill heights below the target.	

Percent Carbonation(A)	Operating pressure(B)			
	25 psi		30psi	
	Line speed (c)		Line speed (c)	
	200	250	200	250
10	-3	-1	-1	1
	-1	0	0	1
12	0	2	2	6
	1	1	3	5
14	5	7	7	10
	4	6	9	11

Do the Analysis of Variance for Battery Life Data and find Sum of Square, Degrees of Freedom

B	Write and explain the stapes to be consider while Using Statistical Techniques in Experimentation.	
C	What are the potential risks of a single large, comprehensive experiment in contrast to a sequential approach?	