

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

Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks	20 marks																									
	<p>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 $\alpha=0.05$)</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Coting type</th> <th colspan="4">conductivity</th> </tr> </thead> <tbody> <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> </tbody> </table>	Coting type	conductivity				1	143	141	150	146	2	152	149	137	143	3	134	136	132	127	4	129	127	132	129	
Coting type	conductivity																										
1	143	141	150	146																							
2	152	149	137	143																							
3	134	136	132	127																							
4	129	127	132	129																							
1.	The mean square of the model is																										
Option A:	281.56																										
Option B:	844.69																										
Option C:	19.69																										
Option D:	236.25																										
2.	Degree of freedom of the model is																										
Option A:	12																										
Option B:	3																										
Option C:	13																										
Option D:	4																										
3	Degree of freedom of the error is																										
Option A:	12																										
Option B:	3																										
Option C:	13																										
Option D:	4																										
4.	The basic principles of experimental design are																										
Option A:	randomization, repetition, blocking																										
Option B:	repetition, randomization, factorization																										
Option C:	replication, blocking, randomization																										
Option D:	Optimization, blocking, factorization																										
5.	The analysis procedure used for experimental data with uncontrollable and measurable nuisance factor is																										
Option A:	blocking																										
Option B:	analysis of covariance																										
Option C:	analysis of variance																										

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																																				
<p>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 $\alpha=0.05$)</p> <table border="1" data-bbox="371 1205 1275 1435"> <thead> <tr> <th rowspan="2">chemical</th> <th colspan="5">bolt</th> </tr> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>73</td> <td>68</td> <td>74</td> <td>71</td> <td>67</td> </tr> <tr> <td>2</td> <td>73</td> <td>67</td> <td>75</td> <td>72</td> <td>70</td> </tr> <tr> <td>3</td> <td>75</td> <td>68</td> <td>78</td> <td>73</td> <td>68</td> </tr> <tr> <td>4</td> <td>73</td> <td>71</td> <td>75</td> <td>75</td> <td>69</td> </tr> </tbody> </table>		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	
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																																																					
	<p>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.</p> <table border="1"> <thead> <tr> <th rowspan="2">Material type</th> <th colspan="6">Temperature (⁰F)</th> </tr> <tr> <th colspan="2">15</th> <th colspan="2">70</th> <th colspan="2">125</th> </tr> </thead> <tbody> <tr> <td rowspan="2">1</td> <td>130</td> <td>155</td> <td>34</td> <td>40</td> <td>20</td> <td>70</td> </tr> <tr> <td>74</td> <td>180</td> <td>80</td> <td>75</td> <td>82</td> <td>58</td> </tr> <tr> <td rowspan="2">2</td> <td>150</td> <td>188</td> <td>136</td> <td>122</td> <td>25</td> <td>70</td> </tr> <tr> <td>159</td> <td>126</td> <td>106</td> <td>115</td> <td>58</td> <td>45</td> </tr> <tr> <td rowspan="2">3</td> <td>138</td> <td>110</td> <td>174</td> <td>120</td> <td>96</td> <td>104</td> </tr> <tr> <td>168</td> <td>160</td> <td>150</td> <td>139</td> <td>82</td> <td>60</td> </tr> </tbody> </table>	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	
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																																																
B	The Analysis of Variance Table for the Two-Factor Factorial, Fixed Effects Model																																																					
	<table border="1"> <thead> <tr> <th>Source of Variation</th> <th>Sum of Squares</th> <th>Degrees of Freedom</th> <th>Mean Square</th> <th>F0</th> </tr> </thead> <tbody> <tr> <td>A treatments</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B treatments</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Interaction</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Error</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Total</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F0	A treatments					B treatments					Interaction					Error					Total																											
Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F0																																																		
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	<p>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</p>																																																					

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?	

University of Mumbai
Examinations Summer 2022
1T01435/T.E. (Mechanical) Engineering/(SEM-V)(Choice Base Credit Grading System)
R2019
32623/Dynamics of Machinery

Time: 2 hour 30 minutes

Max. Marks: 80

Q1.	Choose the correct option for following questions. All the Questions are compulsory and carry equal marks
1.	Porter governor is
Option A:	Pendulum type centrifugal governor
Option B:	loaded centrifugal governor
Option C:	Inertia governor
Option D:	Pendulum type inertia governor
2.	No gyroscopic effect during rolling of ship due to
Option A:	axis of spin and precision are perpendicular to each other
Option B:	axis of spin and precision are parallel to each other
Option C:	axis of spin and precision are coinciding to each other
Option D:	axis of spin not revolving
3.	Crank effort is the net force applied at the crank pinto the crank which gives the required turning moment on the crankshaft
Option A:	Parallel
Option B:	Perpendicular
Option C:	At 45 degree
Option D:	At 135 degree
4.	Which of the following is not required condition for replacing a rigid body by a dynamically equivalent system of two masses?
Option A:	The sum of the two masses is equal to the total mass
Option B:	The sum of the square of two masses equal to square of mass
Option C:	The combined centre of mass coincide with that of body
Option D:	Sum of Moment of inertia of individual mass equal to Moment of inertia of combined centre of mass
5.	Determine natural frequency of a system, which has equivalent spring stiffness of 30000 N/m and mass of 20 kg?
Option A:	12.32 Hz
Option B:	4.10 Hz
Option C:	6.16 Hz
Option D:	5 Hz
6.	Determine logarithmic decrement, if the amplitude of a vibrating body reduces to 1/6th in two cycles.
Option A:	0.223
Option B:	0.8958
Option C:	0.3890
Option D:	0.4

7.	What is the effect of damping on phase angle at resonance frequency?
Option A:	Phase angle increases as damping increases
Option B:	Damping has no effect on phase angle
Option C:	Phase angle increases as damping decreases
Option D:	Inversely proportional
8.	When frequency ratio (ω/ω_n) is greater than unity, phase angle decreases as
Option A:	Damping factor increases
Option B:	Damping factor decreases
Option C:	Damping factor not predicted
Option D:	Damping ratio same
9.	In order to have a complete balance of the several revolving masses in different planes
Option A:	The resultant force must be zero
Option B:	The resultant couple must be zero
Option C:	Both the resultant force and couple must be zero
Option D:	The resultant force must be maximum
10.	The primary unbalanced force is maximum when the angle of inclination of the crank with the line of stroke is
Option A:	0°
Option B:	90°
Option C:	180°
Option D:	360°

Please use either of the 3 option given below while setting up the subjective/descriptive questions

Option 1

Q2 (20 Marks Each)	Solve any Two Questions out of Three	10 marks each
A	<i>Please delete the instruction shown in front of every sub question</i>	
	The arms of a Porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 150 mm when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalent of 20 N of load at the sleeve, determine how the speed range is modified.	
B	The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: 1. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. 2. when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.	

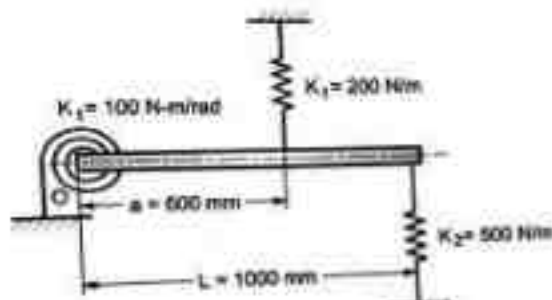
C	A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125° from the top dead centre, the steam pressure above the piston is 30 kN/m^2 and below the piston is 1.5 kN/m^2 . Calculate the effective turning moment on the crank shaft.
---	---

Option 2

Q3 (20 Marks Each)	Solve any Two Questions out of Three <i>Please delete the instruction shown in front of every sub question</i> 10 marks each
A	A mass of 2 kg is to be supported on a spring having a stiffness of 10000 N/m. The damping coefficient is 5 N.sec/m. Determine the natural frequency of the system. Also find Logarithmic decrement & the amplitude after three cycles if the initial displacement is 0.35 cm.
B	A 35 Kg block is connected to a spring of stiffness $1.7 \times 10^5 \text{ N/m}$. The coefficient of friction between block and surface on which its slides is 0.10. The block is displaced 10mm from equilibrium and released. Calculate amplitude of motion at the end of the first cycle. How many cycles of motion occur?
C	If the peak amplitude of a single degree of freedom system under harmonic excitation is observed to be 0.5cm. If the undamped natural frequency of the system is 5Hz . And the static deflection of the mass under the maximum force is 0.25cm, estimate the damping ratio of the system and peak frequency.

Option 3

Q4. (20 Marks Each)	Solve any Two Questions out of Three <i>Please delete the instruction shown in front of every sub question</i> 10 marks each
A	A seismic instrument with natural frequency of 6Hz is used to measure vibration of machine running at 120 rpm. The instrument gives reading for relative displacement of mass as 0.05mm. Determine amplitude of displacement, velocity and acceleration of vibrating machine. Neglected damping.
B	Determine the natural frequency of vibration for a system in Fig. Take mass of the beam as 5 kg.



C	A, B, C and D are four masses carried by a rotating shaft of radii 100mm, 150mm, 150mm and 200mm respectively. The planes in which the masses rotate are spaced at 500 mm apart and magnitude of the masses B, C & D are 9 kg, 5 kg and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance

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.

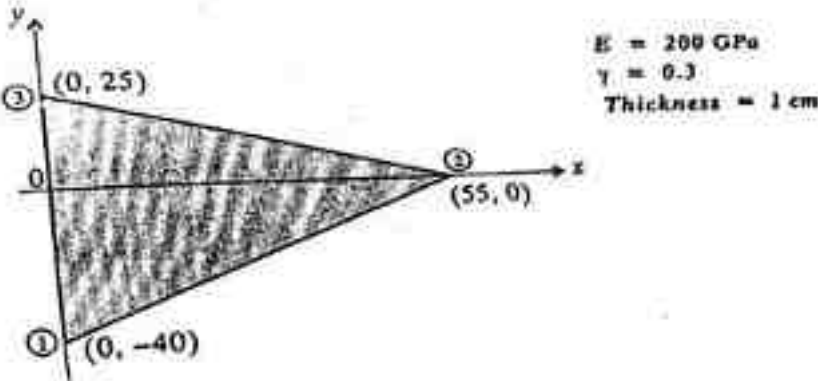
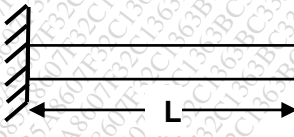
4	The sum of the shape functions over the element is always equal to
Option A	Zero
Option B	Infinity
Option C	Unity
Option D	Half
5	The size of stiffness matrix for 8 node rectangular element is:
Option A	4 x 4
Option B	8 x 8
Option C	16 x 16
Option D	64 x 64
6	The range of natural coordinates is between
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	Cramer
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.	
		$k_1 = 150 \text{ W/(m}\cdot\text{°C)}$ $k_2 = 30 \text{ W/(m}\cdot\text{°C)}$ $k_3 = 70 \text{ W/(m}\cdot\text{°C)}$ $k_4 = 50 \text{ W/(m}\cdot\text{°C)}$ $h_1 = 25 \text{ mm}$ $h_2 = 75 \text{ mm}$ $h_3 = 50 \text{ mm}$

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

Q.3	Solve any Two out of Three	10 Marks Each
A	Derive the shape functions of rectangular element in local coordinate system.	
B	<p>Determine the nodal displacement and stresses in each element. Consider the cross-sectional area of each member of truss as 100 mm^2 and modulus of elasticity as 100 GPa.</p>	
C	<p>For three stepped bar shown, determine the displacement at nodes, stresses in three sections and reaction at the ends.</p>	

Q.4	Solve any Two out of Three 10 Marks Each
A	<p>Find stresses for the CST element shown below. Assume plane stress condition. Nodal displacements are given as: $u_1 = 1\text{mm}$, $u_2 = 0.5\text{mm}$, $u_3 = 2\text{mm}$, $v_1 = 1\text{mm}$, $v_2 = 0\text{mm}$, & $v_3 = 1\text{mm}$.</p> 
B	<p>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 $\xi = 0.8$ and $\eta = 0.2$.</p>
C	<p>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 $E = 70 \times 10^9 \text{ N/m}^2$ and $\rho = 2700 \text{ kg/m}^3$.</p> 

University of Mumbai
Examination First Half 2022

Program: BE Mechanical Engineering
Curriculum Scheme: Rev-2019
Examination: TE Semester V

Course Code: MEC501 and Course Name: **Mechanical Measurement and Control**

Time: 3 hour

Max.Marks: 80

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) $e_{ss} = \lim_{s \rightarrow 0} \frac{s R(s)}{1 \pm G(s)H(s)}$ b) $e_{ss} = \frac{s R(s)}{1 \pm G(s)H(s)}$ c) $e_{ss} = \lim_{s \rightarrow 0} \frac{s}{1 \pm G(s)H(s)}$ d) $e_{ss} = \lim_{s \rightarrow 0} \frac{s R(s)}{G(s)H(s)}$
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	<p>Write differential equation for mechanical system as shown in Fig.1. Obtain an analogues electrical network based on force-current analogy</p> <p style="text-align: center;">Fig.1</p>

B	<p>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</p> <p style="text-align: center;">Fig.2</p>
---	--

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	<p>For a particular unity feedback system</p> $G(s) = \frac{64(S + 2)}{S(S + 0.5)(S^2 + 3.2S + 64)}$ <p>Sketch the Bode Plot, Find ω_{gc}, ω_{pc}, GM and PM. Comment on stability.</p>	
B	<p>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.</p>	
C	<p>What is encoder? With a neat sketch explain working of an incremental and absolute optical encoder. Explain in detail with example</p>	

University of Mumbai
Examinations Summer 2022

Subject: Thermal Engineering

Time: 2 hour 30 minutes

Sem: V

Max. Marks: 80

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, $C_p = 4.187 \text{ kJ/kgK}$) is heated from 40°C to 70°C by an oil (mass flow rate 2kg/s, $C_p 1.9 \text{ kJ/kgK}$) entering at 110°C in a counter flow heat exchanger. If overall heat transfer coefficient is $350\text{W/m}^2\text{K}$. 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.	