Qlcode: 10084804

TE Sem V Mechanical R-19 CScheme

Time: 3 Hours **Total Marks: 80**

N.B: 1) Question No. 1 is ***compulsory.***
2) Attempt any ***THREE*** questions out of remaining ***FIVE*** questions.
3) Assume suitable data wherever necessary.
4) Use of Graph paper is allowed.
5) Figures to the right indicate full marks.

1. Answer of the following questions (*any Four*). **(20)**

i) Differentiate between systematic errors and random errors.

ii) What are optical flats? How can optical flats be used for checking flatness?

iii) The dead zone of a certain pyrometer is 0.15% of the span. The calibration is 500^0C to 859^0C. What temperature change may occur before it is detected?

iv) What is RTD? How does it work?

v) Define control system. What the requirements of a good control system?

vi) Using Routh's criterion examine the stability of a control system whose characteristic equation is $S^5 + S^4 + 2S^3 + 2S^2 + 3S + 15 = 0$

2. (A) Explain the *'Three Wire Method'* used in screw thread measurement. (10)

(B) Draw the root locus and comment on the stability of the control system having open loop transfer function as follows: (10)

$$G(s)H(s) = \frac{K}{s^2(s+1)}$$

3. (A) Explain generalized measurement system elements with block diagram. Describe functions with suitable examples (10)

(B) With neat sketch, explain the constructional features and working of (10)

i) Ultrasonic Flow Meter

ii) Parkinson's Gear Tester

4. (A) Describe with neat diagrams the construction and working principle of ***Ionization and Thermal Conductivity gauges*** for pressure measurement. (10)

(B) A unity feedback system has (10)

$$G(s) = \frac{100}{S^2(0.5S+1)(S+2)}$$

a. Type of system

b. Error constants K_p, K_v, K_a

c. Find steady state error for unit parabolic input

5. (A) Design a general type of Go and No Go plug gauge for inspecting a hole **25 d8**. Given that: (10)

$$i = 0.40\ D^{1/3} + 0.001D \text{ micron}$$

a) Tolerance for hole = **25 i**
b) Fundamental deviation of hole = $16\ D^{0.44}$
c) Wear allowance = 10% gauge tolerance

(B) Define the terms a) Rise time, b) Peak time, c) Settling time d) Peak overshoot with respect to transient response of a system. (10)

6. Write short note on (any Four) 20

a) Optical Encoder
b) Magnetic Flow Meter
c) LVDT
d) Repeatability and Reproducibility
e) Strain Gauge based load cell
f) Frequency Domain Specifications

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QPcode: 10086711

TE Sem V Mechanical R-19 cscheme

[Time: 03 Hours] [Total Marks: 80

Note :

- ***Question No.1 is compulsory.***
- *Solve **ANY THREE** questions from the **remaining** five questions.*
- *Figure to the right indicates full marks.*
- *Assume suitable data wherever required, but justify the same.*

			Marks
Q. 1		Solve **ANY FOUR** questions from following. (Each question carries **5 marks**)	20
	a)	State and explain Fourier's law of conduction.	
	b)	Discuss the relation between thermal boundary layer and hydrodynamic boundary layer with respect to variation in Prandtl number.	
	c)	Explain the concept of critical radius of insulation with reference to a cylinder.	
	d)	Define overall heat transfer coefficient and explain its significance.	
	e)	Explain knocking in SI engines and methods to suppress it.	
	f)	Explain the term Volumetric Efficiency in internal combustion engines.	
Q. 2	a)	During the trial of a single-cylinder, four-stroke oil engine, the following results were obtained. Cylinder diameter = 20 cm Stroke = 40 cm Mean effective pressure = 6 bar Torque = 407 Nm Speed = 250 rpm Oil consumption = 4 kg/h Calorific value of fuel = 43 MJ/kg Cooling water flow rate = 4.5 kg/min Air used per kg of fuel = 30 kg Rise in cooling water temperature = 45°C Temperature of exhaust gases = 420°C Room temperature = 20°C Mean specific heat of exhaust gas = 1 kJ/kg K Specific heat of water = 4.18 kJ/kg K Find the ip, bp and draw up a heat balance sheet for the test in kJ/h.	8
	b)	A wall of a furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240 mm thick. The temperatures at the inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If thermal conductivities of silica and magnesite bricks are 1.7 W/m°C and 5.8 W/m°C, calculate (i) The rate of heat loss per unit area of walls, and (ii) The temperature drop at the interface.	12
Q. 3	a)	Air at atmospheric pressure and 40°C flows with a velocity of U = 5 m/s over a 2 m long flat plate whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficient over the 2 m length of the plate. Also find out the rate of heat transfer between the plate and the air per 1 m width of the plate. [The thermo-physical properties of air at 1 atm. and 80°C are $\upsilon = 2.107 \times 10^{-5}$ m²/s, k = 0.03025 W/mK; Pr = 0.6965]. Use the following correlation: $\overline{Nu} = 0.664\,(Re_L)^{1/2}(Pr)^{1/3}$	8

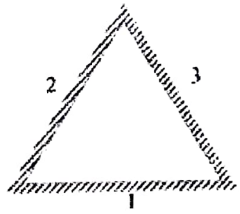
b) The air flow to a four cylinder, four-stroke oil engine is measured by means of a 5 cm diameter orifice having a coefficient of discharge of 0.6. During a test on the engine the following data were recorded : bore = 10 cm; stroke = 12 cm; speed = 1200 rpm; brake torque = 120 Nm; fuel consumption = 5 kg/h; calorific value of fuel = 42 MJ/kg; pressure drop across orifice is 4.6 cm of water; ambient temperature and pressure are 17 °C and 1 bar respectively. Calculate 12

i. the thermal efficiency on brake power basis;
ii. the brake mean effective pressure and
iii. the volumetric efficiency based on free air condition.

Q. 4 a) The temperature of an air stream flowing with a velocity of 3 m/s is measured by a copper-constantan thermocouple which may be approximated as a sphere of 2.5 mm in diameter. Initially the junction and air are at a temperature o f 25°C. The air temperature suddenly changes to and is maintained at 215°C. Determine the time required for the thermocouple to indicate a temperature of 165°C. The thermal junction properties are: ρ = 8750 kg/m^3, c = 380 J/kg°C, k (thermocouple) = 28 W/m°C and h = 145 W/m^2 °C. 8

b) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 W/m^2 °C, calculate the area of the heat exchanger. 12

Q. 5 a) Calculate the shape factors for the configurations shown in the Fig. 5



A tube with cross-section of an equilateral triangle

b) Explain Willan's line method for measurement of frictional power. 5

c) Illustrate the variation of temperature of hot fluid and cold fluid from inlet to outlet in case of a parallel flow heat exchanger and counter flow heat exchanger. 5

d) Differentiate between the efficiency and effectiveness of an extended surface. 5

Q. 6 a) Explain Nucleate boiling and Film boiling. 5

b) Why is short ignition delay favourable for CI engines whereas it is undesirable for an SI engine? 5

c) State and explain Fick's Law of diffusion. 5

d) Explain different types of emission control norms implemented in order to control the air pollution due to IC engines. 5

QPcode: 10087505

TE Sem V th Mechanical R-19 cschome

Time: 3 Hours **Total Marks: 80**

N.B.

1. **Question No. 1 is compulsory**
2. **Answer any three questions from reaming questions**
3. **Assume suitable data if required**
4. **Figure to the right indicates full marks.**

Q 1 Solve any four **[20]**

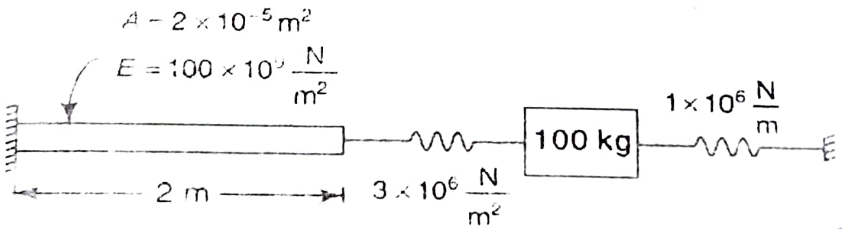
1. State the different type of governors. Explain construction and working of centrifugal Governor.
2. Explain two mass dynamical equivalent systems.
3. Explain Static and Dynamic Balancing
4. Compare Viscous and Coulomb damping.
5. Classify vibration measuring instruments? Explain anyone.

Q 2 A) A porter governor has equal mass each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the range of speed, sleeve lift, governor effort and power of the governor in the following cases: **[10]**

(i)When friction at sleeve is neglected?
(ii)When friction at sleeve is equal to 10 N?

Q2 B) The connecting rod of a gasoline engine is 300 mm long between its centres. It has a mass of 15 kg and mass of inertia of 7000 kg-mm^2. Its centre of gravity is at 200 mm from its small end centre. Determine the dynamical equivalent two-mass system of the connecting rod if one of the masses is located at the small end centre **[10]**

Q 3 A) Determine the natural frequency for the given system as shown in Fig below **[10]**



Q3 B) Derive the equation for critical speed of a light shaft with a single disk without damping **[10]**

Q 4 A) A Vibrometer has a period of free vibration of 2 sec. It is attached to a machine with a vertical harmonic frequency of 1 Hz. If the Vibrometer mass has an amplitude of 3 mm relative to the vibrometer frame, what is the amplitude of vibration of machine? **[10]**

Q 4 B) A seismic instrument with natural frequency of 6Hz is used to measure vibration of machine running at 125 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. **[10]**

Q 5 A) A,B,C,D are four masses carried by a rotating shaft at radii 100mm,125mm, 200mm, and 150mm respectively. The planes in which masses revolve are spaced 600 mm apart and mass of B,C,D are 10kg, 5kg, 4kg respectively. Find the required mass and angular position of mass A in order to have complete balance. **[10]**

Q 5 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: **[10]**

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.

Q 6 A) In Hartnell governor, the lengths of ball and sleeve arms of bell crank lever are 120 mm and 100 mm respectively. The distance of the fulcrum of the bell crank lever from the governor axis is 140 mm. Each governor ball has a mass of 4 kg. The governor runs at a mean speed of 300 rpm with the ball arms vertical and sleeve arms horizontal. For an increase of speed of 4%, the sleeve moves 10 mm upwards. Neglecting friction, Find **[10]**

(i)The minimum equilibrium speed if the total sleeve movement is limited to 20 mm.
(ii) Spring stiffness.
(iii)The sensitiveness of the governor

Q 6 B) 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 have 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. **[10]**

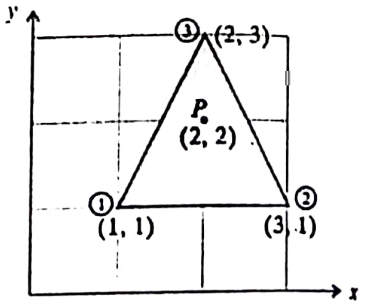
QP — 1008275

TE/ sem 5th / R-19. C-scheme / Mechanical

Time: 3 Hours **Marks: 80**

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** five questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.

			Marks
Q. 1		Solve **ANY FOUR** questions from following. (Each question carries 5 marks)	**20**
	a)	Differentiate between Essential and Natural boundary conditions with suitable examples.	**5**
	b)	Summarize the properties of shape functions.	**5**
	c)	Explain lumped mass matrix, consistent mass matrix and HRZ lumping scheme with suitable examples.	**5**
	d)	Distinguish between h and p methods of mesh refinement with necessary illustrations.	**5**
	e)	Describe the significance of principle of minimum potential energy.	**5**
Q. 2	**a)**	Solve the following differential equation by Galerkin method and Sub-domain method for y (0.5). $$\frac{d^2y}{dx^2} + y - 2 = 0; \quad 0 \le x \le 1$$ BCS; $y(0) = y(1) = 0$	**15**
	b)	Derive shape functions for linear bar element in local coordinates and show the variations over element domain.	**5**
Q. 3	**a)**	For the triangular element shown in figure, the nodal values of displacement are : $u_1 = 2.0, u_2 = 3.0, u_3 = 5.0$ $v_1 = 1.0, v_2 = 2.0, v_3 = 3.0$ Determine the displacement (i.e. u, v) of point P (2, 2) within the element.	**10**



b) Solve the following differential equation by Rayleigh Ritz method. 10

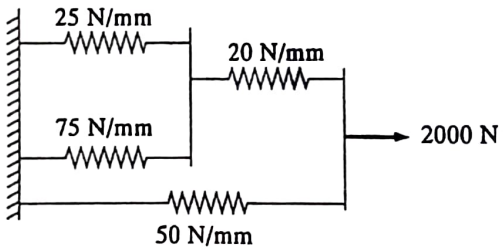
$$\frac{d^2y}{dx^2} - 10x^2 = 5 \quad ; \quad 0 \le x \le 1$$

Given Boundary Conditions are: $y(0) = y(1) = 0$

Q. 4 a) For a uniform cross-section bar of length L = 1 m made up of a material having $E = 2 \times 10^{11}$ N/m^2 and $\rho = 7800$ kg/m^3, estimate the natural frequencies of axial vibrations of the bar using both consistent and lumped mass matrices. Use a two element mesh. If the exact solution is given by the relation. 10

$\omega_i = \frac{i\pi}{2L}\sqrt{\frac{E}{\rho}}$; $i = 1, 3, 5, \ldots\ldots\ldots\infty$. Compare your answer and give your comments. $A = 30 \times 10^{-6}$ m^2.

b) Figure shows a cluster of four springs. Calculate deflections of each spring when a force of 2000 N is applied. Model the springs as 1-D element. 10

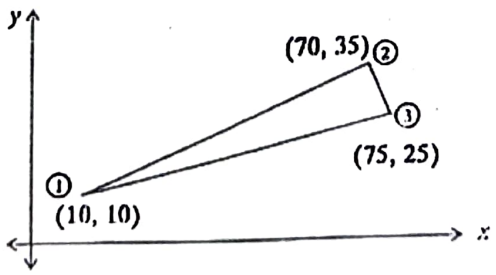


Q. 5 a) The CST element has nodal coordinates (10, 10), (70, 35) and (75, 25) for node 1, node 2 and node 3 respectively. The element is 2 mm thick and is of material with properties E = 70 GPa. Poisson's ratio is 0.3. Upon loading of model the nodal deflections were found to be $u_1 = 0.01$ mm, $v_1 = -0.04$ mm, $u_2 = 0.03$ mm, $v_2 = 0.02$ mm, $u_3 = -0.02$ mm and $v_3 = -0.04$ mm. 10

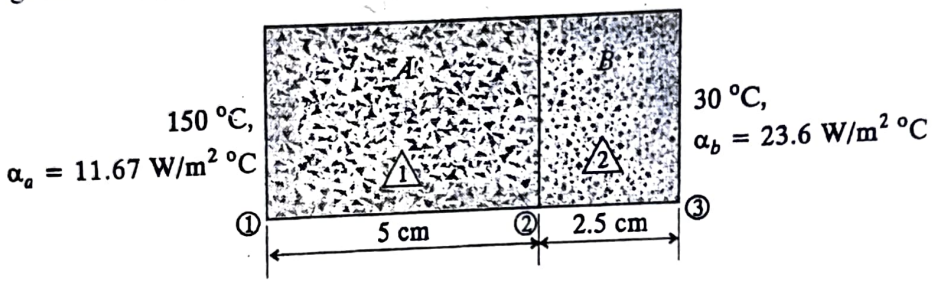
Determine: -

i) The Jacobian for (x-y) – ($\xi - \eta$) transformation.

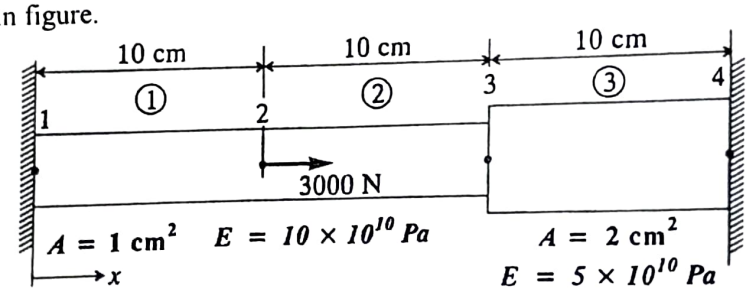
ii) The Strain displacement relation matrix.



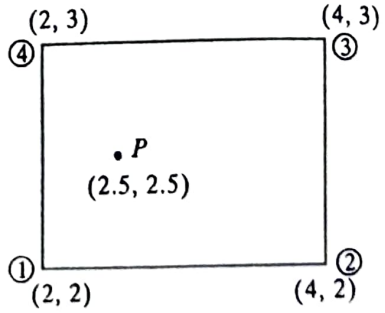
b) Consider a plain composite wall which is made of two materials of thermal conductivity k_a = 204 W/m °C and k_b = 46 W/m °C and thickness h_a = 5 cm and h_b = 2.5 cm. Material A adjoins a hot fluid at 150 °C for which heat transfer coefficient α_a = 11.67 W/m² °C and the material B is in contact with a cold fluid at 30 °C and heat transfer coefficient α_b = 23.6 W/m² °C. Calculate rate of heat transfer through the wall and the temperature at the interface. The wall is 2 m high and 2.5 m wide. 10



Q. 6 a) Determine the unknown reactions and displacement for the arrangement of bars shown in figure. 10



b) Coordinates of nodes of a quadrilateral element are as shown in the figure. Temperature distribution at each node is computed as T_1 = 100°C, T_2 = 60°C, T_3 = 50°C and T_4 = 90°C. Calculate temperature at point P (2.5, 2.5). Use local co-ordinate system. 10



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QPCode: 10082978

TE Sem V Mechanical R-19 cscheme

Time: 3 Hours

Marks: 80

Note :

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** five questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.

Q. 1 Solve **ANY FOUR** from the following.

a) Show the formulation of a generalized transportation problem. **(5)**

b) Show the conditions for the Positive definite, Positive semi-definite, Negative definite and Negative semi-definite functions. **(5)**

c) Show the flowchart for the genetic algorithm. **(5)**

d) Solve and decide the definiteness of the function **(5)**

$f(x) = -3\,x_1^2 + 2\,x_2^2 - 3x_3^2 - 10\,x_1x_2 + 4\,x_2x_3 + 6\,x_1x_3$

e) Illustrate 'Design of Experiment'. **(5)**

Q. 2 **a)** Calculate maximum and minimum values of the function **(10)**

$$f(x) = 3x^4 - 4x^3 - 24x^2 + 48x + 15$$

b) Solve the following LPP by the simplex method. **(10)**

Minimize $7\,x_1 + 5\,x_2$

S.T. $x_1 + x_2 \geq 4$

$5\,x_1 + 2\,x_2 \geq 10$

$x_1, x_2 \geq 0$

Q. 3 **a)** Solve using the Lagrange's multiplier method the following NLPP **(10)**

Optimize $Z = 6x_1^2 + 5x_2^2$

S. T. $x_1 + 5x_2 = 7$

$x_1, x_2 \geq 0$

b) List the non-traditional optimization techniques and explain any one in detail. **(10)**

Q. 4 **a)** A person has to select a house from given 3 alternatives he has with the details as given in the table. He considers 3 attributes of price, near to market and near to school with weights as 0.625, 0.125 and 0.25 respectively. Select the best alternative of house by SAW method. **(10)**

Alternative / Criteria	Price (Rs. Lakhs)	Near Market (km)	Near School (km)
House 1	100	1.5	2.75
House 2	140	1.0	3.5
House 3	80	1.7	3.0

b) Classify optimization problems in detail. **(10)**

Q. 5 a) Apply Dynamic Programming to solve the following problem (10)

Minimize $Z = x_1^2 + x_2^2 + x_3^2$

S.T. $x_1 + x_2 + x_3 = 15$

$x_1, x_2, x_3 \geq 0$

b) Describe the procedure of AHP method step wise in detail. (10)

Q. 6 a) A company manufactures 2 products, radios and transistors, which must be processed through assembly & finishing departments. Assembly has 90 hours available, finishing can handle up to 72 hours of work. Manufacturing one radio requires 6 hours in assembly and 3 hours in finishing. Each transistor requires 3 hours in assembly and 6 hours in finishing. If profit is Rs. 120 per radio and Rs. 90 per transistor, determine the best combination of radios and transistors to realize profit of Rs. 2100. (10)

b) A sample of 100 arrivals of a customer at a retail sales depot is according to the following distribution. (10)

Time between arrivals (mins.)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Frequency	2	6	10	25	20	14	10	7	4	2

A study of the time required to service customer by adding up the bills, receiving payments and placing packages yields the following distribution.

Service time (mins.)	0.5	1.0	1.5	2.0	2.5	3.0
Frequency	12	21	36	19	7	5

Estimate the average of customer waiting time and average of idle time of the server by simulation for the next 10 arrivals.

Use random number for arrivals: 93, 22, 53, 64, 39, 07, 10, 63, 76, 35

Use random number for service: 78, 76, 58, 54, 74, 92, 38, 70, 96, 92

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