AIKTC/KRRC/SoET/ACKN/QUES/2022-23/ **Date:** 25/01/23

School: SoET-REV. C-SCHEME **Branch:** MECH. ENGG. **SEM:** V

To,
Exam Controller,
AIKTC, New Panvel.

Dear Sir/Madam,

Received with thanks the following **Semester/Unit Test-I/Unit Test-II (Reg./ATKT)** question papers from your exam cell:

Sr. No.	Subject Name	Subject Code	Format		No. of Copies
			SC	HC	
1	Mechanical Measurement & Controls	MEC501		✓	
2	Thermal Engineering	MEC502		✓	
3	Dynamics of Machinery	MEC503		✓	
4	Finite Element Analysis	MEC504		✓	
5	Department Level Optional Course I Statistical Techniques	MEC505		✓	

Note: SC – Softcopy, HC - Hardcopy

(Shaheen Ansari)
Librarian, AIKTC

2:30pm Sem-V-CBCS-19-Reg. Time: 3 Hours R-19 ME 24/11/22 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 the following questions. **20**

i) Distinguish between Line, End and Wavelength Standard.

ii) Distinguish between open loop and closed loop control system with suitable examples.

iii) Explain working LVDT with neat sketch.

iv) While measuring the speed of steam turbine with stroboscope, stationary image was observed for three consecutive stroboscope settings of 3000, 4000 and 5250 flashes per minute. Calculate the rotational speed of turbine.

2. (A) Reduce the following block diagram and find the transfer function. **10**

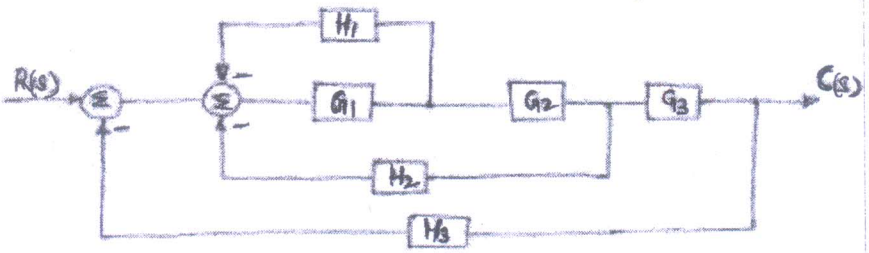

Fig.1

(B) What is Taylors principle, explains in detail? Write note on Hole Basis System and Shaft Basis System. **10**

3. (A) For a particular unity feedback system **10**

$$G(s) = \frac{10}{S(S+1)(S+5))}$$

Sketch the Bode Plot, Find ω_{gc}, ω_{pc}, GM and PM. Comment on stability.

(B) b) A unity feedback system characterized by an open loop transfer function **10**

$$G(s) = \frac{K}{S(S+2)(S^2+4S+5))}$$

Determine the gain K. so that the system will be stable.

4. (A) Explain principle of interference. How flatness can be checked with help of optical interferometer. **10**

   (B) What are desired, Modifying, Interfering input? Explain with example of each. Also suggest method to minimize the effect of Modifying & Interfering inputs. **10**

5. (A) Draw the Root-Locus of the system having **10**

$$G(s)H(s) = \frac{K}{S(S+5)(S+10)}$$

   (B) Draw neat labelled diagram of Taylor Hobson Talysurf and briefly explain working principle. State one major advantage and disadvantage of this instrument over Tomlinson surface meter . **10**

6. (A) What are the different elastic transducers used for pressure measurement? Illustrate working principle of any one transducer in detail. **10**

   (B) Write short note on **(any Two)** **10**

   i) Parkinson's gear tester

   ii) Two wire method

   iii) Optical encoder

Mechanical
2:30 PM

Sem-V-CBCS-19-Reg.

Time: 3 hours

Max. Marks: 80

Note: 1. Assume suitable data if necessary
2. Figures to the right indicate full marks
3. Question No. 1 is compulsory
4. Solve any **three** out of the remaining **five** questions

Q1. Solve any four

A	Derive an expression for the critical radius of insulation for the sphere.	5
B	State Fourier and Biot numbers? Also explain the significance of these numbers.	5
C	Draw a boiling curve and identify the different boiling regimes. Explain each regime in brief.	5
D	State and explain Fick's Law of diffusion.	5
E	Explain the valve timing diagram for four-stroke SI engines.	5
F	Explain EURO and BHARAT norms.	5

Q2.

A A Cylindrical tank of 1.0 m diameter and 5 m total length has hemispherical ends. It contains liquid oxygen, which has a boiling point and heat of vaporization of -180 °C and 210 kJ/kg, respectively. It is required to insulate the tank so as to reduce the boil-off rate of oxygen in a steady state to 14 kg/h. Determine the thermal conductivity of the insulating material if its maximum thickness is limited to 70 mm. Assume room temperature outside the insulation as 25 °C. **10**

B During the trial of a single-cylinder, four-stroke oil engine, the following results were obtained. **10**

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	1kJ/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.

Q3.

A Discuss the electrical analogy of combined heat conduction and convection in two-layer composite wall. **5**

B A steel ball 50 mm in diameter and at 900 °C is placed in a still atmosphere of 30 °C. Calculate the initial rate of cooling of the ball in °C per min. **5**

C Explain with neat sketch stages of combustion of the CI engine. **10**

Q4.

A A steel rod (k = 32 W/m°C), 12 mm in diameter and 60 mm long, with an insulated end, is to be used as a spine. It is exposed to surroundings with a temperature of 60°C and a heat transfer coefficient of 55 W/m²°C. The temperature at the base of fin is 95°C. Determine: **10**
(i) The fin efficiency.
(ii) The temperature at the edge of the spine.
(iii) The heat dissipation.

B State and explain kirchoff's law. **5**

C With suitable example/ values prove that during the load test of an engine, increases in the load increases the mechanical efficiency of the engine. **5**

Q5.

A A counter-flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500 kg/h. The steam enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperatures of water are 30°C and 80°C, respectively. If the overall heat transfer coefficient from steam to water is 814 W/m²°C, calculate the heat transfer area. What would be the increase in the area if the fluid flows were parallel? **10**

B A 4-stroke motorcycle petrol engine cylinder consists of 15 hollow fins. If the outside and inside diameters of each fin are 200 mm and 100 mm, respectively, the average fin surface temperature is 475°C, and the atmospheric air temperature is 25°C, calculate the heat transfer rate from the fins When the motor cycle is running at a speed of 60 km/h. The fin may be idealised as a single horizontal flat plate of the same area. **10**
Assume characteristic length is 0.9 times the outside diameter.

$\overline{Nu} = 0.036(Re)^{0.8}\,(Pr)^{0.33}$

$\overline{Nu} = 0.54(Gr.Pr)^{0.25}$

The thermophysical properties of air at 250 °C are
$k = 4.266 \times 10^{-2}$ W/m °C, $\nu = 40.61 \times 10^{-6}$ m²/s, Pr = 0.677

Q 6.

A Explain with a neat sketch working of the battery ignition system. **5**

B Explain the Fouling of Heat Exchangers. **5**

C Calculate the heat transfer from a 60W incandescent bulb at 115°C to ambient air at 25°C. Assume the bulb is a sphere of 50 mm in diameter. Also, find the percentage of power lost by free convection. **5**

The correlation is given by: $Nu = 0.60\,(Gr.Pr)^{1/4}$
The thermophysical properties of air at 70 °C are
$k = 2.964 \times 10^{-2}$ W/m °C, $\nu = 20.02 \times 10^{-6}$ m²/s Pr = 0.694

D Write down the general heat conduction equation in cartesian coordinates. State the assumptions and get the Fourier, Poisson's and Laplace equations from it. **5**

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3 Hours **Total Marks: 80**

Note:

1. Question No. 1 is compulsory.
2. Attempt any three from the reaming five questions.
3. **Assume suitable data wherever required** with proper justification.

Q1 Attempt any four of the following. All sub-question carries equal marks

A	Differentiate between Porter and Hartnell governor.	5
B	Explain the effect of Gyroscopic couple on a naval ship during steering, pitching and rolling.	5
C	A connecting rod of mass m = 3x 10^{-3} kg and I =0.432x10^{-4} kgm^2 is suspended on a knife edge about the upper inner surface of a wrist-pin bearing, When disturbed slightly, the rod was observed to oscillate harmonically with ω_n = 6 rad/s. Determine the distance between the support and the C.G.	5
D	Define (a) Critical damping coefficient (b) Damping factor (c) Logarithmic Decrement (d) Significance of logarithmic decrement (e) Viscous Damping	5
E	Explain Correction Couple in dynamically equivalent system.	5
F	Plot variation between frequency ratio vs phase angle.	5

Q2

2A. Calculate natural frequency of simple pendulum by using Energy method. 08

2B. 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. 12

Q3

3A. 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.

3B.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. 10

Q4.

4A. 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. 10

4B. A 35 Kg block is connected to a spring of stiffness 1.7×10^5 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? 10

Q5.

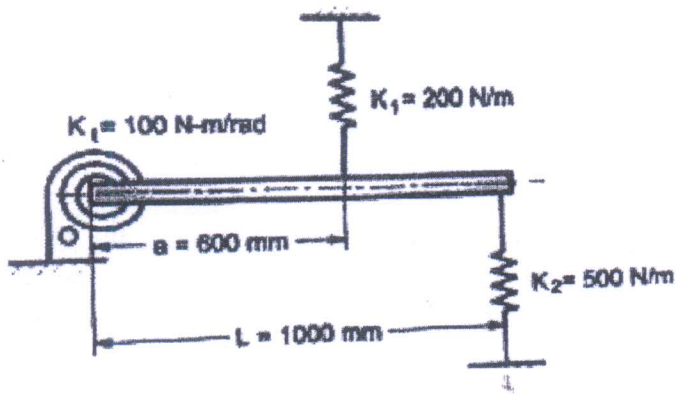
5A. If the peak amplitude of a single degree of freedom system under harmonic excitation is observed to be 0.5cm. If the undamped natural frequency of the system is 5Hz . And the static defection of the mass under the maximum force is 0.25cm, estimate the damping ratio of the system and peak frequency. 12

5B. 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, by Neglecting damping. 08

Q6.

6A. The four masses m1, m2, m3 and m4 having their radii of rotation as 200 mm, 150 mm, 250 mm and 300 mm are 200 kg, 300 kg, 240 kg and 260 kg in magnitude respectively. The angles between the successive masses are 45 degree, 75 degree and 135 degree respectively. Find the position and magnitude of the balance mass required, if its radius of rotation is 200mm 08

6B. Determine the natural frequency of vibration for a system in Fig. Take mass of the beam as 5 kg. 12



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2.30 pm ME R-19 30/11/22

Sem-V- CBCS-19- Reg.

(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 if required.

Q1 Solve any 4 **[Each 5 Marks]**

i) Why Finite Element Method is an approximate solution? Explain in brief how the accuracy of FEM results improve.

ii) Explain the Principle of minimum total potential with suitable example.

iii) Derive the shape function for One Dimensional Linear Element in Natural Coordinates.

iv)What is Convergence in FEA? Explain its types in brief.

v) What is the significance of Jacobian Matrix in FEA? Explain in brief.

vi)What do you mean by Consistent and Lumped mass matrix? Explain in brief with their importance.

Q2 a) Solve the following differential equation using Galerkin Method. [12]

$$-\frac{d}{dx}\left[(x-1)\frac{du}{dx}\right] = x^2 ; \quad 3 \le x \le 5$$

Boundary Conditions are; $u(5) = 10$ *and* $u'(3) = 5$

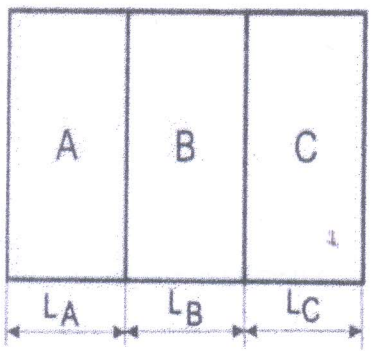
Also compute the value of primary (u) variable at x = 3.5, 4.5

b) What are the sources of Errors in FEA? [04]

c) What is Boundary Condition? Explain its type in brief. [04]

Q3 a) Find the temperature at interfaces and heat transfer per unit area through the wall. [10]

$T_L = 100°C$,
$h_L = 150\ w/m°C$,



$T_R = 30°C$,
$h_R = 20 w/m°C$,
$L_A = 50mm$
$L_B = 50mm$,
$L_C = 50mm$
$K_A = K_B = K_C = 40\ W/m°C$

Where K- denotes thermal conductivity, h- denotes heat transfer coefficient and T-temperature

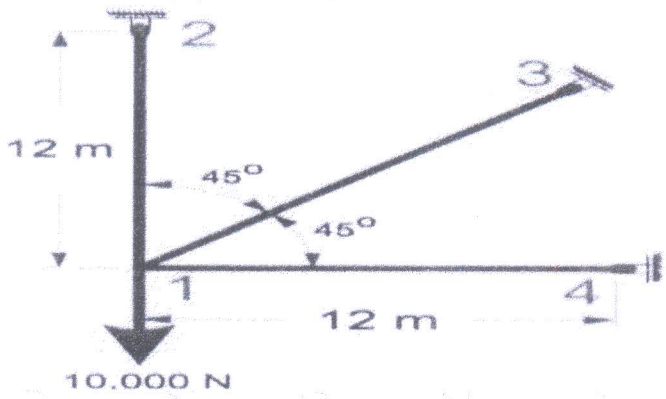
b) Develop the finite element equation for the most general element using Rayleigh Ritz Method for vertical bar with axial loading. The governing differential equation is given below [10]

$$\frac{d}{dx}\left(EA\frac{du}{dx}\right)+f=0 \quad ;0\le x\le L$$

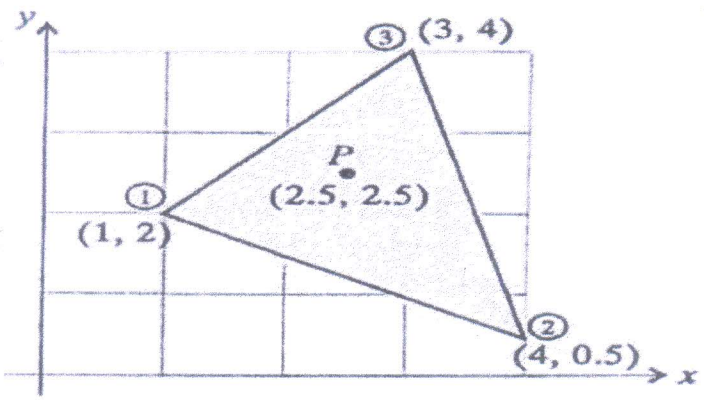
Where f is the weight of the bar. Consider one end of the bar to be fixed and other end free.

Q4 a) For the plane truss shown in figure. [12]

(i) Determine the displacement at nodes
(ii) Determine the stresses in each bar.



b) The triangular element used for ground water flow simulation is shown in below figure. The nodal coordinates are ($x_1 = 1, y_1 = 2$), ($x_2 = 4, y_2 = 0.5$), ($x_3 = 3, y_3 = 4$). The nodal values of hydraulic heads { φ} at these nodes are [3.5, 2.2, 4.4] respectively. Find the values of hydraulic head φ at point (2.5, 2.5) [08]



Q5 a) For 2D loaded plat shown in below figure below. Determine the displacements of nodes 1 and 2 and the element stresses using the plane stress conditions. Assume thickness as 10 mm, E = 225 GPa and poisons ratio = 0.25, All Dim are in mm [12]

2/12/22

2:30pm Sem-V - CBCS-19 - Reg. ME (R-19)

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

Note:

1. **Question No. 1 is compulsory.**
2. Attempt any **THREE** out of the remaining **FIVE** questions.
3. Assume suitable data if necessary.
4. Use of Statistical Tables are allowed

Q. 1. Write short notes on **any FOUR** questions. (20)

(a) Explain parametric and non-parametric test

(b) Explain spearman's rank correlation

(c) Describe any one type of sampling with example

(d) Explain level of significance and confidence level

(e) Explain types of correlations

Q. 2. (a) An ambulance service claims that it takes on an average 8.9 min for ambulance to reach its destination in emergency calls. To check on this claim the agency that licenses ambulance service has timed them on 50 emergency calls getting mean of 9.3 min with standard deviation of 1.6 min. What can they conclude at 5% level of significance. (10)

(b) To access the significance of possible variation in performance in a certain test between the convent school of a city, a common test was given to a few students taken at random from the senior fifth class of each of the four schools concerned. The results are given below, make an analysis of variance of data (10)

A	B	C	D
8	12	18	13
10	11	12	9
12	9	16	12
8	14	6	16
7	4	8	15

Q. 3. (a) Find from the following values of the demand and the corresponding price of a commodity, the degree of correlation between the demand and price by computing Karl Pearson's coefficient of correlation (10)

Demand in quintals	65	66	67	67	68	69	70	72
Price in paise per kg	67	68	65	68	72	72	69	71

(b) Fit a second-degree parabolic curve to the following data (10)

X :	1	2	3	4	5	6	7	8	9
Y :	2	6	7	8	10	11	11	10	9

Q. 4. (a) 7 fair dice are thrown 729 times. How many times do you expect at least four dice to show three or five? (10)

(b) Explain different types of sampling with example (10)

Q. 5. (a) Fit a straight line to the following data (10)

X :	1	2	3	4	5	6
Y :	49	54	60	73	80	86

(b) The following table give the number of breakdowns in a factory in various days of a week. Using Chi- Square Test check whether breakdown is uniformly distributed or not (10)

Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
No of Breakdowns	14	22	16	18	12	19	11

Q. 6. (a) Explain steps in Two-way ANOVA with example (10)

(b) If discrete random variable has values (10)

X	1	2	3	4	5	6	7
P (X = x)	K	2K	3K	K^2	$K^2 + K$	$2K^2$	$4K^2$

Find

i. K
ii. Mean
iii. Variance
iv. $P(X \leq 6)$
v. $P(X \geq 2 / X \leq 5)$