



Knowledge Resource & Relay Centre (KRRC)

AIKTC/KRRC/SoET/ACKN/QUES/2019-20/

Date: 15/01/2020School: SoET-CBCSBranch: MECH. ENGG.SEM: VI

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	Metrology & Quality Engg.	MEC601		✓	02
2	Machine Design – I	MEC602		✓	02
3	Finite Elements Analysis	MEC603		✓	02
4	Refrigeration and Air Conditioning	MEC604		✓	02
5	Department Level Optional Course II <i>Mechatronics</i>	MEC605		✓	02

Note: SC – Softcopy, HC - Hardcopy

(Shaheen Ansari)
Librarian, AIKTC

Max. Marks: 80

Duration: 3 Hrs

- N.B. : 1. Q. 1 is compulsory.
2. Solve any **three** from the remaining questions.
3. All question carry equal marks.

Q1 Answer Any Four Questions

- a) What do you mean by sampling? Explain its advantages.
b) Differentiate between precision and accuracy.
c) Write a note on Nano metrology.
d) Write a note on quality tools.
e) In a limit system, the following limits are specified for a hole and shaft assembly:

$$\text{Hole} = 50^{+0.02}_{+0.00}$$

$$\text{Shaft} = 50^{-0.05}_{-0.08}$$

Determine the (i) tolerance and (ii) allowance with clear explanation.

20

- Q2 a) Explain Gear terminologies and gear errors in detail with diagrams. 10
b) What is Mechanical comparator? Explain Electrical/Electronic comparator in detail with advantages, applications and limitations. 10

- Q3 a) What is Interferometry? Explain Laser Interferometer with diagram in detail. 10
b) Explain method of major diameter measurement of internal threads. 10
Also explain minor diameter measurement of internal threads using
i. Taper Parallel and
ii. Rollers.

- Q4 a) Enlist various methods for effective diameter measurement of screw thread also derive expression for best wire size. 10
b) Write classification of gauges and explain Taylors Principle of gauge design. 10

- Q5 a) Explain construction and working of Autocollimator with neat diagram. 10
b) Explain various SQC tools in detail and write a note on its applications in engineering. 10

Q6 Answer Any FOUR Questions

- a) Explain various surface roughness symbols with neat diagram. 20
b) Write a note on Eddy Current testing methods.
c) Write a note c-chart and u-chart.
d) What is CMM? Explain its various types.
e) Explain role of computers in metrology with suitable examples.

[Time: 03 Hours]

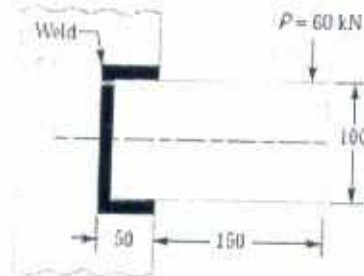
[Total marks: 80]

N.B.

1. Question No.1 is compulsory
2. attempt any three out of remaining questions
3. Draw neat sketches to illustrate your answers
4. Figures to the right indicate full marks.
5. Use of **Standard Data Book** is permitted

- Q1 Answer any **four** of the following 20
- a) What is the necessity of theories of failure? List different theories of failure
 - b) Explain overhauling and self-locking of screw.
 - c) What are the assumptions made in analysis of curved beam
 - d) Explain the nipping of the leaf spring with neat sketch.
 - e) Explain aesthetic consideration in design with suitable examples.
- Q2 a) Design socket and spigot joint for 100kN, which varies from tension to compression. 14
Select suitable material, factor of safety and draw neat sketch.
- b) Explain Notch sensitivity and Endurance limit related to design of machine elements subjected to variable loads. 06
- Q3 a) Design screw, nut, and handle of screw jack to lift a load of 90kN through a height of 400mm. select suitable material and factor of safety to design screw jack. 12
- b) Design a helical valve spring for an operating load range of 600N to 1200N. The compression at the maximum load is 30mm. Take the spring index 6 and permissible endurance shear stress for spring material as 480Mpa and yield stress in shear is 960Mpa and $G = 80\text{kN/mm}^2$ 08
- Q4 a) Design flange coupling to connect the output shaft of an electrical motor to the shaft of centrifugal pump. The motor delivers a power of 20KW at 960rpm. The overall torque for motor is 18% higher of mean torque. 14
- b) Define stress concentration and discuss the various methods to reduce the effect of stress concentration. 06
- Q5 a) A horizontal nickel steel shaft rests on two bearings, A at the left and B at the right end and carries two gears C and D located at distances of 250 mm and 400 mm respectively from the centre line of the left and right bearings. The pitch diameter of the gear C is 600 mm and that of gear D is 200 mm. The distance between the centre line of the bearings is 2400 mm. The shaft transmits 20 kW at 120 r.p.m. The power is delivered to the shaft at gear C and is taken out at gear D in such a manner that the tooth pressure F_{IC} of the gear C and F_{ID} of the gear D act vertically downwards. Find the diameter of the shaft, if the working stress is 100 MPa in tension and 56 MPa in shear. The gears C and D weighs 950 N and 350 N respectively. The combined shock and fatigue factors for bending and torsion may be taken as 1.5 and 1.2 respectively. 14
- b) What is preferred number? Explain use of preferred number in engineering design? 06

- Q6 a) Select suitable standard hook for the lifting load of 110kN of trapezoidal cross section and find the stress induced at the most critical cross section of the hook. 12
- b) A rectangular steel plate is welded as a cantilever to a vertical column and supports a single concentrated load P , as shown in Figure. Determine the weld size if shear stress in the same is not to exceed 140 MPa. 08



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Sem - III - ~~BSGG~~ Mech

(3 Hours)

Max. Marks: 80

choice Based

Note:

1. Question 1 is Compulsory
2. Solve any three from remaining five
3. Figures to right indicate full marks
4. Assume suitable data if necessary

Q.1 Attempt any four

20

- a) Write element matrix equation in the following fields explaining each term:
 - i. 1D steady state, heat transfer by conduction
 - ii. Torsion Analysis
- b) Prove that linear triangular element is CST element.
- c) Explain different types of Boundary conditions with examples.
- d) Explain plane stress and plane strain conditions with examples.
- e) What do you mean by consistent mass matrix and lumped mass matrix. Give suitable mathematical expression?

Q.2

10

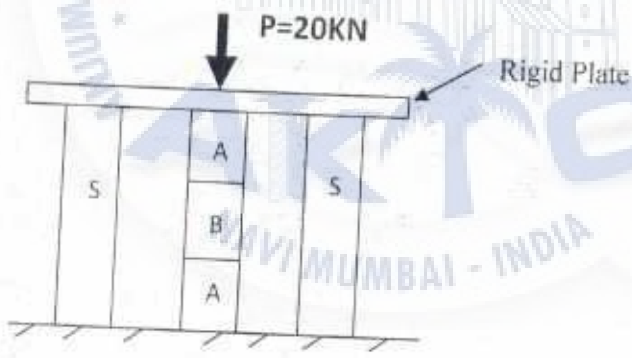
- a) Solve the following differential equation using Method of least square and Galerkin method.

$$\frac{d^2y}{dx^2} - 10x^2 = 5; 0 \leq y \leq 1; y(0) = 0, y(1) = 0$$

Compare answer with exact solution at x = 0.5

- b) Find the displacement at nodes and stresses over each element.

10



PROPERTIES	STEEL (S)	ALUMINIUM (A)	BRASS (B)
AREA, mm ²	200	370	370
E, N/mm ²	2x 10 ⁵	7x 10 ⁴	8.8x 10 ⁴
Length, mm	1000	350	300

- Q.3 a) A copper fin of diameter 2 cm, length 6 cm and thermal conductivity is $100 \text{ W/m}^\circ\text{C}$ and is exposed to ambient air at 30°C with a heat transfer coefficient $25 \text{ W/m}^2 \cdot ^\circ\text{C}$. If one end of the fin is maintained at temperature 500°C and other end is at 200°C . Solve the following differential equation for obtaining the temperature distribution over the length of a fin. 14

$$kA \cdot \frac{d^2\theta}{dx^2} - hp\theta = 0$$

$\theta =$ Temperature difference $= T_x - T_a$.

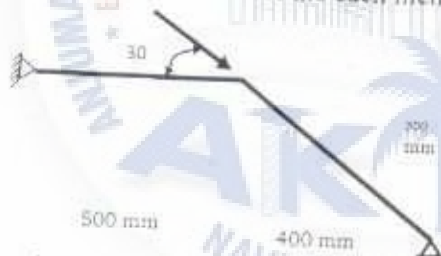
Use Rayleigh-Ritz method, mapped over general element, taking Lagrange's linear shape functions and three linear elements.

Write all the steps clearly. Compare your answer with exact at $x = 2, 4 \text{ cm}$

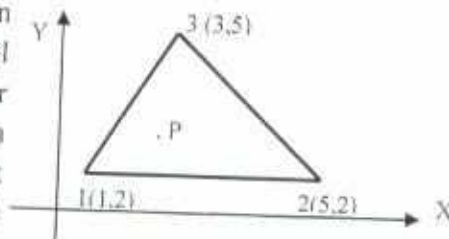
- b) For the iso parametric quadrilateral element shown in figure. Determine Cartesian coordinates of point P which has local coordinates $(\xi, \eta) = (0.57735, 0.57735)$. 6



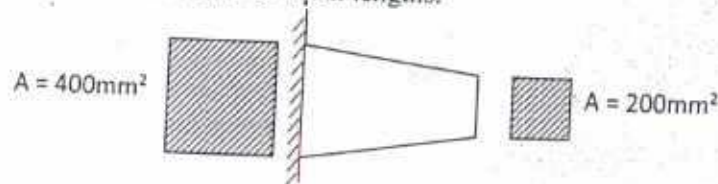
- Q.4 a) Compute the stress developed in the members of the truss shown in figure. $E = 200 \text{ GPa}$. Area of the each member is 200 mm^2 . 10



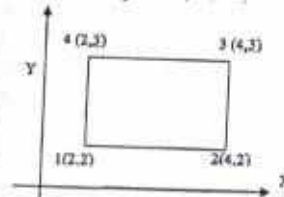
- b) The nodal coordinate of the triangular element are as shown in figure. Take the nodal displacement vector $Q^T = [2.0, 1.0, 3.0, 2.0, 5.0, 3.0]$ in mm. Obtain the displacement at the interior point P whose x and y coordinate is (1.5). 10



- Q.5 a) Evaluate the natural frequencies for the bar with varying cross sections shown in figure. $L = 200$ mm, $E = 200$ GPa and $\rho = 8000$ kg/m³. Consider two elements of equal lengths. 10

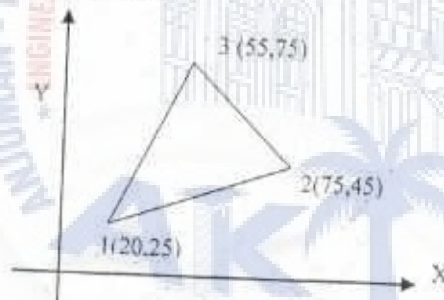


- b) Quadrilateral element is shown in figure. The temperatures at the nodes are $T_1=100^\circ\text{C}$, $T_2=60^\circ\text{C}$, $T_3=50^\circ\text{C}$ and $T_4=90^\circ\text{C}$ respectively. Determine the temperature at a point P (2.5, 2.5) 10



- Q.6 a) A CST element is shown in figure. The modulus of elasticity and Poisson's ratio for plate material are 70×10^3 N/mm² and 0.3 respectively. Upon loading of the plate, the nodal deflections were found to be in x and y direction respectively as $u_1 = 0.01$ mm and $v_1 = -0.04$ mm, $u_2 = 0.03$ mm and $v_2 = 0.02$ mm, $u_3 = -0.02$ mm and $v_3 = -0.04$ mm. Determine:

- i. The Jacobian for (x,y)-(ξ,η) transformation
- ii. The strain-displacement relation matrix
- iii. The stress in plate



- b) Explain Convergence criteria. What do you understand by h & p method of Finite Element Analysis? 08

(Time: 3 Hours)

(Total Marks: 80)

N.B.

1. Question no.1 is compulsory.
2. Attempt any *three* from question no. 2 to 6.
3. Use of Refrigerant Charts/Tables, Psychrometric charts, friction charts and steam tables are permitted

Q1) Attempt any *four*

- a) What are primary and secondary refrigerants? Explain the use of secondary refrigerant in Ice manufacturing plant. 05
- b) What all can you do to make your building a GREEN BUILDING? 05
- c) Why was the refrigeration and air conditioning regarded luxurious in the olden days? Is it luxurious now a days? Explain with examples in support of your arguments. 05
- d) Describe briefly the working principle of a Vortex Tube Refrigeration 05
- e) Explain the terms ODP & GWP. What are India's commitments in the Montreal Protocol? 05

Q2) a) Discuss the effect of evaporator and condenser pressure on standard vapour compression system using p-h chart. 08

b) The following data refer to a simple aircraft refrigeration system:

Ram Air temperature and pressure	: 30°C and 1 atm	12
Cabin air temperature and pressure	: 27°C and 1 atm	
Pressure at the exit of main compressor	: 4.5 bar	
ϵ = Heat Exchanger effectiveness cooling	: 0.8, $\eta_c = 0.84$, $\eta_e = 0.8$	
Load = 21kW		

Determine a) Tonnage, b) mass of air bled from main compressor for refrigeration, c) heat rejection, d) power, e) COP and f) power supplied to the blower.

Q3) a) A refrigeration system of 10TR capacity at an evaporator temperature of -12°C, needs a condenser temperature of 28°C. The refrigerant NH₃ is subcooled by 5°C before entering the expansion valve. The vapour is 0.95 dry when it leaves the evaporator. Using p-h chart for NH₃, find:

1. Condition of vapour at the outlet of compressor
2. Condition of vapour at the entrance of evaporator
3. C.O.P.
4. Power Required

b) Derive the expression for equivalent diameter of a circular duct for a rectangular duct, when the quantity of air passing through the rectangular and circular duct is same. 10

- Q4) a) Explain with schematic the working of Lithium-Bromide Water refrigeration system. 10
- b) Moist air at 30°C, 1.01325 bar has a relative humidity of 80%. Determine without using psychrometric chart. 10
1. Partial pressure of water vapour and air
 2. Specific humidity
 3. Specific volume and
 4. Dew Point Temperature
- Q5) a) An air conditioned auditorium is to be maintained at 27°C dry bulb temperature and 60% RH. The ambient condition is 40°C dry bulb temperature and 30°C wet bulb temperature. The total sensible heat load is 100000KJ/h and the total latent heat load is 40000kJ/h. 60% of the return air is recirculated and mixed with 40% of make-up air after the cooling coil. The condition of air leaving the cooling coil is at 18°C. Determine: 10
1. Room sensible heat factor
 2. The condition of air entering the auditorium
 3. The amount of make-up air
 4. Apparatus dew point
 5. BPF of cooling coil
- Show the process on the psychrometric chart.
- b) Explain the condition of human comfort. What are the factors effecting human comfort? 06
- c) Explain different types of Expansion devices 04
- Q6) Write short notes on *any four* 20
- a) Packaged Air Conditioners
 - b) Recent developments in variable refrigerant flow systems
 - c) Recent substitutes for refrigerants
 - d) Performance assessment parameters for cooling towers
 - e) BEE Star rating program

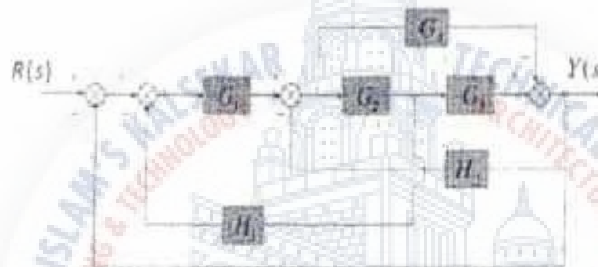
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(Time: 3 Hours)

[Total marks: 80]

- N.B.: 1. Question No.1 is Compulsory
 2. Attempt any three questions out of the remaining five questions.
 3. Assume suitable data if required.
 4. Figures to the right indicate full marks to that question.
 5. Support your answers with appropriate sketches wherever required.

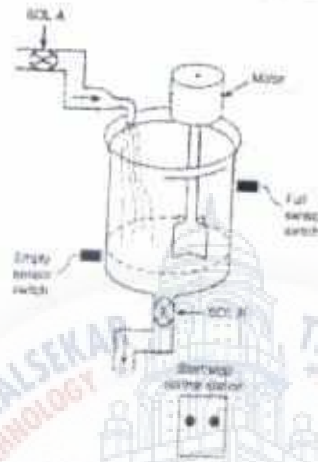
- Q1** a. Explain the architecture of mechatronics system with neat block diagram. 5
 b. Explain the classification of pressure sensor used in systems depending on range i.e. low, medium & high pressure measurement. 5
 c. Explain with neat sketch architecture of PLC. 5
 d. Write short note on FRL unit. 5
- Q2** a. Reduce following block diagram to simplified form 8



- b. Explain working of brushless DC motors (BLDC). 6
 c. Write note on Signal Filters - Low pass, High Pass and Band Pass with circuit diagrams in detail. 6
- Q3** a. Two double acting pneumatic cylinders A, B are selected for an industrial application. The sequence of movement for piston of the cylinder is proposed as below—
 Delay A+ B+ (AB)-
 Develop the electro pneumatic circuit using 5/2 double solenoid as final directional control valves. The piston motions mentioned in bracket is simultaneous. Design for user option single cycle & multi cycle. 10
- b. For the unity feedback system having transfer function as follows 10
 Determine
 1. Damping ratio & natural frequency
 2. Rise time, Peak time, settling time
 3. Peak Overshoot

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

- Q4 a.** A process control system illustrated in figure. The sequence of operation is to be as follows 15
- when start button is pressed solenoid A energizes to start filling
 - As the tank fills, empty level sensor switch closes also solenoid A de-energized
 - then motor starts automatically and runs for 5 min to mix liquid
 - when motor stops, solenoid B is energized to empty the tank.
- Develop a PLC ladder logic diagram for the sequential tasks.



- b.** What is aliasing? Explain Nyquist sampling theorem in detail 5

- Q5 a.** Explain with neat sketch classification of stepper motors with its applications, advantages & disadvantages. 10

- b.** A system has $G(s)H(s)$ as given below, Draw root locus & comment on stability of a system. 10

$$G(s)H(s) = \frac{s+3}{s^2-s-2}$$

- Q6** Write short note on (5 marks each) 20
- a. Parameters to be considered for selection of actuators 5
 - b. Accumulators used in hydraulic circuits 5
 - c. Explain successive approximation A/D convertor. 5
 - d. Define Mechatronics & explain applications of Mechatronics domestic, industrial one example each. 5