

Total Marks: 80

Duration: 3 Hours

N.B.:-

1. Question No.1 is compulsory
2. Solve any three out of remaining questions
3. Assume suitable data if required and mention it clearly
4. Figures to right indicate full marks

- |    |   |    |
|----|---|----|
| Q1 | A] How will maintain compromise between quality and cost?                                 | 5  |
|    | B] Differentiate between primary and tertiary standards?                                  | 5  |
|    | C] Explain concept of flatness.   | 5  |
|    | D] Explain importance of surface conditions   | 5  |
| Q2 | A] Explain construction and working of any one mechanical comparator                      | 10 |
|    | B] Explain following terms with respect to limit, fit and tolerances:-                    | 10 |
|    | 1) Upper deviation  |    |
|    | 2) Lower deviation  |    |
|    | 3) Fundamental Deviation  |    |
|    | 4) Tolerance grades   |    |
|    | 5) Clearance Fit  |    |
| Q3 | A] Explain Taylor Hobson surface roughness measuring instrument in detail                 | 10 |
|    | B] Explain different quality costs  | 10 |
| Q4 | A] Explain Principle, Construction and working of Parkinson's Gear tester.                | 10 |
|    | B] Explain following:-  | 10 |
|    | 1. Pie Charts   |    |
|    | 2. Bar Charts   |    |
|    | 3. Scatter Diagrams   |    |
| Q5 | A] Explain three wire method used in screw thread measurement.                            | 10 |
|    | B] Explain following:-  | 10 |
|    | 1. R -Chart   |    |
|    | 2. P-Charts   |    |
|    | 3. np charts  |    |
|    | 4. X bar charts   |    |
| Q6 | A] Explain construction and working of Tool Maker's Microscope                            | 10 |
|    | B] Sketch OC curve and explain various elements of it. Also explain double sampling plans | 10 |

Q.P.Code:13216

(3 Hours)

Total Marks:80

- Question No. 1 is compulsory.
- Attempt any three questions from the remaining.
- Assumption made should be clearly stated.
- Use of standard Design Data Book by PSG, Mahadevan is permitted.

- Q.1 Answer any **four** of the following 20
- (a) 'Ergonomic is compromise in order to achieve performance and aesthetic' explain this statement with example.
- (b) Explain mechanism of fatigue failure in ductile and brittle material.
- (c) Explain overhauling of screw and self-locking of screw.
- (d) What is surge in spring? How it can be eliminated.
- (e) What is the necessity of theories of failures? Name different theories of failures.
- Q.2 (a) Why the cotter in the Cotter joint is kept as weakest part, explain. 4
- (b) A knuckle joint is to be design to connect two Mild Steel bars under a tensile load of 150 KN. The allowable stresses are 75Mpa in tension, 50Mpa in shear and 150 Mpa in crushing. (Assume empirical relations as Diameter of knuckle pin  $d_1 = d$ , Outer diameter of eye  $d_2 = 2d$ , diameter of knuckle pin head and collar  $d_3 = 1.5d$ , thickness of single eye  $t = 1.25d$ , thickness of fork  $t_1 = 0.75d$ , thickness of pin head  $t_2 = 0.5d$ )
1. Draw neat sketch of knuckle joint. 3
  2. Find the diameter of the rod (d). 2
  3. Using empirical find all dimensions. 3
  4. With neat sketches for failure cross section areas check all components under different failures. 8

Turn Over

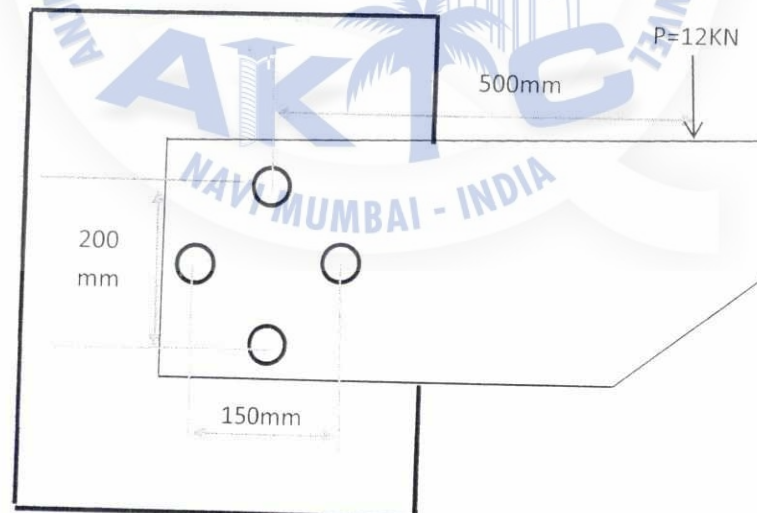
Q.P.Code:13216

- Q.3 (a) Show the variation of the tangential stress and radial stress across the cylinder thickness and derive the Lames equation for the thickness of thick cylinder subjected to an internal pressure only. 5
- (b) A horizontal shaft transmitting 20KW at 120 rpm is supported at the bearing at A at the left end and B at the right end which are 2400mm apart. Gear C and gear D located at a distance of 250mm and 400mm from the Centre line of left and right bearing respectively. The PCD of gear C and D are 600mm and 200mm. The tangential force of the gear C and D are act vertically downward. The weight of gear C and D are 950N and 350N respectively. The combined shock and fatigue factors for bending and torsion are 1.5 and 1.2 respectively. Find the diameter of the shaft if the design stress is 100MPa in tension and 60MPa in shear. 15
- Q.4 (a) Design a bush pin type flexible coupling to connect a electric motor with the shaft of centrifugal pump. The motor delivers a power of 20KW at 960 rpm. The diameter of the motor and pump shaft 40mm. Allowable bearing pressure in the rubber bush is  $0.45 \text{ N/mm}^2$ . Select standard key and check it for shear and crushing failure. 12
- (b) Design a Helical valve spring for an operating load range of 600N to 1200N. 08  
The compression at the maximum load is 25mm. Take the spring index 6 and permissible endurance shear stress for the spring material as 480Mpa and yield stress in shear is 960MPa and  $G = 80\text{KN/mm}^2$ .

Turn Over



- Q.5 (a) Explain the following terms related to the design of machine elements 10  
subjected to the variable loads.
1. Notch sensitivity
  2. Endurance limit
  3. Surface finish factor
  4. Size factor
  5. Stress concentration factor
- (b) The circular rod is subjected to 700kN tensile to 300kN compressive varying 10  
axial load. Find the diameter of the rod using Soderberg criteria and assuming  
following data. Endurance limit = 280MPa, tensile yield strength = 350MPa,  
factor of safety = 2, correction factor for loading = 0.7, surface factor = 0.8, size  
factor = 0.85, stress concentration factor = 1.
- Q.6 (a) Select suitable standard hook for the lifting load of 110kN of trapezoidal cross 10  
section and find the stress induced at the most critical cross section of the hook.
- (b) A bracket is supported by four rivets of equal diameter as shown to support a 10  
load of 12kN. Determine the size of the rivet taking the permissible shear stress  
as 60MPa.



Q. P. Code: 27652

[Total Marks : 80]

(3 Hours)

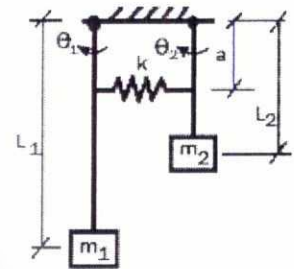
N.B: 1. Question No.1 is compulsory

2. Attempt **any three** from the remaining five questions

3. Assume suitable data wherever required with proper justification

1. Attempt **any four** of the following. All sub-questions carry equal marks. 20

- (a) An instrument has a natural frequency of 8 Hz. It can withstand a maximum acceleration of  $10 \text{ m/s}^2$ . Determine—angular frequency, displacement amplitude, and maximum velocity.
- (b) It is required to design a viscous damper. On what factors does the damping coefficient  $c$  depend? Explain briefly.
- (c) State the general form of Lagrange's Equation for free, undamped, multi-degree of freedom vibration system for a generalized coordinate  $x_i$  for  $i^{\text{th}}$  d.o.f. For the given double pendulum system, write the expressions for total kinetic energy and total potential energy.

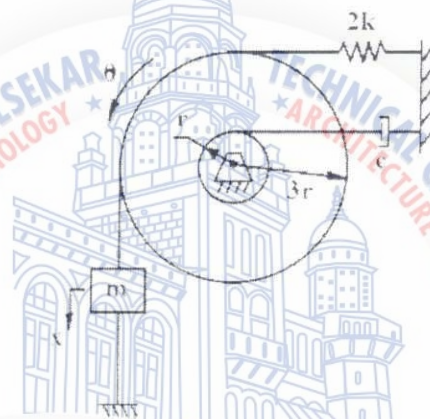


- (d) Derive the expression for obtaining peak frequency ratio for the case of frequency-squared excitations. What is the range of values of damping ratio  $\zeta$  for the peak to occur?
- (e) An undamped vibration pick-up having a natural frequency of 1 Hz is used to measure a harmonic vibration of 4 Hz. If the amplitude recorded is 0.52 mm, what is the correct amplitude?
- (f) Four holes are drilled in a uniform circular disc at a radius of 100 mm and angles of  $0^\circ$ ,  $60^\circ$ ,  $120^\circ$  and  $180^\circ$ . The mass removed at holes 1 and 2 is 100 gm each and the mass removed at holes 3 and 4 is 125 gm each. If the disc is to be balanced statically by drilling a fifth hole at a radius of 125 mm, find the mass to be removed and the angular location of the fifth hole.
2. (a) A water tank column is 100 m high and is made of reinforced concrete with a tubular cross section of inner diameter 2.5 m and outer diameter 3 m. The tank weighs 270 tonnes when filled with water. By neglecting the mass of the column and assuming the Young's modulus of reinforced concrete as  $2.76 \times 10^{10} \text{ N/m}^2$ , determine—(i) the natural time period of transverse vibration of the water tank (ii) the vibration response of the water tank due to an initial transverse displacement of 25 cm, and (iii) the maximum values of the velocity and acceleration experienced by the water tank. 10
- (b) A 75 kg machine is mounted on springs of stiffness  $11.76 \times 10^5 \text{ N/m}$  with 0.2 as damping ratio. A 2 kg piston within the machine has reciprocating motion with a stroke of 0.08 m and a speed of 3000 r.p.m. Assuming the motion of the piston to be simple harmonic, determine—(i) the amplitude of motion of the machine, and (ii) its phase angle with respect to the exciting force. 10



## Q. P. Code: 27652

3. (a) A body of mass 2 kg lies on a dry horizontal plane and is connected to a rigid support through an inclined spring of stiffness 200 N/m. The spring has its own mass of 600 grams. The mass is displaced from the unstressed position by an amount equal to 0.25 m, and then released with zero velocity. How long will the body vibrate and at what distance from the unstressed position will it stop if the coefficient of friction is 0.25? 10
- (b) An accelerometer is constructed by suspending a mass of 0.1 kg from a spring of stiffness 10,000 N/m with negligible damping. When mounted on the foundation of an engine, the peak-to-peak travel of the mass of the accelerometer has been found to be 10 mm at an engine speed of 1000 rpm. Determine the maximum values of displacement, velocity, and acceleration of the foundation. 10
4. (a) Using  $x$  as the generalized coordinate, determine the following system's equivalent parameters. 8



- (b) Four masses A, B, C and D as shown below are to be completely balanced. 8

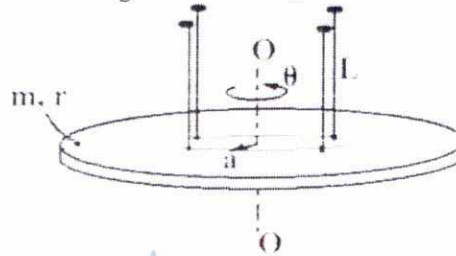
Masses (kg)	$m_A$	$m_B = 30$	$m_C = 50$	$m_D = 40$
Radius (mm)	180	240	120	150

The planes containing masses B and C are 300 mm apart. The angle between planes containing B and C is  $90^\circ$ . B and C make angles of  $210^\circ$  and  $120^\circ$  respectively with D in the same sense. Find—(i) the magnitude and the angular position of mass A, and (ii) the position of planes A and D.

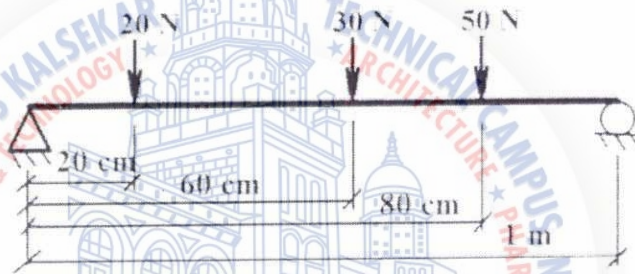
- (c) Name the methods available for the frequency analysis of the systems with several degrees of freedom. 4
5. (a) The reciprocating mass, crank-radius, and connecting-rod length of each of the cylinders in a two-cylinder in-line engine are given by  $m$ ,  $r$ , and  $l$ , respectively. The crank angles of the two cylinders are separated by  $180^\circ$ . Find the unbalanced forces and couples in the engine. Assume that the reference plane is placed mid-way between the two cylinders. 10
- (b) An engine is mounted on a rigid foundation through four springs. During operation, the engine produces an excitation force at a frequency of 3000 rpm. If the weight of the engine causes the springs to deflect by 10 mm, determine the reduction in the force transmitted to the foundation. 10

Q. P. Code: 27652

6. (a) A circular disc of mass  $m$  and radius  $r$  is suspended freely by four taut massless strings of the same length  $L$ , at radius  $a$  from the polar axis and at equal angular intervals, as shown in the figure below. The disc is disturbed (rotated) slightly about the polar axis. Derive the differential equation of resulting motion using Newton's method, assuming small  $\theta$ . 5



- (b) The natural frequency of transverse vibration of beam in figure below is 20 rad/s. Find the natural frequency of vibration if another 50 N load is added at 40 cm from the left support. 15



Influence coefficient for simply supported beam can be calculated from the formula—

$$u_{ij} = \frac{S_i Z_j (l^2 - S_i^2 - Z_j^2)}{\text{constant}} = u_{ji}$$

where,  $S_i$  is the distance of node  $i$  from the left support, and  $Z_j$  is the distance of node  $j$  from the right support.

## NOTE:

- Question No 1 is **COMPULSORY**.
- Attempt any **THREE** questions from question number 2 to 6.
- Assume suitable data wherever required.
- Illustrate answers with sketches wherever required.
- Use of steam table is permitted.

- Qu.1. Solve any four. 20
- Define equivalent evaporation of boiler. Distinguish between boiler mounting and accessories with examples.
  - What is the role of fusible plug in boiler? Explain working of fusible plug with neat diagram.
  - Classify different types of steam turbine.
  - Explain the nozzle efficiency and its significance.
  - Explain the working of a turboprop engine by means of a sketch.
- Qu. 2 a) The following observations were made on a boiler plant during one hour test. Steam pressure = 20 bar; Steam Temperature = 260°C; Steam generated = 37500 Kg; Temperature of water entering the economizer = 15°C; Temperature of water leaving the economizer = 90°C; Fuel used = 4400 Kg; Calorific value of fuel = 33000 kJ/kg. Calculate: i) The equivalent evaporation per kg of fuel; ii) Thermal efficiency of plant; iii) The percentage heat energy of the fuel energy utilized by the economiser. 12
- Qu. 2 b) Describe the governing mechanism of reaction turbine with a neat sketch. 08
- Qu. 3 a) A 50% reaction turbine (with symmetrical velocity triangle) running at the 400 rpm has the exit angle of the blades as 20° and velocity of the steam relative to the blades at the exit is 1.35 times the mean blade speed. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m<sup>3</sup>/kg, calculate for this stage :i) Suitable blade height, assuming the rotor mean diameter 12 times the blade height; ii) the diagram work. 10
- Qu. 3 b) Draw the layout of modern high pressure boiler and explain the unique features of this boiler compared to low pressure boiler. 10
- Qu. 4 a) Define Thomas cavitation coefficient and explain in conjunction with cavitation characteristics of rotodynamic projects. 10
- Qu. 4 b) What is NPSH? What is the difference NPSH available and NPSH required? 10



Q.P. Code: 25734

- Qu. 5 a) Obtain the expression for the force exerted by a jet of water on a fixed curved plate when jet strikes at the centre of symmetrical curved plate 10
- Qu. 5 b) Enumerate the various uses of gas turbine. Describe with neat sketch, working of simple constant pressure closed cycle gas turbine. 10
- Qu. 6 a) In a constant pressure open cycle gas turbine air enters at 1 bar and  $20^{\circ}\text{C}$  and leaves the compressor at 5 bar. Using the following data: Temperature of gases entering the turbine =  $680^{\circ}\text{C}$ , pressure loss in the combustion chamber = 0.1 bar, compressor efficiency = 85%, turbine efficiency = 80%, Combustion efficiency = 85%,  $\gamma = 1.4$  and  $C_p = 1.024$  kJ/kgK for air and gas, find a) The quantity of air circulation if the plant develops 1065 kW, b) Heat supplied per kg of air circulation c) The thermal efficiency of the cycle. Mass of the fuel may be neglected. 12
- Qu. 6 b) Explain the working of a turboprop engine by means of sketch. 08



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Q.P. Code : 27639

[Time: 3 Hours]

[Marks: 80]

Please check whether you have got the right question paper.

- N.B:
1. **Question No.1 is compulsory**
  2. Attempt any **three** questions out of remaining **five** questions
  3. Figures to right indicate full marks
  4. Assume suitable data if **necessary**
  5. Notations carry usual meaning

- Q.1 (A) Explain the following (Any Four) 05
- 1) Piezoelectric drive
  - 2) Universal Asynchronous Receiver and Transmitter (UART)
  - 3) Voice-coil actuator
  - 4) Data loggers
  - 5) CNC Machines
- Q.2 (A) With neat sketch explain the constructional feature and working of pressure relief valve used in hydraulic system 05
- (B) Describe possible speed control strategies of A.C. Induction motors 05
- (C) Write a short note on servo amplifier for DC motors 10
- Q.3 (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— 12
- (AB)+ Delay B+ A-**  
Develop the electro-pneumatic circuit using 5/2 double solenoid as final directional control valves. The piston motions mentioned in bracket is simultaneous.
- (B) Explain impedance matching for a part of electro-mechanical system that consists of transmission of power using motor-gear drive system. 08
- Q.4 (A) Explain input and output components (typically sensors and actuators) used in Car Engine Management System. 10
- (B) With neat diagrams illustrate the working of Filter-Regulator- Lubricator (FRL) unit in a pneumatic system 05
- (C) Differentiate between Serial communication and parallel communication interface. 05
- Q.5 (A) A conveyor motor is required to program using a PLC in a process line based on the number of 10 bottles coming off the conveyor as shown in Figure 1.A photo-sensor is used to sense the passage of the bottle. Develop a PLC ladder logic diagram for the following sequential tasks
- i) The start pushbutton can be pressed to start the conveyor
  - ii) Bottles move past the photo-sensor and the conveyor motor stops automatically after a count of 25 bottles.

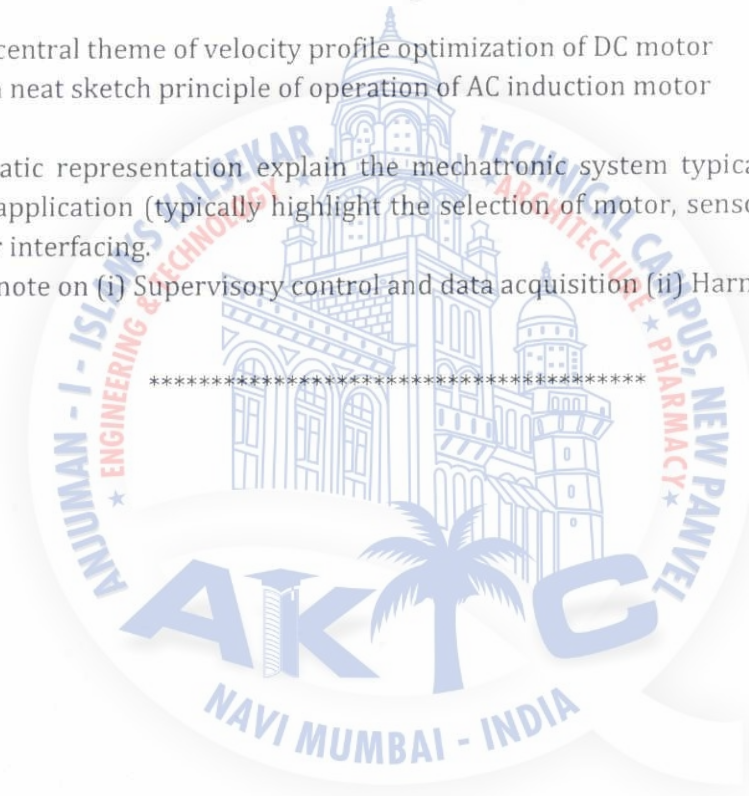
Q.P. Code : 27639

iii) The counter is to be reset to zero after 25 counts  
 The accumulated count of the counter is reset manually by means of the count reset button



- (B) Explain the central theme of velocity profile optimization of DC motor 05  
 (C) Explain with neat sketch principle of operation of AC induction motor 05

- Q.6 (A) With schematic representation explain the mechatronic system typically used in robot for 10  
 firefighting application (typically highlight the selection of motor, sensors and switches. Also  
 discuss their interfacing.  
 (B) Write short note on (i) Supervisory control and data acquisition (ii) Harmonic drive 10





13

Q. P. Code: 24911

(3 Hours)

Max. Marks: 80

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

Question No.		Max. Marks
Q.1	a) Write short note on Advantages and limitations of Finite Element Method	20
	b) Derive shape function for 1D quadratic element in natural co-ordinates.	
	c) Explain plane stress and plane strain conditions with figure.	
	d) Elaborate convergence with example.	

Q.2	a) The governing differential equation for the steady state one dimensional conduction heat transfer with internal heat generation is given by	10
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$$\frac{d}{dx} \left[ k \frac{dT}{dx} \right] = q \text{ for } 0 \leq x \leq L$$

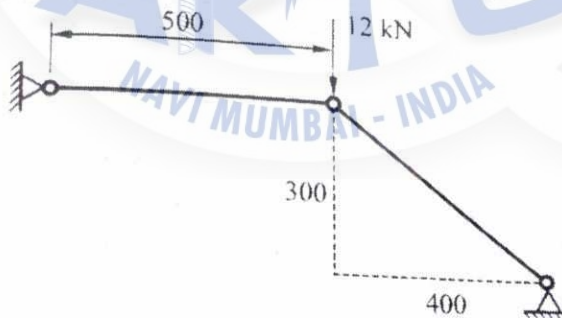
where

k = coefficient of thermal conductivity of the material,

q = internal heat generation

Develop the finite element formulation for linear element. Use Rayleigh Ritz method, mapped over general element.

b)	For the two bar truss as shown in fig, determine the nodal displacements and stress in each member. Take E = 70 GPa and area for both members = 200 mm <sup>2</sup> .	10
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Q.3	a) Solve following differential equation by Galerkin method.	10
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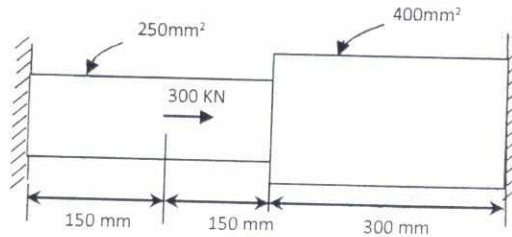
$$\frac{d^2u}{dx^2} + u = x^2, 0 \leq x \leq 1$$

Given Boundary Conditions are:  $u = 0$  at  $x = 0$ ,  $\frac{du}{dx} = 1$  at  $x = 1$

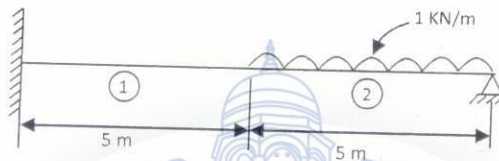
Find values for  $u(0.3)$  &  $u(0.6)$

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- b) Find the displacement, stresses and strain in the elements of stepped bar as shown in figure. Take  $E = 200\text{GPa}$ . 10

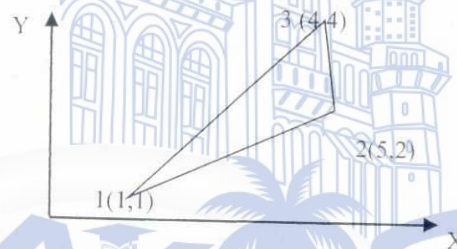


- Q.4 a) Find the deflection and slopes at nodes and reactions at supports for the beam as shown in figure. Take  $E = 200\text{ GPa}$ ,  $I_1 = 2 \times 10^7\text{ mm}^4$  and  $I_2 = 1 \times 10^7\text{ mm}^4$ . 12



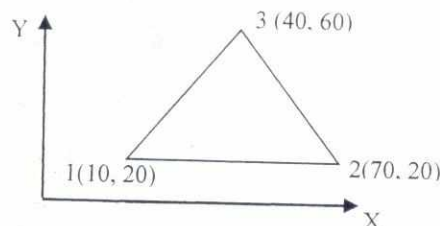
- a) Derive shape function in natural coordinate system for eight noded quadrilateral element. 08

- Q.5 a) A linear interpolation functions for a triangular element as shown in figure. 10



- b) Find the two natural frequencies of transverse vibrations of a beam fixed at both ends. Use Lumped mass matrix. Assume length of beam as 1 unit,  $EI = 10^6$  units,  $\rho A = 10^6$  units. 10

- Q.6 a) Evaluate the stiffness matrix for the CST element shown below. 10  
Coordinates are given in mm. Assume plane stress condition.  
Thickness = 10mm,  $E = 200\text{ GPa}$  and  $\nu = 0.3$ .



- b) Explain significance of Jacobian matrix. Derive for CST element. 10

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