T.E / Sem VI / Mech & Auto / CBSGS / M.D-2 / 2 11 19 1

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 $d3 = 1.5d$, 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.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 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. 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 = 80KN/mm^2. 08

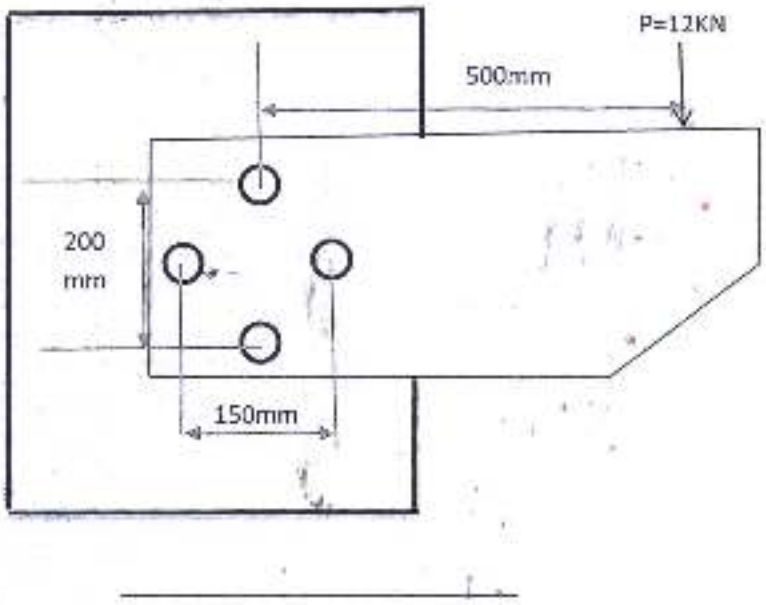
Q.5 (a) Explain the following terms related to the design of machine elements subjected to the variable loads. 10

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 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. 10

Q.6 (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. 10

(b) A bracket is supported by four rivet of equal diameter as shown to support a load of 12KN. Determine the size of the rivet taking the permissible shear stress as 60MPa. 10



T.E / Mech Auto / Sem VI / CBSGS / MV / 04/2023

Q. P. Code: 27652

(3 Hours) [Total Marks : 80]

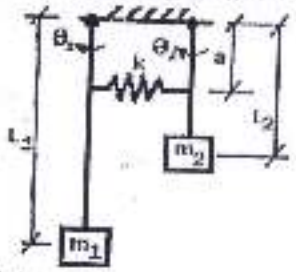
N.B : 1. Question No.1 is compulsory
2. Attempt any three from the remaining five questions
3. Assume suitable data wherever required with proper justification.

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 m/s². 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^{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 ζ 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°, 60°, 120° and 180°. 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.

(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 2.76×10^{10} N/m², 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 11.76×10^5 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

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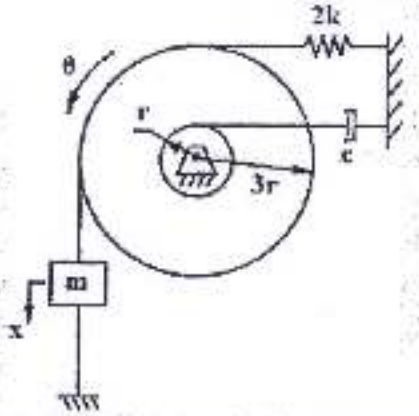
(a) A body of mass 2 kg lies on a dry horizontal plane and is connected to a rigid support through an inclined spring of stiffness 200 N/m. The spring has its own mass of 600 grams. The mass is displaced from the unstressed position by an amount equal to 0.25 m, and then released with zero velocity. 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

(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°. B and C make angles of 210° and 120° 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

(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°. 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

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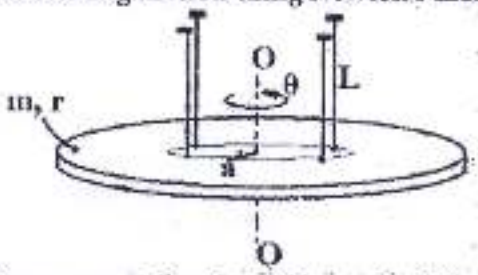
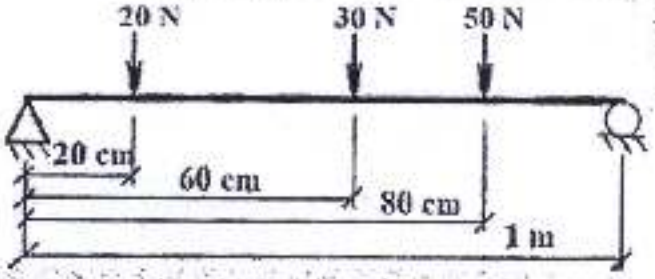
6. (a) A circular disc of mass **m** and radius **r** is suspended freely by four taut massless strings of the same length **L**, at radius **a** from the polar axis and at equal angular intervals, as shown in the figure below. The disc is disturbed (rotated) slightly about the polar axis. Derive the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

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

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.

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Q.P. Code: 25734

(3 Hours) [Total Marks: 80

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

a) Define equivalent evaporation of boiler. Distinguish between boiler mounting and accessories with examples.

b) What is the role of fusible plug in boiler? Explain working of fusible plug with neat diagram.

c) Classify different types of steam turbine.

d) Explain the nozzle efficiency and its significance.

e) 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 stemma flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m^3/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

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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°C and leaves the compressor at 5 bar. Using the following data: Temperature of gases entering the turbine = 680°C, pressure loss in the combustion chamber = 0.1 bar, compressor efficiency = 85%, turbine efficiency = 80%, Combustion efficiency = 85%, γ = 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: 018192

Duration: 3 Hours Total Marks: 80

N.B: (1) Question No.1 is compulsory.
(2) Attempt any three questions out of the remaining five.
(3) Assume suitable data if necessary but justify the same.
(4)Figures to the right indicate full marks.

Q1. Attempt any four. (20)

A. Solve the following L.P. problem using graphical method.

Maximise $Z = 2x_1 + 5x_2$

Subject to, $x_1 + x_2 \leq 30$

$x_1 \geq 3$

$x_2 \leq 12$

$x_1 - x_2 \geq 0$

$0 \leq x_1 \leq 20$

B. Find the initial basic feasible solution to the transportation problem using row minima method.

		To			Available
		5	2	4	3	22
		4	8	1	6	15
From		4	6	7	5	8
Requirement		7	12	17	9	

C. Solve the following assignment problem. The matrix entries are processing time in hours.

		Operators				
		A	B	C	D	E
	1	11	17	8	16	20
	2	9	7	12	6	15
Jobs	3	13	16	15	12	16
	4	21	24	17	28	26
	5	14	10	12	11	13

TURN OVER

D. A bank has only one typist. Since the typing work varies in length the typing rate is randomly distributed approximating a Poisson distribution with mean service rate of 8 letters per hour. The letters arrive at a rate of 6 per hour during the entire 8 hour work day. If the type writer is valued at Rs. 30 per hour, determine:

1. Equipment utilization.
2. Average cost due to waiting on the part of typewriter.
3. Write a note on resource leveling.

E. Write a note on resource leveling.

Q 2. A. A project duration has following characteristics:

Activity	1-2	1-3	2-4	2-6	3-4	3-5	4-5	5-6
t_o (weeks)	1	5	3	1	8	2	5	2
t_m (weeks)	4	10	3	4	15	4	5	5
t_p (weeks)	7	17	3	7	26	8	5	8

Construct a PERT network. Find critical path and variance for each event. Find the project duration at 95% probability. **(10)**

B. A gambler at a horse race is considering placing a bet on a specific horse. There are four possible alternatives and four states of nature with the following pay-offs: **(10)**

Strategies	**States of nature**			
	A wins	*B wins*	*C wins*	*All lose*
Bet A	7	-2	-2	-2
Bet B	-3	3	-2	-2
Bet C	2	-2	2	-2
Do not bet	0	0	0	0

(a) What is the maximin strategy?
(b) What is the minimax strategy?
(c) What strategy should be selected as per Hurwicz criterion with α = 0.5?
(d) What strategy should be selected as per Laplace criterion?

Q4. A. Solve the following L.P. problem using Big-M method. (10)

Maximize $z = -2x_1 - x_2$

subject to $3x_1 - x_2 \geq 3$

$4x_1 + 3x_2 \leq 6$

$x_1 + 2x_2 \leq 4$

where $x_1, x_2 \geq 0$

B. A complex airborne navigating system incorporates a subassembly which unrolls a map of the flight plan synchronously with the movement of the aeroplane. This assembly is bought on very good terms from a subcontractor, but is not always in perfect adjustment on delivery. The subassemblies can be readjusted on delivery to guarantee accuracy at a cost of Rs. 50 per subassembly. It is not, however, possible to distinguish visually those subassemblies that need adjustment.

Alternatively, the subassemblies can each be tested electronically at a cost of Rs. 10 per subassembly tested. Past experience shows that about 30% of those supplied are defective; the probability of the test indicating a bad adjustment when the subassembly is faulty is 0.8, while the probability that the test indicates a good adjustment when the subassembly is properly adjusted is 0.7. If the adjustment is not made and the subassembly is found to be faulty when the system has its final check, the cost of subsequent rectification will be Rs. 140.

Draw up an appropriate decision tree to show the alternatives open to the purchaser and use it to determine his course of action. (10)

Q3. A. Find the optimum solution the following transportation problem, in which cell entries represent unit costs. (10)

From \ To				Available
	2	7	4	5
	3	3	1	8
	5	4	7	7
	1	6	2	14
Required	7	9	18	

B. For a given network data, draw the network, determine the total float, independent and interfering floats and identify the critical path. (10)

Activity	0-1	1-2	1-3	2-4	2-5	3-4	3-6	4-7	5-7	6-7
Duration	2	8	10	6	3	3	7	5	2	8

Q5. A. Solve the following (2 x 3) game graphically. (8)

		Player B		
		I	II	III
Player	I	1	3	11
	II	8	5	2

B. Solve the following game using dominance principle. Solve it optimally. (6)

		Player B					
		1	2	3	4	5	6
	1	4	2	0	2	1	1
Player A	2	4	3	1	3	2	2
	3	4	3	7	-5	1	2
	4	4	3	4	-1	2	2
	5	4	3	3	2	2	2

C. Explain the various costs associated with an inventory? (6)

6. A. Solve the following L.P. problem using Simplex method. (8)

Maximise $Z = 2x_1 + x_2$

Subject to, $x_1 + 2x_2 \leq 10$

$x_1 + x_2 \leq 6$

$x_1 - x_2 \leq 2$

$x_1 - 2x_2 \leq 1$

Where $x_1, x_2 \geq 0$

B. A sandwich maker has the following probabilities of selling the sandwiches in a day. Cost of making a sandwich is Rs. 12 and sales price is Rs. 20. He cannot sell the unsold sandwiches on next day as they get perished. How many sandwiches he should make? (6)

No. of sandwiches sold	Probabilities
80	0.12
82	0.16
84	0.22
86	0.28
88	0.32

C. What is simulation? List its various advantages & applications of the simulation. (6)

TE / MECH & AUTO / 63565 / FEA / 21-12-17 Supplementary

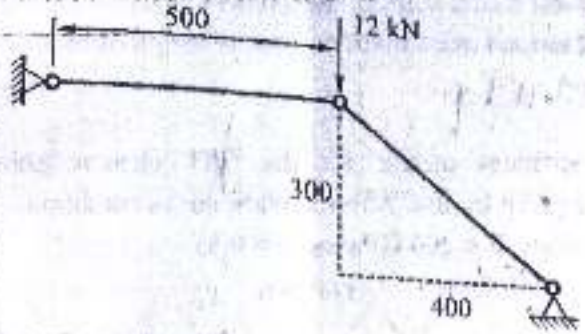
Rem - VI

Q. P. Code: 24911

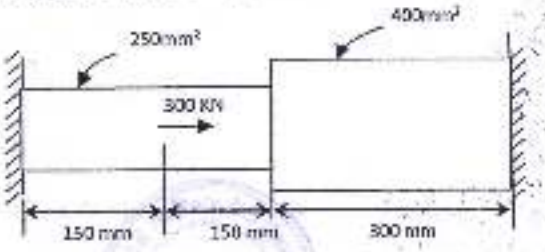
(3 Hours) Max. Marks: 80

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 $\frac{d}{dx}\left[k\frac{dT}{dx}\right]=q$ for $0 \le x \le L$ 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.	10
	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^2. 	10
Q.3	a)	Solve following differential equation by Galerkin method. $\frac{d^2u}{dx^2}+u=x^2, 0 \le x \le 1$ 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)	10

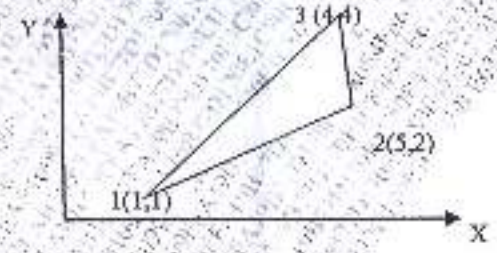
b) Find the displacement, stresses and strain in the elements of stepped bar as shown in figure. Take E = 200GPa. 10



Q.4 a) Find the deflection and slopes at nodes and reactions at supports for the beam as shown in figure. Take E = 200 GPa, $I_1 = 2 \times 10^7$ mm⁴ and $I_2 = 1 \times 10^7$ mm⁴. 12

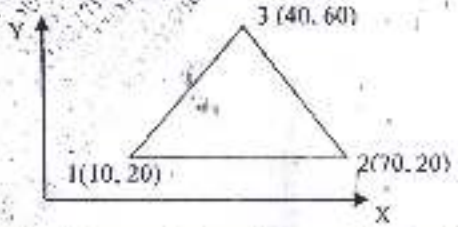
a) Derive shape function in natural coordinate system for eight nodded quadrilateral element. 08

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 1unit, $EI = 10^6$ units, $\rho A = 10^6$ units. 10

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



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

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TE/SEM VI/ Auto/ CBSGS/ AS/ 21/ 11717-

T0526 / T0884 AUTOMOTIVE SYSTEM

Q.P. Code : 13448

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

N.B: (1) **Question no 1** is compulsory.

(2) Attempt **any three** out of remaining **five** questions.

(3) Draw neat and labelled diagrams wherever necessary.

Q.1 Answer the following questions:

a) Explain clutch centre plate construction with neat diagram. 05

b) What is double declutching? Why is it necessary and explain the gearbox in which it is used. 05

c) What are components of Drive lines? Sketch and explain the working of Universal Joint and Constant Velocity Joints. 05

d) Explain Rack and Pinion steering gear box with neat diagram. 05

Q.2 a Explain Coil spring and Diaphragm type clutch with neat sketch for each. 10

b Explain fluid flywheel/coupling & Torque converter with respect to working, construction and application along with neat diagram. 10

Q.3 a Explain working of clutch control systems with neat labeled diagram. 10

b Explain Rear Axle drives in brief with neat diagrams. 10

Q.4 a Explain minimum 5 terms related to Front end/Steering Geometry with neat diagram for each. 10

b Explain need of differential in automobiles. Also explain working of simple open differential with neat labelled diagram. 10

Q.5 a Sketch and explain working of Transfer case and Transaxle. 10

b Explain hydraulic brake system and air brake system with neat and labelled diagram. 10

Q.6 Write short note on:

a) Mc pherson strut type suspension. 05

b) Radial and Cross ply type tire construction 05

c) Types of Rear Axle casings. 05

d) Over drive and Tandem axle drives. 05