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BHARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

Munshi Nagar, Andheri (West), Mumbai 400 058

(A Government Aided Autonomous Institute)

Kt-exam Jun-2017 **ME403 – Finite Element Analysis**

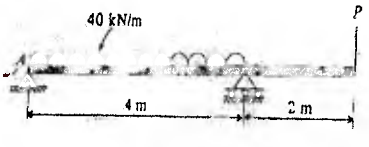
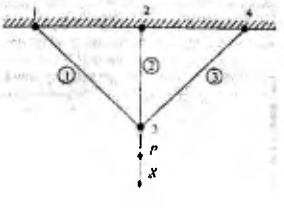
Class/sem: Final year B. Tech. (Mechanical)/ VII

Duration: 4 hours, Marks: 100

MASTER FILE.

Note:

- **Question No 1 is compulsory**
- **Attempt any four questions out of remaining six.**
- Assume suitable data if required and state it clearly.
- Answers to all sub-questions should be grouped together.

Q.no		Max. Mar	Module	COs
1	Answer the following:			
	a) For a quadratic bar of length 'L', show that if nodes are uniformly distributed then jacobian is 'L/2'.	5		
	b) What are the mesh revision methods? Elaborate with suitable sketch.	5		
	c) What do you mean by CST element? Discuss.	5		
	d) What is the use of natural coordinates in FEM?	5		
2	a) A bar is suspended vertically under its self-weight, find out the expression for deformation using Galerkin weighted residual technique.	08		
	b) Obtain the consistent nodal load vector for the loading shown in adjacent figure. 	06		
	c) Explain different types of boundary conditions with suitable example	06		
3	a) Obtain the stiffness matrix for struss elements (shown in adjacent figure) 1,2 and 3. The co-ordinates for nodes 1,2,3 and 4 in centimeters are (0,-35); (0,0); (15,0); (0,10) respectively. Cross sectional area for truss element is 25 cm^2 and material modulus E= 200GPa. 	15		
	b) State and explain properties of the stiffness matrix. What is the significance of each column in the matrix fot 1-D problem?	05		
4	a) The struss shown in above (Q.no. 3a) is subjected to a point load P=1kN in positive 'X' direction, find the deformation at node 3 and stress in each element.	10		
	b) Solve the following equation using Galerkin method, compare the solution with exact solution at x=0.7 $\frac{dy}{dx} + y = 0\,; \quad 0 \le x \le 1 \;\; and \;\; y(0) = 1$ Assume the trial solution as, $y = C_0 + C_1 x + C_2 x^2$	10		

5 a) Evaluate the stiffness matrix for the triangular element having nodal co-ordinates as (0,0); (b,0) and (b,a) for nodes 1,2 and 3 respectively. Use plane stress formulation with ν=0.3. 15

b) The quadrilateral element having nodes 1(0,0); 2(2a,0); 3(2a,2b); 4(0,2b) has three linear sides and one quadratic side. Derive the shape functions if 5th node is located at: i) (0,b) and ii) (a,0). 5

6 For quadrilateral element having nodal coordinates in x-y space are (-1,0), (0,0.5), (1,0), (0,1) for nodes 1 to 4 respectively; if it has to be evaluated by 2X2 Gauss quadrature rule (parent element in ξ,η), compute the mapping point in x-y space for each gauss point and also Jacobian at each gauss point. 20

7 a) Consider two adjacent plane (quadrilateral) quadratic elements. Obtain the shape function for such quadratic element and show that these shape functions provide inter-element continuity of the field quantity along the shared boundary. 10

b) A discretised linear bar element is as shown in fig.1. Give answer to the following:

i. Develop stiffness matrix and show the skyline. 10

ii. Show one dimensional array to store the matrix and find the matrix profile

iii. Find the semi-bandwidth for each row of the matrix and for the entire matrix.

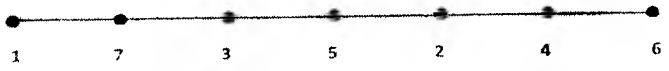


Fig.1

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

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Munshi Nagar, Andheri (West), Mumbai – 400058

Re-Examination
June 2017

Program: **B.Tech. in Mechanical Engineering**
Class: **Final Year B.Tech. (Mechanical)**
Course code: **ME401**
Name of the Course: **Machine Design II**

Date: **Jun 2017**
Duration: **4 Hr.**
Max. Marks: **100**
Semester: **VII**

MASTER FILE

Instructions:

- Question No 1 is **compulsory**. Attempt any four questions out of remaining six.
- Answers to all sub questions should be grouped together.
- Use of PSG Design Data book permitted. Assume suitable data if necessary.

		Max. Marks	CO No.	Module No.
Q1 A)	Explain with neat sketch the nature of forces acting on a bevel gear. What is virtual or formative bevel gear?	**(5)**	*1*	*1*
B)	Explain design of a two-stage helical gear box. Highlight design considerations which are important to achieve its functionality.	**(5)**	*2*	*2*
C)	Compare between the rolling contact and sliding contact bearings.	**(5)**	*3*	*4*
D)	Classify and explain different types of followers used in cam-follower mechanisms with neat sketch.	**(5)**	*4*	*5*
Q2 A)	A pair of parallel helical gears consists of a 28 teeth pinion meshing with 140 teeth gear. The pinion rotates at 750 rpm. The normal pressure angle is 20°, helix angle is 25°. The face width is 48 mm and the normal module is 4 mm. The pinion as well as gear is made of forged steel (S_{UTS} = 800 MPa, S_{YS} = 650 MPa) and heat treated to surface hardness of 390 BHN. The service factor and factor of safety are 1.25 and 2.0 respectively. Assume that the velocity factor accounts for the dynamic load and calculate the power transmitting capacity of the gears.	**(10)**	*1*	*1*
B)	A self-aligning ball bearing is subjected to radial load of 3.5 kN and thrust force of 1.1 kN. The shaft rotates at 900 rpm. The expected life of bearing is 5000 hours. The minimum acceptable diameter of shaft is 45 mm. Select suitable bearing. Consider outer race as stationary.	**(10)**	*1*	*3*
Q3 A)	A helical spring loaded cam rotates at 1000 rpm with a translating roller follower. The cam profile is : (a) rise by 15 mm in 160°, constant acceleration curve; (b) dwell for 20°; (c) fall same as rise and (d) dwell for 20°. There is no offset provided to the translation axis. The radii of base circle and roller are 50 mm and 15 mm respectively. Mass of follower linkage is 0.60 kg and external force on the system is constant 20 N. Calculate the following. (i) Spring stiffness, (ii) roller pin diameter, (iii) maximum torque on cam shaft, (iv) pressure angle at the instant of maximum contact force acting on the cam.	**(15)**	*1*	*6*
B)	Explain the thermal considerations employed in the design of worm gears. State advantages of worm gears over other types.	**(5)**	*2*	*1*

Q4 A)	Design a full hydrodynamic bearing for a machine tool with the following specifications. Journal diameter = 50 mm; radial load = 10 kN; journal speed = 600 rpm; minimum oil film thickness = 40 micrometres; inlet temperature = 40° C; bearing material = Babbitt. Determine length of the bearing and select suitable oil for this application.	**(10)**	*1*	*4*
B)	Write a short note on dynamic analysis of cams. What do the terms 'jump' and 'cross-over' signify in the context of cam design?	**(5)**	*2*	*5*
C)	Explain static and dynamic seals with examples.	**(5)**	*1*	*4*
Q5 A)	Discuss different types of failures and the associated remedies for rolling contact bearings.	**(5)**	*2*	*5*
B)	Describe important components of a centrifugal pump with a neat sketch. Explain the factors involved in design of pump shaft, impeller, volute casing and selection of electric motor.	**(10)**	*3*	*7*
C)	Write a short note on hydrostatic bearings with neat sketch.	**(5)**	*1*	*4*
Q6 A)	An oil immersed multi-disk clutch for an application consists of five steel plates and four bronze plates. The friction disks have outer diameter of 160 mm and inner diameter of 80 mm. The coefficient of friction is 0.1 and intensity of pressure on friction lining is limited to 0.25 N/mm^2.Assuming uniform wear theory, calculate: (i) required force to engage the clutch and (ii) power transmission capacity at 900 rpm.	**(8)**	*1*	*6*
B)	Following data is given for a caliper brake with annular pad for the front wheel of motorcycle: • Torque capacity = 1400 N-m • Outer radius of pad = 160 mm • Inner radius of pad = 120 mm • Coefficient of friction = 0.3 • Average pressure on pad = 2.2 MPa • Number of pads = 2 Calculate the angular dimension of the pad.	**(7)**	*1*	*6*
C)	List different types of brakes and give at least one practical application of each type.	**(5)**	*1*	*6*
Q7 A)	Discuss advantages and disadvantages of internal gears over the external gears. Briefly explain how the procedure for design of internal gears differs from the one for design of external gears.	**(5)**	*1*	*1*
B)	Sketch two views of a snatch block assembly for an EOT crane and mark main components such as, rope, pulley, cross-block, hook, thrust bearing, side-plates, etc. Explain with necessary equations, the procedure used to select size of rope, hook and sheave for a given load capacity of snatch block.	**(10)**	*3*	*7*
C)	Define static and dynamic load carrying capacity of ball bearings. How these parameters are used in selection of ball bearing for a given service?	**(5)**	*1*	*3*

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