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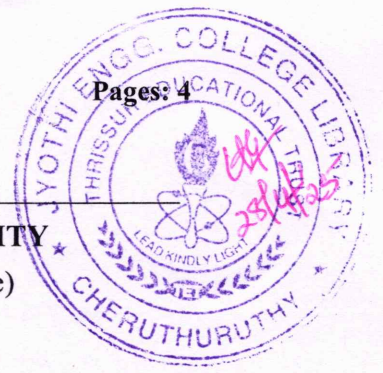
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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R,S) Exam April 2025 (2019 Scheme)



Course Code: RAT302

Course Name: DESIGN OF MACHINE ELEMENTS

Max. Marks: 100

Duration: 3 Hours

**PART A***Answer all questions, each carries 3 marks.***Marks**

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|----|--|-----|
| 1  | Find out the numbers of the R5 basic series from 1 to 10.                | (3) |
| 2  | Endurance limit is not a material property alone. Elucidate.             | (3) |
| 3  | Distinguish between hard and soft gaskets in bolted joints.              | (3) |
| 4  | Draw any 3 AWS welding symbols.  | (3) |
| 5  | What is meant by surging in springs? Discuss ways to avoid it.           | (3) |
| 6  | Distinguish between design for strength and design for rigidity.         | (3) |
| 7  | Schematically explain spur, helical and bevel gears.                     | (3) |
| 8  | Distinguish between V-belts and flat belt drive.                         | (3) |
| 9  | List any 3 types of rolling contact bearings and explain their features. | (3) |
| 10 | Explain the hydrodynamic theory of lubrication.                          | (3) |

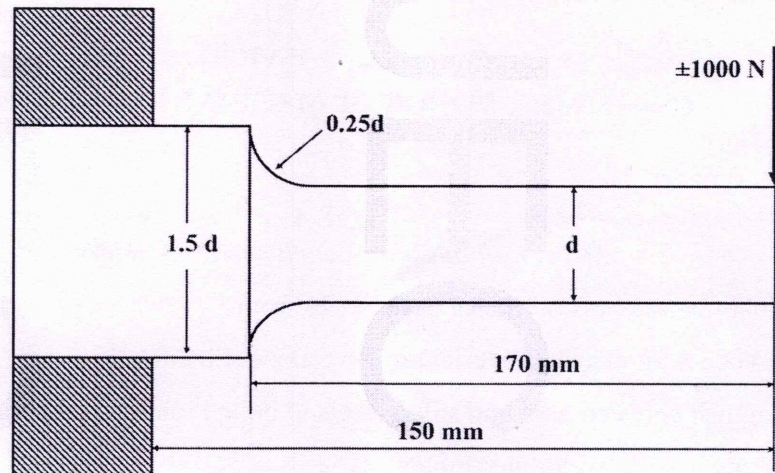
**PART B***Answer any one full question from each module, each question carries 14 marks.***Module I**

- 11 a) A pulley is keyed to a shaft midway between two bearings. The shaft is made of cold drawn steel for which the ultimate strength is 500 MPa and yield strength is 400 MPa. The bending moment at the pulley varies from -100Nm to +400Nm as the torque on the shaft varies from -50 Nm to +150 Nm. Obtain the diameter of the shaft for an infinite life. The fatigue stress concentration factors for the keyway at the pulley in bending and in torsion are 1.6 and 1.3 respectively. Assume the following values; Factor of safety =1.5, Size effect factor =0.85, Surface effect factor =0.90. (10)
- b) What is meant by cyclic stress? What are the types of cyclic stress? Explain. (4)

**OR**



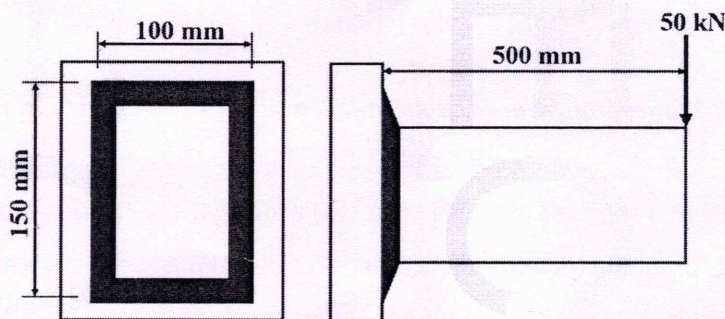
- 12 a) A cantilever beam made of cold drawn steel of ultimate tensile strength  $540 \text{ N/mm}^2$  is subjected to a completely reversed load of  $1000 \text{ N}$  as shown in figure. The notch sensitivity factor at the fillet can be taken as  $0.85$  and size factor is  $0.80$ . Determine the diameter ' $d$ ' of the beam for a life of  $10000$  cycles. (10)



- b) What are the steps in machine design process. Explain with examples. (4)

### Module II

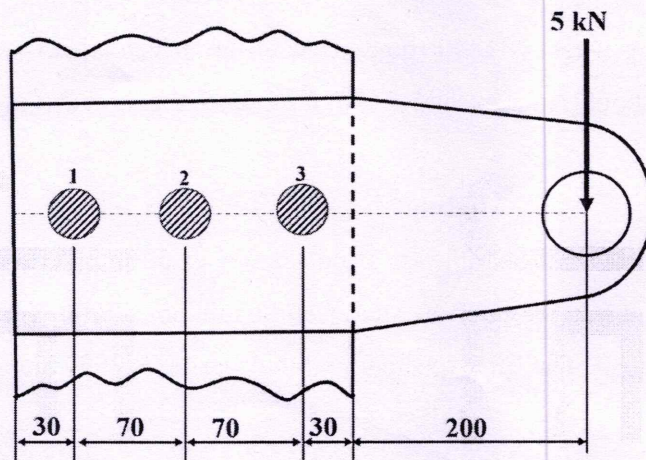
- 13 a) A beam of rectangular cross section is welded to a support by means of fillet welds as shown in Figure. Determine the size of the welds, if the permissible shear stress in the weld is limited to  $75 \text{ N/mm}^2$ . (14)



OR

- 14 a) A steel plate subjected to a force of  $5 \text{ kN}$  and fixed to a channel by means of three identical bolts as shown in figure. The bolts are made from plain carbon steel of yield strength  $380 \text{ N/mm}^2$ . Specify the size of bolts for a factor of safety  $3$ . (12)





- b) What is the significance of washer in a bolted joint? (2)

### Module III

- 15 a) A mild steel shaft transmits 20 kW at 200 rpm. It carries a central point load of 900 N and is simply supported between the bearings 2.5 metres apart. Determine the size of the shaft, if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is not to exceed 56 MPa. Combined fatigue and shock factors for bending and torsion may be taken as 1.5 and 1.2 respectively. Use both maximum shear stress theory and principal stress theory. (10)
- b) Derive the expression for critical speed of shafts. Suggest methods to avoid failure by whirling. (4)

OR

- 16 a) Design a helical spring for a spring-loaded safety valve for the following conditions: Diameter of valve seat = 65 mm; Operating pressure = 0.7 N/mm<sup>2</sup>; Maximum pressure when the valve blows off freely = 0.75 N/mm<sup>2</sup>; Maximum lift of the valve when the pressure rises from 0.7 to 0.75 N/mm<sup>2</sup> = 3.5 mm; Maximum allowable stress = 550 MPa; Modulus of rigidity = 84 kN/mm<sup>2</sup>; Spring index = 6. Draw a neat sketch of the free spring showing the main dimensions. (14)

### Module IV

- 17 a) A motor shaft rotating at 1440 rpm has to transmit 15 kW power to a low speed shaft running at 500 rpm. A 20° full depth involute system of gear tooth is used. The pinion has 25 teeth. Both gear and pinion are made of cast iron having allowable static strength of 55 MPa. Design a suitable spur gear drive and check the design for dynamic load and wear. (14)

OR



- 18 a) Design a V-belt drive for the following specifications. Power transmitted is 20 kW, speed of the driving wheel is 1440 rpm, speed of the driven wheel is 400 rpm, centre distance should not exceed 2500 mm, and the service of the equipment is 16 hrs/day. (14)

**Module V**

- 19 a) Select suitable deep groove ball bearing for a shaft diameter 50 mm. The shaft operates at 3000 rpm and is acted upon by steady and continuous 5000 N radial load and 2000 N thrust load. The life expectancy of the bearing is 2000 hrs. (14)

**OR**

- 20 a) A 360° hydrodynamic journal bearing operates at 1200 rpm and carries a load of 5.5 kN. The journal diameter is 55 mm and length is 55 mm. The bearing is lubricated with SAE 20 oil and the operating temperature of the oil is 80°. Assume radial clearance as 0.025 mm and the attitude angle as 60°. Determine: (i) bearing pressure (ii) attitude (iii) minimum film thickness (iv) heat generated (v) heat dissipated, if the ambient temperature is 25°C and (vi) amount of artificial cooling if necessary. (14)

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