Reg No.:_____ Name:_____

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Sixth Semester B.Tech Degree (R, S) Examination May 2024 (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

1	Enumerate the major steps in machine design process.	(3)
2	How can we prevent the fatigue failure of a component?	(3)
3	What are the effects of pretension in bolted joints?	(3)
4	Describe with neat sketches, three different types of welded joints.	(3)
5	What is Wahl's factor? Explain its significance in spring design.	(3)
6	Define critical speed of shafts. Discuss ways to avoid failure of shafts by whirling.	(3)
7	Discuss about different modes of failure of gear tooth.	(3)
8	List out advantages and disadvantages of V -Belt drives	(3)
9	Define L_{10} and L_{50} life of ball bearings.	(3)
10	Discuss the significance of Bearing characteristic number.	(3)

PART B

Answer any one full question from each module, each question carries 14 marks.

Module I

11	a)	A circular bar of 500 mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by: Ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa.	(10)
	b)	Define factor of safety? What are the factors to be considered in selection of factor of safety?	(4)

OR

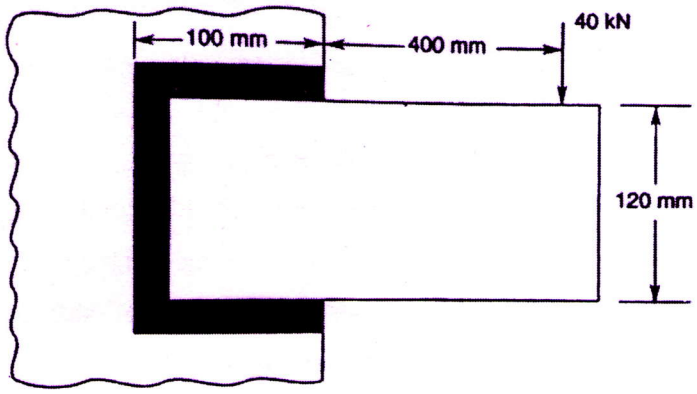
12	a)	A hot rolled steel shaft of uniform cross section is subjected to a torsional moment that varies from 330 N-m clockwise to 110 N-m counterclockwise and an applied	(12)

bending moment at a critical section varies from 440 N-m to – 220 N-m. Determine the required shaft diameter. The material has an ultimate strength of 550 MPa and a yield strength of 410 MPa. Assume the endurance limit as half the ultimate strength, Factor of safety of 2, size factor of 0.85 and a surface finish factor of 0.7.

b) Define endurance limit. (2)

Module II

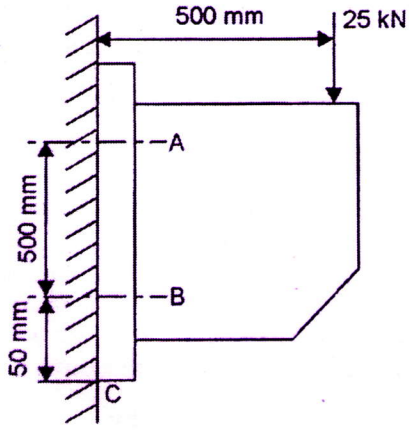
13 a) A bracket is welded to a column as shown. Calculate the size of the weld, if the permissible shear stress in the weld is limited to 70MPa. (12)



b) What is the significance of throat thickness in the design of fillet welds? (2)

OR

14 a) A wall bracket is attached to a wall by means of 4 identical bolts, two at A and two at B, as shown in figure. Assuming that the bracket is held against the wall and prevented from tipping about C, by all four bolts, and using an allowable stress in the bolts as 35 MPa, determine the size of the bolts on the basis of maximum principal stress theory. (10)



b) Describe with neat sketches any two types of standard screw threads. (4)

Module III

15 a) A railway wagon moving at a velocity of 1.5 m/s is brought to rest by a spring. The mass of the wagon is 1500 kg. The spring is compressed by 150 mm in bringing the wagon to rest. The spring index can be taken as 6. The springs are made of oil-hardened and tempered steel wire with ultimate tensile strength of 1250 N/mm^2 and modulus of rigidity of 80 KN/mm^2. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils; (v) solid length; (vi) free length; (vii) pitch of the coil; (viii) required spring rate; and (ix) actual spring rate. (14)

OR

16 a) A shaft is supported in bearings 600 mm apart. It carries a pulley of diameter 500 mm at 250 mm to the left of the left bearing and another pulley of diameter 380 mm at 130 mm to the right of right bearing. The belt drive connected to both the pulley are vertically downwards. The maximum tension in the smaller pulley is 5500 N. The coefficient of friction and at the angle of contact of both the pulleys are 0.3 and 180° respectively. Determine the diameter of the shaft for a factor of safety of 3, if the yield strength of shaft material in shear is 120 MPa. (12)

b) List out any two examples and applications of rigid and flexible couplings. (2)

Module IV

17 a) A pair of straight teeth spur gears, having 20° involute full depth teeth is to transmit 12 kW at 300 rpm of the pinion. The speed ratio is 3:1. The allowable static stresses for gear of cast iron and pinion of steel are 60 MPa and 105 MPa respectively. Assume the following: (14)

Number of teeth of pinion = 16;

Face width = 14 times module;

Velocity factor, $C_v = 4.5 \div (4.5 + v)$, v being the pitch line velocity in m/s; and

tooth form factor, $y = 0.154 - (0.912 \div \text{No. of Teeth})$

Also given, $\sigma_{es} = 600$ MPa; $E_P = 200$ kN/mm^2 and $E_G = 100$ kN/mm^2.

Determine the module, face width and pitch diameter of gears. Check the gears for wear.

OR

18 a) Select type of V-belt and number of belts required for 12 kW, 800 rpm induction motor to drive an exhaust fan in a steel plant at 200 rpm. The centre distance between shafts is 1 m. Pitch diameter of the motor pulley is 200 mm. (14)

Module V

19 a) A single-row deep groove ball bearing is subjected to a radial force of 8 kN and a thrust force of 3 kN. The shaft rotates at 1200 rpm. The expected life L_{10} of the bearing is 20000 hours. The minimum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application. (14)

OR

20 a) Following data is given for a 360° hydrodynamic bearing: (14)
Radial load = 10 kN, Journal speed = 1440 rpm, unit bearing pressure = 1000 kPa, clearance ratio = 800, viscosity of lubricant = 30 mPas. Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing, calculate: (i) dimensions of bearing; (ii) coefficient of friction;
(iii) Power lost in friction; (iv) Oil flow requirement; (v) Temperature rise

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