Reg No.:_____　　　　　　　　Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S7 (S, FE) / S5 (PT) (S, FE) Examination December 2023 (2015 Scheme)

Course Code: ME401
Course Name: DESIGN OF MACHINE ELEMENTS - I

Max. Marks: 100　　　　　　　　　　　　　　　　　　　Duration: 3 Hours

Use of approved design data book is permitted

Missing data if any may be suitable assumed

PART A

Answer any two full questions, each carries 15 marks.　　　Marks

1　a)　Define standardization. State the standards used in design of machine elements.　(4)

　　b)　Explain the factors which governs the selection of material for a given machine elements.　(5)

　　c)　Write brief note on steps in design processes.　(6)

2　a)　A shaft made of mild steel is subjected to 4 kN-m of bending moment at its critical point and transmits a torque of 3000 N-m. The yield strength of the steel is 380 MPa and assume factor of safety is 2 and $\mu = 0.3$. Determine the diameter of the shaft based on strain energy theory.　(6)

　　b)　A shaft of diameter 55 mm, stepped down to diameter 30 mm having fillet radius of 5 mm and subjected to a tensile load of 12 kN. Find the maximum stress induced in the shaft.　(4)

　　c)　A plate with a hole made of steel is subjected to a completely reversed axial load of 40 k N. The width of the plate is 60 mm and diameter of the hole is 15 mm. The notch sensitivity factor can be taken as 0.8, size factor is 0.85 and the expected reliability is 90%. Determine the thickness of the plate using a factor of safety of 2.5 for an infinite life.　(5)

3　　A rotating round bar made of steel has an ultimate strength of 590 MPa and yield strength of 324 MPa. The shaft subjected to torsional load that varies from 2.5 kN-m to 5 kN-m, bending moment varying from 12 kN-m to 14 kN-m. Adapt a factor safety of 2, calculate the size of the bar.　(15)

PART B
Answer any two full questions, each carries 15 marks.

4   A bracket connection as shown in figure below is subjected to an eccentric load   (15)
     (P) of 4 kN with an eccentricity of 600 mm from the CG of the bolts. All the
     bolts are identical and have yield strength of 316 MPa. Determine the size of the
   bolts, assuming a factor of safety 3.
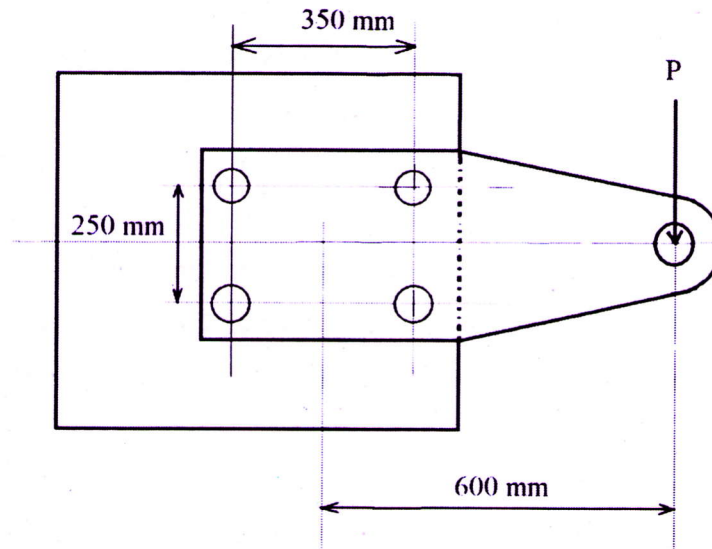
5   A boiler with inside diameter of 1.5 m is subjected to steam pressure of 2 MPa.   (15)
     Design a triple riveted longitudinal double strap zig-zag butt joint with unequal
     straps for the boiler. The working tensile, shear and crushing stresses are 78
     MPa, 58 MPa and 120 MPa respectively for the plate and rivet. Assume the
     efficiency of the joint as 80%. The longer pitch in the outer row is twice the
     pitch in the inner row.

6   Two rods, made of Carbon steel SAE 1095 annealed are to be connected by   (15)
     means of a cotter joint. Design the cotter joint to carry a load of 150 kN. Take
     factor of safety of 4 for tension and shearing, 2 for crushing.

PART C

Answer any two full questions, each carries 20 marks.

7   Design a valve spring for an internal combustion engine. The spring is 45 mm   (20)
     long when spring load is 400 N and spring length is 53 mm when   spring load is
     200 N. The inside diameter of the spring should not be less than 30 mm.

8   Design a carbon steel shaft of 850 mm long made of SAE 1025 annealed which   (20)

is driven by a belt drive with a tension of 6.5 kN and 2.5 kN as shown in figure below. The shaft is supported on bearings at free ends. The shaft carries a gear at 200 mm to the right of the left bearing and a pulley at 250 mm to the left of right bearing. The gear is subjected to radial force of 4 kN acting horizontally and tangential force of 10 kN acting vertically upward. The shock and fatigue factors for bending and torsion are 2 and 1.5 respectively and weight of the pulley to be 1500 N. Take factor of safety = 2.
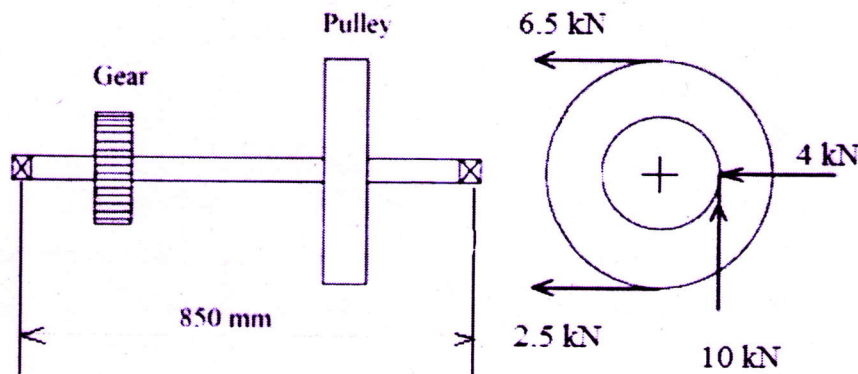
9   A 50 mm diameter shaft has to transmit 18 kW at 500 rpm. Assume maximum   (20) torque transmitted to be 30 % greater than the normal torque and bolts are fitted in reamed holes. Design a cast iron flange coupling to connect shafts. The material properties are as follows:

  i.   The permissible shear strength and permissible compressive stress for the shaft, bolt and key are 50 MPa and 120 MPa respectively.

  ii.   The allowable shear stress for cast iron is 15 MPa.

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