Q/K/TY

Reg. No: 23BMM0065

VIT
Vellore Institute of Technology

Final Assessment Test – November 2025

Course: BMEE301L - Design of Machine Elements
Class NBR(s): 2121 / 2122 / 2125 / 2127
Time: Three Hours
Slot: A1+TA1+TAA1
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instructions

i. PSG design data book is permitted.
ii. Assume suitable data wherever necessary.

COs	CO Statements
CO1	Evaluate the design of machine components using theories of failure.
CO2	Analyse machine components subjected to dynamic loads against fatigue failure.
CO3	Recommend suitable mechanical springs for various applications.
CO4	Design shafts, keys and couplings as per the international standards.
CO5	Investigate the design aspects of temporary and permanent joints.
CO6	Design and develop the engine components.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

PART – A (5 X 12 = 60 Marks)

Answer ALL Questions

1. A cylindrical shaft made of steel of yield strength 710 MPa is subjected to static loads consisting of bending moment 12 kNm and a torsional moment 32 kNm. Determine the diameter of the shaft using three different theories of failure (Maximum shear stress theory, Maximum strain energy theory and Maximum distortion energy theory), and assuming a factor of safety of 2. Take E = 210 GPa and poisson's ratio = 0.25. **CO1 BL3**

2. A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500 mm, and its cross-section is circular with a diameter of 60 mm. Taking for the beam material ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 330 MPa for reversed bending and a factor of safety of 1.4. Calculate the maximum value of P, take a size factor of 0.85 and a surface finish factor of 0.9. **CO2 BL3**

3. A helical compression spring made of oil tempered carbon steel is subjected to a load which varies from 700N to 1700 N. The spring index is 6 and the design factor of safety is 1.5. Yield shear stress of steel is 700 N/mm^2 and the endurance stress in shear is 350 N/mm^2. The compression at the maximum load is 40 mm. Assume Modulus of rigidity as 80 GPa. Find the size of the spring wire, mean diameter of coil, pitch of the spring and its free length. **CO3 BL3**

4. A 50 mm diameter solid shaft is welded to a flat plate as shown in Fig. 1. If the size of the weld is 15 mm, Examine the maximum normal and shear stress in the weld. CO5 BL4

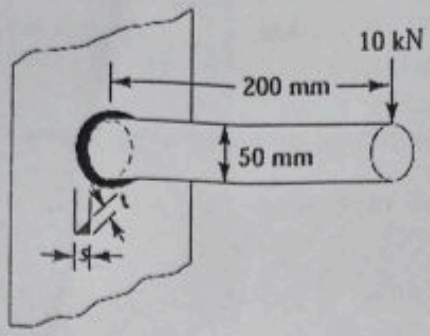

Fig. 1

5. Two mild steel rods 40 mm diameter are to be connected by a cotter joint. The thickness of the cotter is 12 mm. Calculate the dimensions of the joint, if the maximum permissible stresses are: 46 MPa in tension; 35 MPa in shear and 70 MPa in crushing. CO5 BL3

PART – B (2 X 20 = 40 Marks)

Answer ALL Questions

6. A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulley is 180^0 and Poisson ratio is 0.24. Evaluate the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley. CO4 BL5

7.a) The connecting rod of a petrol engine is to be designed for the following data. Piston diameter = 80 mm, stroke = 120 mm, weight of reciprocating parts = 15 N, length of connecting rod = 240 mm and speed = 2800 rpm. Explosion pressure corresponding to 100 of crank angle is 3 MPa. Factor of safety = 6. If the connecting rod is to be made of 40 Cr1 steel, find the dimensions of the I-section connecting rod. CO6 BL3

OR

7.b) The turning moment diagram of a multi-cylinder engine is drawn with a scale of (1 mm = 1°) on the abscissa and (1 mm = 250 N-m) on the ordinate. The intercepted areas between the torque developed by the engine and the mean resisting torque of the machine, taken in order from one end are – 350, + 800, – 600, + 900, – 550, + 450 and –650 mm^2. The engine is running at a mean speed of 750 rpm and the coefficient of speed fluctuations is limited to 0.02. A rimmed flywheel made of grey cast iron FG 200 (density = 7100 kg/m^3) is provided. The spokes, hub and shaft are assumed to contribute 10% of the required moment of inertia. The rim has rectangular cross-section and the ratio of width to thickness is 1.5. Determine the dimensions of the rim. CO6 BL3

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