



B.E DEGREE EXAMINATIONS: MAY 2017

(Regulation 2015)

Fourth Semester

MECHANICAL ENGINEERING

U15MET401: Design of Machine Elements

COURSE OUTCOMES

CO1: Apply concepts of steady stresses in design of machine elements

CO2: Solve the problems in machine elements subjected to varying loads

CO3: Design the shafts and couplings for various applications

CO4: Select bearings, seals and gaskets for specific applications

CO5: Design temporary and permanent joints/identify the dimensions of various energy storing elements

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

(Use of approved Design Data Book is permitted)

PART A (10 x 1 = 10 Marks)

1. Match list I items with list II and select the correct answer using the codes given below.

CO1 [K₁]

List I	List II
A. A cast iron designation	i. hyperbolic variation of bending stresses
B. Cold working applied on metals	ii. reduction of stress concentration
C. Force flow around round corner	iii. FG300
D. Curved beam	iv. to increase fatigue strength

- | | A | B | C | D |
|----|-----|----|-----|----|
| a) | ii | i | iii | iv |
| b) | iii | iv | ii | i |
| c) | ii | iv | iii | i |
| d) | iii | i | ii | iv |

2. A bolt diameter of 32 mm, having safe tensile stress 100 N/mm^2 can safely carry a load of

CO1 [K₁]

- | | |
|-----------|-----------|
| a) 80 kN | b) 100 kN |
| c) 120 kN | d) 150 kN |

3. The type of stresses developed in the key are

CO2 [K₂]

1. Shear stress
2. Bearing stress
3. Bending stress
4. Tensile stress

- | | |
|--------|--------|
| a) 1,3 | b) 1,4 |
| c) 1,2 | d) 2,3 |

18. A joint is required between the links of bicycle chain. Select whether cotter or knuckle or bolted joint is suitable and tell the type of the force transmitted in links. CO4 [K₂]
19. Why cracks are developed at the inner side of helical springs used in railways. CO5 [K₂]
20. State the reasons for using flywheels in punching press.. CO5 [K₂]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. A multi-cylinder engine is to run at a constant load at a speed of 600 rpm. On drawing the crank effort diagram to a scale of 1mm = 250 N-m and 1 mm = 3°, the areas in mm² above and below the mean torque line are as follows: (14) CO5 [K₃]

$$+ 160, - 172, + 168, - 191, + 197, - 162 \text{ mm}^2$$

The speed is to be kept within $\pm 1\%$ of the mean speed of the engine. Calculate the necessary moment of inertia of the flywheel.

Determine suitable dimensions for a cast iron flywheel with a rim whose breadth is twice its radial thickness. The density of cast iron is 7250 kg / m³, and its working stress in tension is 6 MPa. Assume that the rim contributes 92% of the flywheel effect.

22. i) A pull of 80 kN is transmitted from a bar X to the bar Y through a pin as shown in Fig 1. If the maximum permissible tensile stress in the bars is 100 N/mm² and the permissible shear stress in the pin is 80 N/mm², calculate the diameter of bars and of the pin. (7) CO1 [K₃]

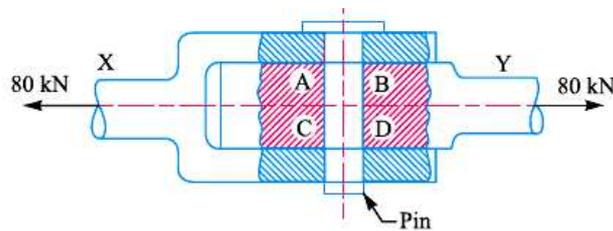


Fig 1

- ii) The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Calculate the diameter of bolt required according to maximum shear stress theory. Take permissible tensile stress at elastic limit = 100 MPa (7) CO1 [K₃]
23. i) Determine the maximum stress induced in a rectangular plate 60 mm × 10 mm with a hole 12 diameter as shown in Fig.2 and subjected to a tensile load of 12 kN. Consider the stress concentration. (5) CO2 [K₃]

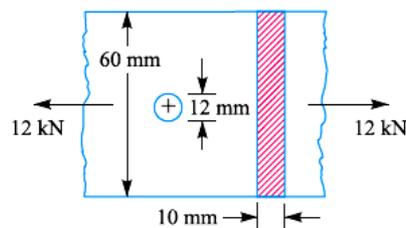


Fig 2

- ii) 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 is given by: ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa. Use Soderberg relation (9) CO2 [K₃]
24. A hollow steel shaft is to transmit 20 kW at 300 r.p.m. The loading is such that the maximum bending moment is 1000 N-m, the maximum torsional moment is 500 N-m and axial compressive load is 15 kN. The shaft is supported on rigid bearings 1.5 m apart. The maximum permissible shear stress on the shaft is 40 MPa. The inside diameter is 0.8 times the outside diameter. The load is cyclic in nature and applied with shocks. The values for the shock factors are: applied to torsional moment, $K_t = 1.5$ and applied to bending moment, $K_m = 1.6$. Design the hollow shaft. CO3 [K₃]
25. Design and draw a cotter joint to support a load varying from 30 kN in compression to 30 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. Tensile stress = compressive stress = 50 MPa ; shear stress = 35 MPa and crushing stress = 90 MPa. CO5 [K₃]
26. i) A 150 mm diameter shaft supporting a load of 10 kN has a speed of 1500 r.p.m. The shaft runs in a bearing whose length is 1.5 times the shaft diameter. If the diametral clearance of the bearing is 0.15 mm and the absolute viscosity of the oil at the operating temperature is 0.011 kg/m-s, find the power wasted in friction. (6) CO4 [K₃]
- ii) Following data is given for a hydrostatic thrust bearing: (8) CO4 [K₃]
 thrust load = 500 kN
 shaft speed = 720 rpm
 ratio of recess radius to shaft radius = 0.6
 average bearing pressure = 4 MPa
- Calculate:
 (a) radius of shaft and recess
 (b) supply pressure
27. A semi-elliptic spring used for automobile suspension, consists of two extra full-length leaves and ten graduated-length leaves, including the master leaf. The centre-to-centre distance between the two eyes is 1000 mm. The leaves are made of steel 55Si2Mo90 (tensile yield stress = 1500 N/mm² and Young's modulus = 207 000 N/mm²) and the factor of safety is 2. The maximum spring load is 30 kN. The leaves are pre-stressed so as to equalize stresses in all leaves under maximum load. Determine CO5 [K₃]
 i) the dimensions of the cross-section of the leaves
 ii) the deflection at the ends of spring.
