

B.E DEGREE EXAMINATIONS: NOV/DEC 2024

(Regulation 2018)

Fifth Semester

MECHATRONICS ENGINEERING

U18MCT5105: Design of Machine Elements

Use of approved design data books are permitted

COURSE OUTCOMES

- CO1:** Recognize the design process and the factors influencing it and design the simple components for static loading.
- CO2:** Apply the basic concepts of design to Estimate the life of the components subjected to varying loads.
- CO3:** Design the circular shafts based on strength and rigidity, keys and couplings for power. transmitting elements.
- CO4:** Apply the basics of power transmission to select the belts.
- CO5:** Design the welded joints, threaded joints and springs subjected to static and dynamic loads.
- CO6:** Select the rolling contact bearings for static and cyclic loads.

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

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|---|-----------------------|
| 1. List the factors influencing the design of artificial hip. | CO1 [K ₂] |
| 2. Compare leverage and mechanical advantage of levers. | CO1 [K ₂] |
| 3. List the derating factors used in the design for cyclic loading. | CO2 [K ₂] |
| 4. Define endurance limit. | CO2 [K ₂] |
| 5. Compare the functions of keys and couplings in power transmission. | CO3 [K ₂] |
| 6. Compare welded joints and bonded joints. | CO5 [K ₂] |
| 7. What is the necessity of using Wahl's stress factor? | CO5 [K ₂] |
| 8. Differentiate keys and Splines. | CO4 [K ₂] |
| 9. List the functions of the bearings. | CO6 [K ₂] |
| 10. Compare ball bearing and roller bearing. | CO6 [K ₂] |

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. The dimension of an overhang crank are given in figure1. The force P acting at the pin is 1 kN. The crank is made of steel 30C8 ($\sigma_y = 400$ MPa) and the factor of safety is 2. Using maximum shear stress theory of failure and maximum principal stress theory to determine the diameter 'd' at section-XX. All dimensions are in 'mm'. 16 CO1 [K₃]

Fig.1

12. A cantilever beam made of cold drawn steel 20C8 ($\sigma_{ut} = 540$ N/mm²) is subjected to a completely reversed load of 1000 N as shown in figure2. The notch sensitivity factor q for the fillet can be taken as 0.85 and the expected reliability is 90%. Determine the diameter 'd' of the beam for a life of 10000 cycles. All dimensions are in 'mm' 16 CO2 [K₃]

Fig.2

13. An intermediate shaft of a gearbox, supporting two spur gears A and B and mounted between two bearings C1 and C2 as shown in figure3. The pitch circle diameter of gears A and B are 500 and 250 mm respectively. The shaft is made of alloy steel ($\sigma_u = 620$ and $\sigma_y = 480$ N/mm²). The factors k_b and k_t of the ASME code are 2 and 1.5 respectively. The gears are keyed to the shaft. Determine the shaft diameter using the ASME code. All dimensions are in 'mm'
- 16 CO3 [K₃]

Fig.3

14. a) A plate, 75 mm wide and 10 mm thick, is joined with another plate by means of single transverse and double parallel fillet welds as shown in figure4. The joint is subjected to maximum tensile force of 55 kN. The permissible tensile and shear stresses for the welding materials are 70 N/mm² and 50 N/mm² respectively. Determine the required length of the parallel fillet weld. All dimensions are in 'mm'.
- 6 CO5 [K₃]

Fig.4

- b) A bracket for supporting the travelling crane is shown in figure5. The bracket is fixed to the steel column by means of four identical bolts, two at A and two at B. The maximum load that comes on the bracket is 5 kN acting vertically downward at a distance of 250 mm from the face of the column. The bolts are made of steel 40C8 ($\sigma_{yt} = 380 \text{ N/mm}^2$) and the factor of safety is 5. Determine the major diameter of the bolts on the basis of maximum principal stress. Assume $d_c = 0.8$ d. All dimensions are in 'mm'.
- 10 CO5 [K₃]

Fig.5

15. In an automotive plate clutch, six helical compression springs arranged in parallel provide the thrust of 1500 N. The springs are compressed by 10 mm to provide this thrust force. The springs are identical and the spring index is 6. The springs are made of cold-drawn steel ($\sigma_{ut} = 1200 \text{ MPa}$, $G = 81370 \text{ MPa}$). The permissible shear can be taken as 50% of the σ_{ut} . There should be a gap of 1 mm between adjacent coils when the springs are subjected to the maximum force. Determine wire diameter, coil diameter, and free length of the spring.
16. As a design engineer, you are expected to estimate the life of a single row deep-groove ball bearing is used to support the lay shaft of a four-speed automobile gearbox. It is subjected to the following loads in respective speeds.
- 16 CO6 [K₄]

The lay shaft is fixed to engine shaft and rotates at 1750 rpm. The static and dynamic load carrying capacities are 11600 and 17600 N respectively.
