B.E. / B.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025

Fifth Semester

Mechanical Engineering

20MEPC504 – DESIGN OF MACHINE ELEMENTS

Regulation - 2020

(Use of approved *Design Data Book* is permitted)

Duration: 3 Hours   Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)
Answer ALL Questions

		Marks	K–Level	CO
1.	Which design phase focuses on understanding how the forces affect the components?	1	K1	CO1

(a) Material selection   (b) Force analysis
(c) Ergonomic design   (d) Economic design

2. Stress concentration is caused by   **1 K1 CO2**
(a) Uniform cross-sections   (b) External load
(c) Changes in cross-sectional geometry   (d) Fatigue

3. When a shaft is subjected to both bending and torsion, what is the resulting stress called?   **1 K1 CO3**
(a) Principal Stress   (b) Combined Stress   (c) Equivalent Stress   (d) Residual Stress

4. What type of failure generally occurs in shafts subjected to torsional load?   **1 K1 CO3**
(a) Tensile Fracture   (b) Compressive Cracking   (c) Shear Failure   (d) Buckling

5. For a Double Cover Butt Joint, the efficiency is generally _____ than that of a Single Cover Joint.   **1 K1 CO4**
(a) Lower   (b) Higher   (c) Same   (d) Zero

6. Which type of welded joint is used when the plates to be joined are perpendicular to each other?   **1 K1 CO4**
(a) Lap Joint   (b) Butt Joint   (c) Fillet Joint   (d) Corner Joint

7. The material commonly used for making helical springs is   **1 K1 CO5**
(a) Brass   (b) Stainless Steel   (c) Carbon Steel   (d) Aluminum

8. The coefficient of fluctuation of speed if maximum speed is 2500rpm and minimum speed is 1800rpm.   **1 K2 CO5**
(a) 1.44   (b) 1.33   (c) 0.44   (d) 0.33

9. In a full journal bearing, the angle of contact of the bearing with the journal is   **1 K2 CO6**
(a)120º   (b) 180º   (c) 130º   (d) 360º

10. The length to diameter ratio for a short bearing is   **1 K1 CO6**
(a) more than 1   (b) less than 1   (c) ∞   (d) 1

PART - B (12 × 2 = 24 Marks)
Answer ALL Questions

		Marks	K–Level	CO
11.	Distinguish between hardness and toughness of materials.	2	K2	CO1
12.	List the factors to be considered in the selection of materials for a machine element.	2	K1	CO1
13.	List some methods of reducing stress concentration.	2	K1	CO2
14.	Define endurance limit.	2	K1	CO2
15.	List the types of stresses are induced in shafts.	2	K1	CO3
16.	Distinguish between keys and splines.	2	K2	CO3
17.	How is a bolt designated?	2	K1	CO4
18.	What are the advantages of welded joints compared with riveted joints?	2	K1	CO4
19.	What is nipping in a leaf spring?	2	K1	CO5
20.	Explain why I-section is chosen for the connecting rod.	2	K2	CO5

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create   ***14066***

21. List the types of bearing materials.   *2*   *K1*   *CO6*

22. Differentiate sliding contact bearing and rolling contact bearing.   *2*   *K2*   *CO6*

PART - C (6 × 11 = 66 Marks)
Answer ALL Questions

23. a) Explain in detail the various phases involved in the design process of machine components with neat sketches and examples.   *11*   *K2*   *CO1*

OR

b) A Crane hook has a trapezoidal section at A-A as shown in Figure 1. Identify the maximum stress at points P and Q.   *11*   *K3*   *CO1*
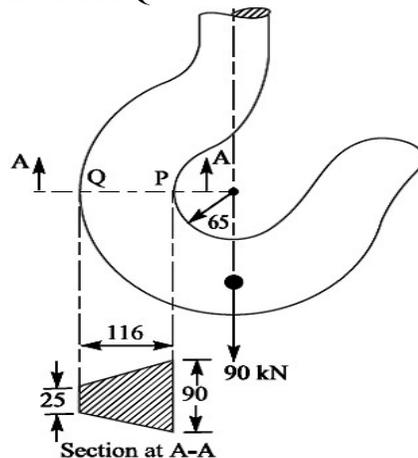

Figure 1

24. a) The load on a bolt consists of an axial pull of 10kN together with a transverse shear force of 5kN. Find the diameter of bolt required according to 1. Maximum principal stress theory 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory; and 5. Maximum distortion energy theory. Take permissible tensile stress at elastic limit = 100 MPa and Poisson's ratio = 0.3.   *11*   *K3*   *CO2*

OR

b) A machine component is subjected to a flexural stress which fluctuates between +300 MN/m^2 and -150 MN/m^2. Determine the value of minimum ultimate strength according to 1.Modified Goodman relation; and 2. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength= 0.5 Ultimate strength and factor of safety = 2.   *11*   *K3*   *CO2*

25. a) The shaft, as shown in Figure2, is driven by pulley B from an electric motor. Another belt drive from pulley A is running a compressor. The belt tensions for pulley A is 1500 N and 600 N. The ratio of belt tensions for pulley B is 3.5. The diameter of pulley A is 150 mm and the diameter of pulley B is 480 mm. The allowable shear stress is 85 MPa. Taking torsion and bending factors as 1.25 and 1.75 respectively, find the shaft diameter.   *11*   *K3*   *CO3*
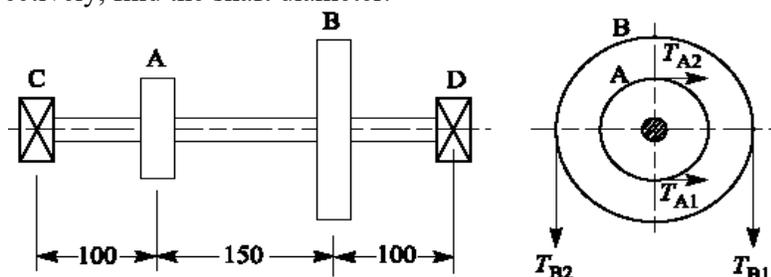

Figure 2.

OR

b) Design a muff coupling to connect two shafts transmitting 15kW at 200 rpm. The shaft keys and bolts are made of C45 steel and the coupling is cast iron. Design the coupling.

11 K3 CO3

26. a) A plate 200 mm wide is welded to a vertical plate by fillet welding on three sides to form a cantilever with an overlap of 150 mm and overhang of 400 mm. A vertical downward load of 40 kN is applied atthe free end for a weld stress of 80 MPa. Determine the size of the weld.

11 K3 CO4

OR

b) A knuckle joint is to transmit a force of 140 kN. Allowable stresses in tension, shear and compression are 75 N/mm^2, 65 N/mm^2 and 140N/mm^2 respectively. Design the joint.

11 K3 CO4

27. a) Design a leaf spring for the following specifications: Total load = 140 kN; Number of springs supporting the load = 4; Maximum number of leaves = 10; Span of the spring = 1000 mm; Permissible deflection = 80 mm. Take Young's modulus, E = 200 kN/mm^2 and allowable stress in spring material as 600 MPa.

11 K3 CO5

OR

b) Determine the dimensions of a connecting rod for an IC engine from the following data; Piston diameter = 125mm; Stroke = 150mm; Length of the connecting rod = 300mm Maximum gas pressure is at 5% of the stroke = 5MPa; Mass of reciprocating parts = 2kg; Factor of safety = 5; Material = steel of 35NiCr 60.

11 K3 CO5

28. a) Design a journal bearing for 12MW, 1000 rpm steam turbine, which is supported by two bearing. Take the atmospheric temperature as 16^{0}C and operating temperature of oil as 60^{0}C. Assume viscosity of oil as 23CP.

11 K3 CO6

OR

b) Select a suitable deep groove ball bearing for a drilling machine spindle of 40mm diameter and suggest necessary tolerances on the shaft and bushing; radial load is 2kN and thrust load is 1.5 kN. Spindle speed is 3000 rpm; desired life for bearing is 3000 hrs.

11 K3 CO6

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create

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