B.E/B.TECH DEGREE EXAMINATIONS: NOV/ DEC -2024

(Regulation 2018)

Fifth Semester

MECHANICAL ENGINEERING

U18MET5003: Design of Machine Elements
(Use of approved Design Data Book is permitted in the Examination)

COURSE OUTCOMES

CO1: Apply the concept of steady stresses in design of machine elements subjected to steady loads
CO2: Solve problems in machine elements subjected to varying loads
CO3: Design shafts and couplings for various applications
CO4: Select bearings for specific applications.
CO5: Design temporary and permanent joints
CO6: Design energy storing springs and flywheel

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions: -
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1.	Differentiate the stress distribution in a bar subjected to axial load and subjected to bending moment	CO1	[K$_2$]
2.	For ductile material, which of the strength is considered for designing a (a) Component subjected to static loading (b) Component subjected to dynamic loading	CO1	[K$_2$]
3.	Mention some standard codes of specification of steel?	CO2	[K$_1$]
4.	What are the methods to reduce the stress concentration?	CO2	[K$_2$]
5.	A line shaft rotating at 200 rpm is to transmit 200 Kw.it is assumed to be made of mild steel with an allowable shear stress of 42 MPa. Determine the diameter of the shaft, Neglecting the bending moment of the shaft.	CO3	[K$_3$]
6.	Under what circumference the flexible couplings are used?	CO3	[K$_3$]
7.	What do you understand from bearing number 6408?	CO4	[K$_2$]
8.	What is the minimum size for fillet weld? If the required weld size from the strength consideration is too small, how will you fulfill the condition of minimum weld size?	CO5	[K$_2$]
9.	Why riveted joints are preferred over welded joints in aircraft body?	CO5	[K$_2$]
10.	The helical spring rate 10 N/mm is mounted on top of another springs of rate 8 N/mm. Find the	CO6	[K$_3$]

force required to give deflection of 45 mm.

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

11. a) Mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to

    1. The maximum principal stress

    2. The maximum shear stress

                                                        8   CO1 [K$_2$]

   b) The C-clamp in Figure.1 is made of cast zinc, ZA12. Determine the allowable clamping of force "F" that the clamp can exert if its desired to have a design factor of 3 based on ultimate strength in either tension or compression.
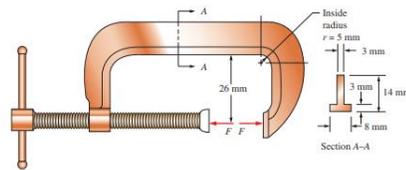
                                                          8   CO1 [K$_3$]

Figure.1

12. a) Find the diameter of a shaft to transmit twisting moments varying from 500 Nm to 2000 Nm as shown in Figure.2.

    The Ultimate tensile strength is $= 600$ N/mm^2 and Yield stress is $= 450$ MPa

    Assume Stress concentration factor due to keyway as 1.2

    Surface finish factor for torsion as 0.8

    size factor as 0.85
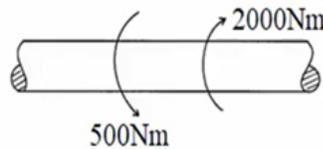
    Taking factor of safety as 2

                                10   CO2 [K$_2$]

Figure.2

   b) A rectangular plate of 80 mm wide and 12 mm thickness with transverse hole of 16 mm diameter is subjected to a tensile load of 20 kN as shown in figure.3. Taking stress concentration into account, calculate the maximum stress induced?
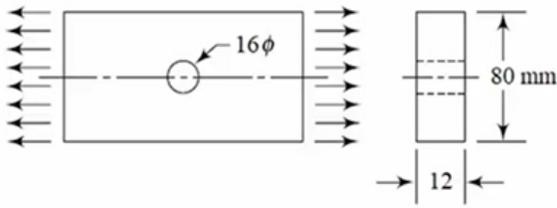
                              6   CO2 [K$_2$]

Figure.3

13. a) Design a flexible flange coupling of bush pin type to transmit 10 kW at 720 rpm from an electric motor to a centrifugal pump as shown in figure 4. Allowable shear stress for shaft, bolt and key material may be taken as 50 MPa and the crushing stress for the key as 110 MPa. The permissible shear stress for the coupling should be limited to 18 MPa and the bearing pressure between the bush and the coupling should be limited to 2 MPa.

    12   CO3 [K₃]

Figure.4. Electric motor driving a centrifugal pump through a flexible coupling

b) What are the agreeable dimension of rigid flange coupling for the shaft diameter of 30 mm?

    4   CO3 [K₂]

14. a) A ball bearing is operated on a work cycle consisting of three parts:

    8   CO4 [K₃]

   (i) A radial load of 3500 N at 1440 rpm for 30 % cycle,

   (ii) A radial load of 6000 N at 750 rpm for 35 % cycle,

   (iii) A radial load of 2500 N at 1440 rpm for the remaining cycle.

The expected life of the bearings is 10,000 hrs. Calculate the dynamic load carrying capacity of the bearings.

b) The following data refers to ball bearing work cycle

    8   CO4 [K₃]

Sr. no	Radial load (N)	Axial load (N)	Radial factor	Thrust factor	% time	Service factor	Speed (r.p.m.)
1	4000	800	1	0	30 %	1.25	900
2	8000	3000	0.56	2	40 %	1	600
3	-	-	-	-	30 %	-	600

Calculate the dynamic load rating of the bearing, if the expected bearing life is 10000 hrs with reliability of 95 %.

15. a) Inner diameter of a boiler is 1500 mm and the steam pressure is 2 N/mm^2 . Use a proper joint along the length and design a circumferential lap joint for boiler shell and calculate the   8   CO5   [K$_3$]

    (i)   Number of rivets and pitch of the circumferential lap joint.

    (ii)   Number of rows and efficiency of the circumferential lap joint.

   Use following permissible values of stress.

Tensile stress (σt) = 90 MPa:

Shear stress (τs)= 75 MPa

Crushing stress (σc) = 150 MPa

b) A 50 mm diameter solid shaft is welded at its one edge to the vertical side of rectangular pillar by an all-round fillet weld as shown in figure. A load of 10 kN is applied at the free end of the shaft which is at 200 mm from the fixed end. Find the size of the weld assuming the stress of the weld material in tension as 94 MPa   8   CO5   [K$_3$]
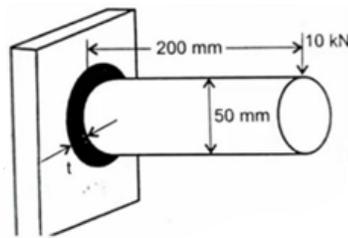

Figure.5

16. A helical compression spring made of oil tempered carbon steel, is subjected to a load which varies from 600 N to 1600 N. The spring index is 6 and the design factor of safety is 1.5. If the yield stress in shear is 700 MPa and endurance stress in shear is 350 MPa, The compression of the spring at the maximum load is 40 mm. The modulus of rigidity for the spring material may be taken as 80 GPa.   16   CO6   [K$_3$]

  find:

        1. Size of the spring wire,

        2. Mean diameters of the spring coil,

        3. Pitch of the spring

        4. Number of turns of the spring, and

        5. Free length of the spring.

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