CBCS Scheme

USN ☐☐☐☐☐☐☐☐☐☐ **15MA54**

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Elements of Machine Design

Time: 3 hrs.   Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

1   a.   State and explain the theories of failure
            i)   Maximum principle stress theory
            ii) Maximum shear stress theory   **(04 Marks)**
     b.   What is stress concentration? Explain the factors affecting the stress concentration.
                                                                                             (04 Marks)
     c.   A round rod of diameter 1.2d has a semi circular groove of diameter 0.2d. The rod is subjected to a bending moment of 10kN/m. the material of the rod is C 30 steel ($\sigma_y = 294$ MPa). Determine a safe value of 'd'. Factor of safety is 2.   **(08 Marks)**

OR

2   a.   A unknown weight falls through 15mm on to a collar rigidly attached to the lower end of a vertical bar 2m long and 500mm^2 section. If the maximum instantaneous extension is 2mm. What is the corresponding stress and value of unknown weight. Take E = 200GPa.
                                                                                             (06 Marks)
     b.   Design a cast-iron flange coupling for mild steel shaft transmitting 90kW at 250rpm. The allowable shear stress in the shaft is 40MPa and the angle of twist is not to exceed 1° in a length of 20 diameters. The allowable shear stress in the coupling bolts is 30MPa. **(10 Marks)**

Module-2

3   a.   Derive Soderberg's relation for a member subjected to fatigue loading.   **(06 Marks)**
     b.   A 40mm diameter steel shaft has $\sigma_y = 413$MPa, $\sigma_{en} = 336$MPa, Factor of safety is 2. What i) repeated ii) reveres, torques can the shaft sustain indefinitely? The shaft has a groove machined on it. The radius of the groove is 2mm and the diameter at the bottom of the groove is 36mm. Take size factor is 0.85, surface factor = 1.   **(10 Marks)**

OR

4   A mild steel shaft transmits 20kW at 200rpm. It carries a central lend of 900N and is simply supported between the bearing 2.5m apart. Determine the size of the shaft, if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is not to exceed 56MPa. What size of the shaft will be required, if it is subjected to gradually applied loads.
                                                                                             (16 Marks)

Module-3

5   Design a pair of steel spur gears required to transmit 12kW at 2000rpm of pinion. The velocity ratio received is 2.5:1. The allowable static stress for both may be taken as 138 MPa. Not less than 24 teeth are to be used on either gear. The teeth are 20° stub teeth.
                                                                                             (16 Marks)

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OR

6   Two shafts inclined at 60° are connected by a pair of bevel gears to transmit 9kW at 900 rpm of 24 tooth cast steel pinion having allowable static stress of 138 MPa. The gear is made of high grade CI having allowable static stress of 103 MPa and is to run at 300 rpm. The teeth are $14\frac{1}{2}^\circ$ involutes form. Design the gears completely.   **(16 Marks)**

Module-4

7   a.   Prove that a square key is equally strong in shear and compression.   **(06 Marks)**
    b.   Design a knuckle joint to transmit 120kN. The design stresses may be taken as 75MPa in tension, 60MPa in shear and 150 MPa in compression.   **(10 Marks)**

OR

8   a.   A splined connection in an automobile transmission consists of 10 spliners cut in 58mm diameter shaft. The height of each spline is 5.5mm and keyways in the hub are 45mm long. Determine the power that may be transmitted at 2500 rpm. Allowable normal pressure on spline is limited to 5MPa.   **(06 Marks)**
    b.   Design a sleeve type cotter joint to connect two tie rods subjected to an axial pull of 60kN. The allowable stress of C30 material used for the rods and cotter are σ_t = 65 MPa, σ_c = 75MPa, τ = 35 MPa, caststeel used for the sleeve has allowable stresses σ_t = 70MPA, σ_y = 110MPa and τ = 45MPA.   **(10 Marks)**

Module-5

9   a.   Derive the Petroff's equation for coefficient of friction.   **(06 Marks)**
    b.   A full journal bearing 90mm diameter and 150mm long has a radial load of 2MPa per unit projected area shaft speed is 500 rpm. The bearing is operating with SAE 20 Oil at 50°C. The specific gravity of oil at the operating temperature is 0.985. Calculate the following :
        i)   Minimum film thickness
        ii)   Heat lost due to fraction
        iii)   Whether artificial cooling is necessary.   **(10 Marks)**

OR

10   a.   Explain the mechanism of hydrodynamic journal bearing.   **(06 Marks)**
     b.   Determine the main dimensions and power less of a multicollar thrust bearing for a propeller shaft of 450 kW marine oil engine. The engine makes 250rpm. The shaft diameter is 150mm and the speed of the slip is 5m/sec.   **(10 Marks)**

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