

# CBCS SCHEME

15MA54

## Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020 Elements of Machine Design

Time: 3 hrs.

Max. Marks: 80

- Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. Use of design data hand book is permitted.  
3. Missing data, if any, may be suitably assumed.

### Module-1

- 1 a. Explain codes and standards. (04 Marks)  
b. A circular rod of diameter 50mm is subjected to loading conditions as shown in the Fig.Q1(b). Determine the nature and magnitude of stresses at the critical points. (12 Marks)

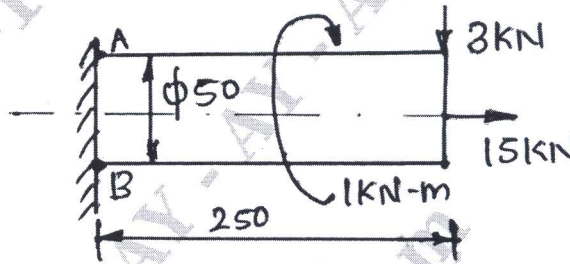


Fig.Q1(b)

OR

- 2 a. Derive an expression for instantaneous stress due to an axial loading. (08 Marks)  
b. Design a cast iron flange coupling for a steel shaft transmitting 30KW at 200rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is 20% greater than full torque. The allowable shear stress in the bolt is 60MPa and the allowable shear stress in the flange is 40MPa. (08 Marks)

### Module-2

- 3 a. Explain briefly Miner's rule. (04 Marks)  
b. A steel rod (SAE 9260 oil quenched  $\sigma_{ut} = 1089.5\text{MPa}$ ,  $\sigma_{yt} = 689.4\text{MPa}$ ;  $\sigma_{-1} = 427.6\text{MPa}$ ) is subjected to a tensile load which varies from 120kN to 40kN. Design the safe diameter of the rod using soderberg diagram. Take FOS = 2; SCF = 1 and correction factor for load, size and surface as 0.75, 0.85 and 0.91 respectively. (12 Marks)

OR

- 4 A shaft is supported by two bearings 1m apart. A 500mm diameter pulley is mounted at a distance of 200mm to the right of the left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 3000N. The pulley weighs 1000N. Another pulley 300mm in diameter is placed 300mm to left of the right hand bearing is driven with the help of eccentric motor and the belt which is placed horizontally to the right when viewed from left bearing. The pulley weighs 500N. The angle of contact for both the pulleys is 180 and  $\mu = 0.24$ . Determine suitable diameter for solid shaft, assuming torque on one pulley is equal to torque on other pulley. Choose C-15 steel ( $\sigma_y = 235.4\text{MPa}$ ;  $\sigma_u = 425\text{MPa}$ ) as the shaft material and use ASME code for design of shaft. Assume minor shock condition. (16 Marks)

**Module-3**

- 5 A pair of spur gears having 20 FDI system is to transmit 12 KW at 300 rpm of the pinion. The allowable static stress for CI gear is 60MPa and for the steel pinion is 105MPa. Design the gear and check strength for dynamic and wear condition. Assume surface endurance strength 580MPa and velocity ratio is 3 : 1. (16 Marks)

**OR**

- 6 A pair of bevel gear with 20 pressure angle, consisting of 20 pinion teeth meshing with 30 gear teeth. The module is 4mm, while the face width is 20mm. The material for pinion and gear is steel ( $\sigma_0 = 250\text{N/mm}^2$ ). The gear teeth are lapped and ground (class - 3) and the surface hardness is 400 BHN. The pinion rotates at 500rpm and receives 2.5KW power from the electric motor. The starting torque of the motor is 150% of the rated torque. Determine the FOS against bending failure and against pitting failure. (16 Marks)

**Module-4**

- 7 a. Design a socket and spigot type cotter joint to sustain an axial load of 100kN. The material selected for the joints has the following design stresses  $\sigma_t = 100\text{N/mm}^2$   $\sigma_c = 150\text{N/mm}^2$   $\tau = 60\text{N/mm}^2$ . (08 Marks)  
 b. Design a knuckle joint to connect two mild steels rods subjected to an axial pull of 100kN. The allowable stresses for rod and pin are 100MPa, 130MPa and 60MPa in tension. Crushing and shear respectively. (08 Marks)

**OR**

- 8 a. Determine the dimensions of the tapered key used to transmit 10KW at 1000rpm. Also find the axial force necessary to drive the key home. The permissible shear and compressive stresses in the key material are  $60\text{N/mm}^2$  and  $130\text{N/mm}^2$  respectively. (10 Marks)  
 b. Show that the strength of square key is equal in both shear and compression. (06 Marks)

**Module-5**

- 9 a. Derive the Petroff's equation and state the assumptions. (08 Marks)  
 b. A 75mm long full journal bearing of 75mm in diameter supports a load of 12 kN at a speed of 1800rpm. Assume ratio of diameter to diametral clearance as 1000. The viscosity of the oil is 0.01 pa-s at the operating temperature. Determine :  
 i) Sommerfield number  
 ii) Co-efficient of friction based on Mckee equation  
 iii) Amount of heat generated. (08 Marks)

**OR**

- 10 a. Define hydrodynamic lubrication. Explain its principle. (08 Marks)  
 b. A single row deep groove ball bearing is subjected to a radial force of 7kN and the thrust force of 2.2kN. The shaft rotates at 1200rpm. The expected life 40h of the bearing is 20000h. The minimum acceptable diameter of the shaft is 75mm. Select a suitable ball bearing for this application. Take  $\chi = 0.56$  and  $Y = 1.8$ . (08 Marks)

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