



# CBCS SCHEME

17MT51

## Fifth Semester B.E. Degree Examination, July/August 2021 Design of Machine Elements

Time: 3 hrs.

Max. Marks: 100

**Note: 1. Answer any FIVE full questions.  
2. Use of design Data Hand Book is permitted.**

- 1 a. Explain briefly the six steps involve in the design procedure. (12 Marks)  
b. Explain the methods of reducing stress concentration. (08 Marks)
- 2 a. Explain the following theories for failure :  
i) Maximum Normal Stress theory  
ii) Maximum shear stress theory  
iii) Maximum distortion energy theory. (12 Marks)  
b. A machine element is loaded so that  $\sigma_1 = 120\text{MPa}$ ,  $\sigma_2 = 0$  and  $\sigma_3 = -90\text{MPa}$ . The material has a yield strength in tension and compression of  $360\text{MPa}$ . Find the factor of safety for each of the following failure theories.  
i) Maximum normal stress theory  
ii) Maximum shear stress theory  
iii) Distortion energy theory. (08 Marks)
- 3 Design a socket and spigot type cutter joint to sustain an axial load of  $100\text{kN}$ . The material selected for the joint has the following design stresses.  
 $\sigma_t = 100\text{N/mm}^2$ ;  $\tau = 60\text{N/mm}^2$ . (20 Marks)
- 4 Design a sleeve coupling to transmit  $10\text{KW}$  at  $200\text{ rpm}$ . The allowable values of shear stress and compressive stress for the shaft and key material may be taken as  $60\text{N/mm}^2$  and  $130\text{N/mm}^2$  respectively. Use allowable shear stress in cast iron sleeve equal to  $15\text{N/mm}^2$ . (20 Marks)
- 5 A shaft is supported by two bearings placed  $1\text{m}$  apart. A  $500\text{mm}$  diameter pulley is mounted at a distance of  $200\text{mm}$  to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of  $3000\text{N}$ . The pulley weighs  $1000\text{N}$ . Another pulley  $300\text{mm}$  diameter is placed  $300\text{mm}$  to the left of right hand bearing is driven with the help of electric motor and the belt which is placed horizontally to the right when viewed from the left bearing. This pulley weighs,  $500\text{N}$ . The angle of contact for both the pulleys is  $180^\circ$  and  $\mu = 0.24$ . Determine suitable diameter for a solid shaft, assuming torque on one pulley is equal to torque on other pulley. Choose (15 steel  $\sigma_y = 235.4\text{MPa}$ ,  $\sigma_u = 425\text{MPa}$ ) as the shaft material and use ASME code for the design of shaft. Assume minor shock condition. (20 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg,  $42+8 = 50$ , will be treated as malpractice.

- 6 A solid steel shaft running at 600rpm is supposed on bearings 600mm apart. The shaft receives 40KW through a 400mm diameter pulley weighing 400N located 300mm to the right of left bearing by a vertical flat belt drive. The power is transmitted from the shaft through another pulley of diameter 600mm weighing 600N located 200mm to the right of right bearing. The belt drives are at right angles to each other and ratio of belt tension is 3. Determine the size of shaft necessary, if the allowable shear stress in the shaft material is 40MPa and the loads are steady. (20 Marks)
- 7 A pair of carefully cut spur gears with 20 full depth involutes profile is used to transmit 12KW at 1200rpm of pinion. The gear has to rotate at 300rpm. The material used for both pinion and gear is medium carbon steel whose allowable bending stress may be taken as 230MPa. Determine the module and face width of the spur pinion and gear. Suggest suitable hardness. Take 24 teeth on pinion. Modulus of elasticity may be taken as 210GPa. (20 Marks)
- 8 Design a pair of helical gears to transmit power of 15KW at 3200rpm with speed reduction 4 : 1 pinion is made of cast steel 0.4% e-untreated. Gear is made of high grade CI. Helix angle is limited to  $26^\circ$  and not less than 20 teeth are to be used on either gear. Suggest suitable surface hardness for the gear pair. (20 Marks)
- 9 a. Define the following :  
i) Lubrication  
ii) Viscosity  
iii) Attitude  
iv) Eccentricity  
v) Square bearing. (10 Marks)
- b. State assumptions and derive Petroff's equation for coefficient of friction for hydrodynamic bearing. (10 Marks)
- 10 Design the main bearing of a stream turbine that runs at 1800rpm. The load on the bearing is estimated to be 2500N. (20 Marks)

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