ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

USN | | | | | | | | | | |

10MA53

Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Design of Machine Elements

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Use of data hand book is permitted.

PART – A

1 a. State and explain : i) max normal stress theory ii) max shear stress theory iii) distortion energy theory. **(09 Marks)**

b. A point in the structural member subjected to a plane stress as shown in Fig. Q1(b).

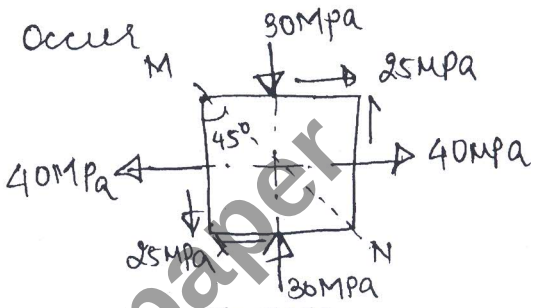

Fig. Q1(b)

Determine the following :
i) Normal and tangential stress intensities on plane inclined at 45°
ii) Principal stress and direction
iii) Max shear stress and direction on plane on which they occur. **(11 Marks)**

2 a. Derive Goodman relationship. **(05 Marks)**

b. Explain S–N diagram with neat figure. **(05 Marks)**

c. A steel rod of circular cross section is subjected to completely reversed bending moment of 500 N–m. Determine the diameter of rod required if the factor of safety is 2. Take σ_{en} = 200 MPa, σ_y = 234 MPa. **(10 Marks)**

3 a. Derive an expression for instantaneous stress due to axial impact. **(08 Marks)**

b. Design a rigid flange coupling to transmit 18 kW at 1440 rpm. the allowable shear stress in the cast iron flange is 4 MPa. The shaft and the key are made of annealed steel material of allowable shear stress with 93.384 N/mm^2. **(12 Marks)**

4 A shaft is supported by two bearings 1.5 mts apart. A 20° involute gear of 175 mm pitch circle diameter is keyed to the shaft at a distance of 400 mm to the left of right hand bearing and is driven by a gear directly behind the shaft. The tangential force on the gears acts vertically downward. A 600 mm dia pulley is keyed to the shaft 600 mn to the right of left bearing and drives a machine pulley with a horizontal belt directly behind it. the ratio of tension in the belt is 3 to 1. The drive transmits 45 kW at 330 rpm. Take $k_b = k_t = 1.5$. Determine the diameter of the shaft taking σ = 140 MPa. **(20 Marks)**

PART – B

5 a. Derive an expression for beam strength of a spur gear tooth with standard notations. **(05 Marks)**

b. A pair of spur gear has to transmit 20 kW from a shaft rotating at 1000 rpm to a parallel shaft, which is to rotate at 310 rpm. Numbers of teeth on Pinion is 31 with 20° full depth involutes form. The material for pinion is SAE 1040 untreated with allowable state stress 206.81 MPa and the material for gear is 0.20% C untreated with allowable static stress of 137.34 MPa. Determine the module and face width of the gear pair. Also find the dynamic tooth load on the gear. Take service factor as 1.5. Assume modulus of elasticity as 210 GPa for both pinion and gear. **(15 Marks)**

6 a. A mild steel plate of 15 mm thickness is welded to another plate by two parallel welds to carry a load of 50 kN. Determine the length of weld required :
i) Load is static ii) load is dynamic **(08 Marks)**

b. Design a socket and socket type cotter joint to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses, $\sigma_t = 100$ N/mm^2 $\sigma_c = 150$ N/mm^2 and $\tau = 60$ N/mm^2. **(12 Marks)**

7 a. A rail way wagon weighing 40 kN and moving with a speed of 10 km/hr loss to be stopped by four buffer springs in which the maximum compression allowed is 200 mm. Find the number of turns in each spring of mean diameters 150 mm. The diameter of spring wire is 25 mm. Take G = 82.7 GPa. **(10 Marks)**

b. Design a truck spring that has 12 number of leaves, two of which are full length leaves. The spring supports are 1 m apart and a central band is 70 mm wide. The central load is to be 6 kN with a permissible stress of 200 MPa. Determine the thickness, width and deflection of spring leaves if the ratio of total depth to width of spring is 3. **(10 Marks)**

8 a. Derive Petroff's equation for a lightly loaded bearing. **(05 Marks)**

b. Explain the bearing modulus. **(05 Marks)**

c. Select a single row deep groove ball bearing to carry a radial load of 4 kN and a thrust load of 5 kN operating at a speed of 1200 rpm for an average life of 15 years working 10 hours/day. Assume 250working days/ year and loads are steady. **(10 Marks)**

* * * * *