Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- Vth SEMESTER–EXAMINATION – MAY/JUNE - 2012

Subject code: 152503 **Date: 04/06/2012**

Subject Name: Design of Machine Elements-I

Time: 02:30 pm – 05:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What is Fatique? Explain factors to be considered while designing machine components to avoid fatique failure. **07**

(b) A plate made of steel 20C8 having ultimate tensile stress 440 N/mm^2 in hot-rolled and normalized condition as shown in figure 1.1, having surface finish factor 0.67. It is subjected to a completely reversed axial load of 30 KN. The notch sensitivity factor can be taken as 0.8 and the expected reliability is 90% (K_c=0.897). The factor of safety is 2. Determine the plate thickness for infinite life. Assume K_b = 0.85 & theoretical stress concentration factor as 2.51. **07**

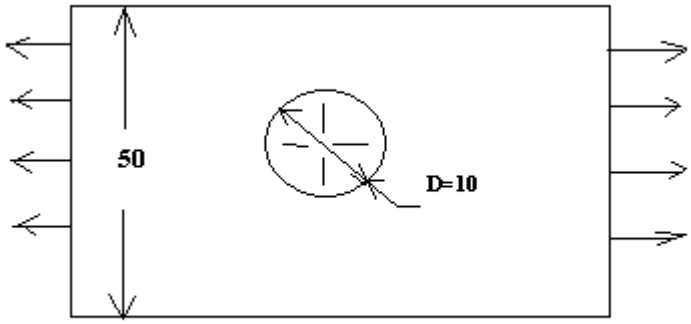

Figure 1.1

Q.2 **(a)** Explain with neat sketch Internal Expanding Break and its torque transmitting capacity. **07**

(b) A multiple disc clutch, steel on bronze, is to transmit 4.5 kW at 750 rpm. The inner radius of the contact is 40 mm and outer radius of the contact is 70 mm. The clutch operates in oil with an expected coefficient of 0.1. The average allowable pressure is 0.35 N/mm^2. Find: 1. The total number of steel and bronze discs; 2. the actual axial force required. **07**

OR

(b) A centrifugal clutch transmitting 20 KW at 750 rpm consists of 4 shoes. The clutch is to be engaged at 500 rpm. The inner radius of the drum is 165 mm while the radius to the centre of gravity of the shoes in engaged position is 140 mm. The coefficient of friction is 0.3. Calculate the mass of each shoe. **07**

Q.3 **(a)** Derive an expression for Lewis equation to calculate the beam strength of the Spur gear. **07**

(b) A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720 rpm. The normal pressure angle is 20^0, while the helix angle is 25^0. The face width is 40 mm and the normal module is 4 mm. the pinion as well as the gear are made of steel 40C8 having an ultimate tensile strength 600 N/mm^2 and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively. Assume velocity **07**

factor as 0.7543 which accounts for the dynamic load and calculate the power transmitting capacity of gears. Take form factor as 0.3475.

OR

Q.3 **(a)** Explain the terms used in bevel gear, i) formative number of teeth, ii) cone radius, iii) Force analysis of bevel gears **07**

(b) A pair of spur gears with 200 full-depth involute teeth consists of a 20 teeth pinion meshing with a 41 teeth gear. The module is 3 mm while the face width is 40 mm. The material for the pinion as well as the gear is steel with an ultimate tensile strength of 600 N/mm^2. The gears are machined to meet the specifications of Gr. 8 for which tolerance on the adjacent pitch is $e = 16 + 1.25\ \Phi$ and heat treated to a surface finish of 400 BHN. The pinion rotates at 1450 rpm and the service factor for the application is 1.75. Assume a minimum factor of safety of 1.5. Determine the rated power that the gears can transmit. **07**

Q.4 **(a)** Prove that "The bending stresses in full-length leaves are 50 % more than those in graduated-length leaves." **07**

(b) The turning moment diagram for a petrol engine is drawn to the following scales: **07**
Turning moment, 1 mm = 5 N-m;
Crank angle, 1 mm = 1º.
The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line, taken in order are 295, 685, 40, 340, 960, 270 mm^2. Determine the mass of 300 mm diameter flywheel rim when the coefficient of fluctuation of speed is 0.3% and the engine runs at 1800 rpm. Also determine the cross-section of the rim when the width of the rim is twice of thickness.
Assume density of rim material as 7250 kg / m^3.

OR

Q.4 **(a)** Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 M Pa and modulus of rigidity is 84 KN / mm^2. **07**

(b) Prove that the ratio of the driving tensions on the two sides of a pulley is $T_1/T_2 = e^{\mu\theta}$ **07**

Where, T_1 = Tension in the tight side of the belt,
T_2 = Tension in the slack side of the belt
Θ = Angle of contact in radians
μ = coefficient of friction between the belt and pulley.

Q.5 **(a)** 1) Differentiate between thick and thin cylinder pressure vessels. 2) Explain the types of stresses induced in thin cylinder pressure vessels. **07**

(b) The piston rod of a hydraulic cylinder exerts an operating force of 10 KN. The friction due to piston packing's and stuffing box is equivalent to 10 % of operating force. The pressure in the cylinder is 10 M Pa. The cylinder is made of cast iron FG 200 and the factor of safety is 5. Determine the diameter and thickness of the cylinder. **07**

OR

Q.5 **(a)** Calculate the diameter of a piston rod for a cylinder of 1.5 m diameter in which the greatest difference of steam pressure on the two sides of the piston may be assumed to be 0.2 N/mm^2. The rod is made of mild steel and is secured to the piston by a tapered rod and nut and to the crosshead
by a cotter. Assume modulus of elasticity as 200 KN/mm^2 and factor of safety as 8. The length of rod may be assumed as 3 meters. **07**

(b) What is stress concentration? Explain the methods of reducing stress concentration with sketch. **07**

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