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Total number of printed pages – 4

B. Tech.
PCME 4306

Sixth Semester Examination – 2011

DESIGN OF MACHINE COMPONENTS

Full Marks – 70

Time : 3 Hours

*Answer Question No. 1 which is compulsory and any **four** from the rest.*

The figures in the right-hand margin indicate marks.

Draw neat sketches wherever necessary.

Assume any missing data suitably.

Use of Prescribed Design Data Book is permitted inside the examination hall.

1. Answer the following questions : 2×10
- (a) What is the difference between S~N Curves for ferrous and non-ferrous mechanical components ?
 - (b) What is stress concentration factor ? What are the methods of reducing stress concentration ?
 - (c) Explain briefly about the following terms :
 - (i) Notch sensitivity
 - (ii) Endurance limit
 - (d) What is the functional difference between a brake and a clutch ?
 - (e) Why in case of thin cylinder subjected to internal pressure, the tangential stress is the criteria for determine the thickness of the cylinder wall ?
 - (f) Describe the working principle of centrifugal clutch.

P.T.O.

- (g) Define basic static load capacity, basic dynamic load capacity and life of a bearing.
- (h) Define virtual number of teeth for a helical gear and bevel gear.
- (i) Why is a hollow piston pin preferred to a solid one ?
- (j) Which type of the cross-section do you prefer for the main body of the connecting rod and why ?
2. (a) A machine component is subjected to a flexural stress which fluctuates between $+350 \text{ MN/m}^2$ and -250 MN/m^2 . Determine the value of minimum ultimate strength according to Goodman's relation and yield strength according to Soderberg's relation. Yield strength = 0.55 ultimate strength, endurance strength = 0.5 ultimate strength and factor of safety = 2. 6.5
- (b) The inner diameter of a cylindrical tank for liquefied gas is 200 mm. The gas pressure is limited to 10 MPa. The tank is made of plain carbon steel 10C4 having ultimate tensile strength 340 N/mm^2 and poisson's ratio 0.3. Design the cylinder wall. 6
3. Design a connecting rod for a carburetor engine from the following data : Diameter of piston is 0.08 m, mass of the reciprocating part is 1.8 kg, length of the connecting rod is 0.350 m, stroke is 0.125 m, speed is 1500 rpm with possible overspeed 2500 rpm, compression ratio is 4 : 1 and maximum explosion pressure is 3 MPa. Material for the connecting rod is 37Mn2 with yield strength 460 N/mm^2 . Allowable bearing pressure is 15 N/mm^2 . Material for the bolt is 35Ni1Cr60 having tensile strength 600 N/mm^2 . Assume other suitable data. 12.5
4. Design a pair of helical gears to transmit 20 kW power at a speed reduction ratio of 4 : 1. The input shaft rotates at 2000 rpm. Take helix and normal pressure angles equal to 25° and 20° respectively. Both pinion and gear are

made of steel having following data. The number of teeth on the pinion may be taken as 30. Assume other suitable data. Young's modulus for shaft, gear and pinion is $0.2 \times 10^6 \text{ N/mm}^2$. The gears are required to be designed against bending failure of the teeth under dynamic condition.

Name of the part	Permissible stress	BHN
Pinion	50 MPa	350
Gear	45 MPa	310

5. (a) What are the design requirements for a friction clutch ? 2.5
- (b) Design a suitable clutch for the speed gear box of a lathe machine to transmit 15 kW at 1200 rpm. Due to space limitation, the outer diameter is limited to 130 mm. Select axial friction clutch with woven asbestos friction lining having co-efficient of friction as 0.2. The maximum operating temperature is limited to 250° . Take overload as 25%. Maximum pressure at inner radius is 0.35 N/mm^2 . 10
6. Design a journal bearing for transmitting power 20 MW, 500 rpm steam turbine which is supported by two bearings for the following data. Consider the bearing to be an average industrial bearing.
- The bearing is 360° Hydrodynamic bearing, Journal diameter = Bearing length, The steam turbine shaft is made of alloy steel 40Ni2Cr1Mo28 having yield strength of about 1275 N/mm^2 , Ambient temperature is 25°C , temperature of the oil film is 60°C , heat transfer coefficient is $15 \text{ W/(m}^2\text{K)}$, Bearing cap is made of gray CI of FG250 with tensile strength 250 N/mm^2 , bolt material is 45C8 having allowable strength 80 N/mm^2 . 12.5
7. Design a flywheel for a single-cylinder, four stroke vertical cylinder diesel engine 12.5 developing 4 kW at 1200 rpm. Assume coefficient of speed fluctuation as 0.01 and coefficient of fluctuation of energy as 2.35. The flywheel is made of gray cast iron having limiting speed 25 m/sec. Assume

the mass of the rim is 90% of the total mass and remaining 10% is contributed by web and hub. Density of the rim material is 7100 kg/m^3 and the width to thickness ratio of rim is 1.5. The flywheel is fixed to a overhang shaft. The length of the overhang is 250 mm. Assume allowable shear stress for the crankshaft and key as 50 MPa and for cast iron in tension as 20 MPa. The combined shock and fatigue factors for tension and bending may be taken as 1.2 and 1.5 respectively. 12.5

8. Answer the following : 2.5×5

(a) Define the following terms :

- (i) Flywheel effect
- (ii) Coefficient of fluctuation of speed and
- (iii) Coefficient of fluctuation of energy.

(b) Discuss the suitability of CI as the gear material.

(c) What is meant by whipping of a connecting rod and what is its effect?

(d) Why the tangential component of gear tooth force is called 'useful' component?

(e) What are the design requirements of piston ?