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Roll No .....

ME-802 (GS)

B.E. VIII Semester

Examination, May 2018

Grading System (GS)

Machine Design

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt five questions.
ii) All questions carry equal marks.
iii) Assume suitable data, if required.
iv) Use of Design Data Book is permitted.

1. A rope drive is to transmit 250 kW from a pulley of 1.2 m diameter, running at a speed of 300 rpm. The angle of lap may be taken as π radians. The groove half angle is 22.5°. The ropes to be used are 50 mm in diameter. The mass of the rope is 1.3 kg per metre length and each rope has a maximum pull of 2.2 kN, the coefficient of friction between rope and pulley is 0.3. Determine the number of ropes required. If the overhang of the pulley is 0.5 m, suggest suitable size for the pulley shaft if it is made of steel with a shear stress of 40 MPa.

2. Design a chain drive to actuate a compressor from 15 kW electric motor running at 1000 rpm, the compressor speed being 350 rpm. The minimum centre distance is 500 mm. The compressor operates 16 hours per day. The chain tension may be adjusted by shifting the motor on slides.

3. A pair of straight bevel gears, mounted on shafts that are intersecting at right angles, consists of a 24 teeth pinion meshing with a 32 teeth gear. The pinion shaft is connected to an electric motor developing 12.5 kW rated power at 1440 rpm. The starting torque of the motor is 150% of the rated torque. The pressure angle is 20°. Both gears are made of case hardened steel (S_{ut} = 750 N/mm^2). The teeth on gears are generated and finished by grinding and lapping processes to meet the requirements of Class-3 Grade. The factor of safety in preliminary stages of gear design is 2.
   i) In the initial stages of gear design, assume that velocity factor accounts for the dynamic load and that the pitch line velocity is 7.5 m/s. Estimate the module based on beam strength.
   ii) Select the first preference value of module and calculate the main dimensions of the gears.
   iii) Determine the dynamic load using Buckingham's equation and find out the effective load for above dimensions. What is the correct factor of safety for bending?
   iv) Specify the surface hardness for the gears assuming a factor of safety of 2 for wear consideration.

4. A pair of parallel helical gears consists of 24 teeth pinion rotating at 5000 rpm and supplying 2.5 kW power to a gear. The speed reduction is 4:1. The normal pressure angle and helix angle are 20° and 23° respectively. Both gears are made of hardened steel (S_{ut} = 750 N/mm^2). The service factor and the factor of safety are 1.5 and 2 respectively. The gears are finished to meet the accuracy of Grade-4.
   i) In the initial stages of gear design, assume that the velocity factor accounts for the dynamic load and that the face width is ten times the normal module. Assuming the pitch line velocity to be 10 m/s, estimate the normal module.

ii) Select the first preference value of the normal module and calculate the main dimensions of the gears.

iii) Determine the dynamic load using Buckingham's equation and find out the effective load for the above dimensions. What is the correct factor of safety for bending?

iv) Specify surface hardness for the gears, assuming a factor of safety of 2 for wear consideration.

5. Design a side crankshaft for a 500mm × 600mm gas engine. The weight of the flywheel is 80 kN and the explosion pressure is 2.5N/mm^2. The gas pressure at maximum torque is 0.9N/mm^2 when the crank angle is 30°. The connecting rod is 4.5 times the crank radius. Any other data required for the design may be assumed.

6. A connecting rod is required to be designed for a high speed, four stroke I.C. engine. The following data are available.

Diameter of piston	= 88 mm
Mass of reciprocating parts	= 1.6 kg
Length of connecting rod (centre to centre)	= 300 mm
Stroke	= 125 mm
R.P.M. (when developing 50 kW)	= 2200
Possible over speed	= 3000 rpm
Compression ratio	= 6.8:1
Probable maximum explosion pressure (Assumed shortly after dead centre, say at about 3°)	= 3.5 N/mm^2

Draw fully dimensioned drawings of the connecting rod showing the provision for the lubrication.

7. Design a bushed-pin type of flexible coupling to connect a pump shaft to a motor shaft transmitting 32 kW at 960 rpm. The overall torque is 20 percent more than mean torque. The material properties are as follows:

i) The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively.

ii) The allowable shear stress for cast iron is 15 MPa.

iii) The allowable bearing pressure for rubber bush is 0.8 N/mm^2.

iv) The material of the pin is same as that of shaft and key.

Draw neat sketch of the coupling.

8. Answer any four of the following:

a) What do you understand by simplex, duplex and triplex chains?

b) State the advantages of the cycloidal gears.

c) State the function of the following in an internal combustion engine:

i) Ribs

ii) Piston Skirt

iii) Piston Rings

d) Compare the stress distribution in a thin and thick walled pressure vessel.

e) What is the difference between a constraint surface and a composite constraint surface?

f) Find the extreme points of the function

$$f(x_1, x_2) = x_1^3 + x_2^3 + 2x_1^2 + 4x_2^2 + 6$$

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