Total No. of Questions : 10] [Total No. of Printed Pages : 5

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ME–802(N)

B. E. (Eighth Semester) EXAMINATION, June, 2011

(Mechanical Engg. Branch)

MACHINE DESIGN

[ME – 802(N)]

Time : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : (i) Attempt any *five* questions. At least *one* question from each Unit. All questions carry equal marks.

(ii) Assume suitable data, if required.

(iii) Use of Design Data Book is permitted.

Unit – I

1. An overhung pulley transmits 35 kW at 240 r.p.m. The belt drive is vertical and the angle of wrap may be taken as 180°. The distance of the pulley centre line from the nearest bearing is 350 mm, $\mu = 0{\cdot}25$. Determine : 20

   (a) Diameter of the pulley

   (b) Width of the belt

   (c) Diameter of the shaft

   (d) Dimensions of the key for securing the pulley on to the shaft

   (e) Size of the arms six in number

The following stresses may be taken for design purposes :

Shaft tension and compression	= 80 MPa
Key shear	= 50 MPa
Belt : Tension	= 2·5 MPa
Pulley rim : Tension	= 4·5 MPa
Pulley arms : Tension	= 15 MPa

Or

2. A rope drive is to transmit 250 kW from a pulley of 1·2 m diameter, running at a speed of 300 r.p.m. 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. 20

Unit – II

3. It is required to design a two stage spur gear reduction unit with 20° full depth involute teeth. The input shaft rotates at 1440 r. p. m. and receives 10 kW power through a flexible coupling. The speed of the output shaft should be approximately 180 r. p. m. The gears are made of plain carbon steel 145C8 (S_{ut} = 700 N/mm^2) and heat-treated to a surface hardness of 340 BHN. The gears are to be machined to the requirements of Grade-6. The service factor can be taken as 1·5. 20

(a) Assuming that the dynamic load to be proportional to the pitch line velocity, estimate the required value of the module. The factor of safety is 1·5.

(b) Select the first preference value of the module and determine the correct value of factor of safety for bending, using Buckingham's equation.

(c) Determine the factor of safety for pitting.

(d) Give a list of gear dimensions.

Or

4. A pair of straight bevel gears is mounted on shafts, which are intersecting at right angles. The number of teeth on the pinion and gear are 21 and 28 respectively. The pressure angle is 20°. The pinion shaft is connected to an electric motor developing 5 kW rated power at 1440 r. p. m. The service factor can be taken as 1·5. The pinion and the gear are made of steel (S_{ut} = 750 N/mm^2) and heat-treated to a surface hardness of 380 BHN. The gears are machined by a manufacturing process that limits the error between meshing teeth to 10 μ m. The module and face width are 4 mm and 20 mm respectively. Determine the factor of safety for bending as well as for pitting. 20

Unit – III

5. A four stroke diesel engine has the following specifications : 20

Brake power	= 5 kW
Speed	= 1200 r. p. m.
Indicated mean effective pressure	= 0·35 N/mm^2
Mechanical efficiency	= 80%

Determine :

(a) Bore and length of the cylinder.

(b) Thickness of the cylinder head.

(c) Size of studs for the cylinder head.

Or

6. Design a cast iron piston for a single acting four stroke engine for the following data : 20

Cylinder bore	= 100 mm
Stroke	= 125 mm
Maximum gas pressure	= 5 N/mm^2
Indicated mean effective pressure	= 0·75 N/mm^2
Mechanical efficiency	= 80%
Fuel consumption	= 0·15 kg per brake power per hour
Higher calorific value of fuel	= 42 × 10^3 kJ/kg
Speed	= 2000 r. p. m.

Any other data required for the design may be assumed.

Unit – IV

7. (a) Discuss the function of a coupling. Give at least *three* practical applications. 6

(b) The shaft and the flange of a marine engine are to be designed for flange coupling, in which the flange is forged on the end of the shaft. The following particulars are to be considered in the design : 14

Power of the engine	= 3 MW
Speed of the engine	= 100 r. p. m.
Permissible shear stress in bolts and shaft	= 60 MPa
Number of bolts used	= 8
Pitch circle diameter of bolts	= 1·6 × Diameter of shaft

Find :

(i) Diameter of shaft
(ii) Diameter of bolts
(iii) Thickness of flange
(iv) Diameter of flange

Or

8. (a) Show that in case of a thin cylindrical shell subjected to an internal fluid pressure, the tendency to burst lengthwise is twice as great as at a transverse section. 6

(b) A shrink fit assembly, formed by shrinking one tube over another, is subjected to an internal pressure of 60 N/mm^2. Before the fluid is admitted, the internal and the external diameters of the assembly are 120 mm and 200 mm and the diameter at the junction is 160 mm. If after shrinking on, the contact pressure at the junction is 8 N/m m^2, determine using Lame's equations, the stresses at the inner, mating and outer surfaces of the assembly after the fluid has been admitted. 14

Unit – V

9. (a) Discuss Constrained and Unconstrained Optimization. 7

(b) Find the dimensions of a box of the largest volume which can be inscribed in a sphere of unit radius. 13

Or

10. (a) Discuss the unimodal function in detail with neat sketches. 6

(b) Determine the maximum and minimum values of the function : 14

$$f(x) = 12x^5 - 45x^4 + 30x^3 + 24x^2 + 5$$