Total No. of Questions : 6]

SEAT No. :

P14

[Total No. of Pages : 4

TE/Insem./APR - 17
T.E. (Mechanical)
302048 : DESIGN OF MACHINE ELEMENTS-II
(2015 Course) (Semester - II)

Time : 1 Hour] *[Max. Marks : 30*

Instructions to the candidates:

1) ***Answer any three questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicates full marks.***
4) ***Use of logarithmic tables and electronic pocket calculator is allowed.***
5) ***Assume suitable data, if necessary.***

Q1) a) How to decide number of stages and gear ratio per stage in the gear box design. **[4]**

b) The following data is given for a pair of spur gears with 20° full-depth involute teeth: **[6]**

Number of teeth on pinion = 24

Number of teeth on gear = 56

Speed of pinion = 1200 rpm

Module = 3 mm

Service factor = 1.5

Face width = 30 mm

Both gears are made of steel with an ultimate tensile strength of 600 N/mm^2. Using the velocity factor to account for the dynamic load, calculate

i. Beam strength;

ii. The static load that the gears can transmit without bending failure, if the factor of safety is 1.5; and

iii. Rated power that the gears can transmit.

Lewis form factor (Y) = 0.484 - 2.87/Z, Where Z - Number of teeth

Velocity factor (C_v)=3/(3+V), Where V - Pitch line velocity in m/s

OR

P.T.O.

Q2) It is required to design a pair of spur gears with 20° full-depth involute teeth based on the Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 15 kW, 1440 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4 : 1. The pinion as well as the gear is made of plain carbon steel 40C8 $\left(\sigma_{ut}=750\text{N/mm}^2\right)$. The factor of safety can be taken as 1.5. Design the gears based on velocity factor by assuming the pitch line velocity to be 5 m/s to account for the dynamic load, specify their dimensions and suggest suitable surface hardness for the gears.

Lewis form factor (Y) = 0.484 – 2.87/Z, Where Z – Number of teeth

Velocity factor (C_v)=3/(3+V), Where V - Pitch line velocity in m/s

Load stess factor (K)=0.16 $(BHN/100)^2$ N/mm^2 **[10]**

Q3) a) What is Virtual Number of Teeth in helical gear. Derive the expression for Virtual Number of Teeth in helical gear. **[4]**

b) 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 $\left(\sigma_{ut}=750\text{N/mm}^2\right)$. The service factor and the factor of safety are 1.5 and 2 respectively. **[6]**

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 10m/s, estimate the normal module.

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

Lewis form factor (Y') = 0.484 - 2.87/Z', Where Z' – Formative Number of teeth Velocity factor (C_v)=5.6/(5.6+√V), Where V - Pitch line velocity in m/s

OR

Q4) 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 rpm. The service factor can be taken as 1.5. The pinion and the gear are made of steel $\left(\sigma_{ut}=750\text{N/mm}^2\right)$ and heat-treated to a surface hardness of 380 BHN. The gears are machined by a manufacturing process, which limits the error between the meshing teeth to 0.01mm. The module and face width are 4 mm and 20 mm respectively. Determine the factor of safety against bending as well as against pitting failure.

Lewis form factor (Y') = 0.484 – 2.87/Z', Where Z' – formative Number of teeth

Load stress factor (K) = 0.16 (BHN/100)^{2}N/mm^2, C = 11400N/mm^2

$$F_d = \frac{21v\left(Ceb+F_t\right)}{21v+\sqrt{\left(Ceb+F_t\right)}}N$$ **[10]**

Q5) a) A ball bearing is operating on a work cycle consisting of three parts - a radial load of 3000 N at 1440 rpm for one quarter cycle, a radial load of 5000 N at 720 rpm for one half cycle, and radial load of 2500 N at 1440 rpm for the remaining cycle. The expected life of the bearing is 10000 h. Calculate the dynamic load carrying capacity of the bearing. **[4]**

b) A system involves four identical ball bearings, each subjected to a radial load of 2500 N. The reliability of the system, i.e., one out of four bearings failing during the lifetime of five million revolutions, is 82%. Determine the dynamic load carrying capacity of the bearing, so as to select it from the manufacturer's catalogue based on 90% reliability. **[6]**

OR

Q6) A shaft transmitting 50 KW at 125 rpm from the gear G_1 to the gear G_2 and mounted on two single-row deep groove ball bearings B_1 and B_2 is shown in Fig 1. The gear tooth forces are Pt_1 = 15915 N, Pr_1 = 5793 N, Pt_2 = 9549 N,

Pr_2 = 3476 N. The diameter of the shaft at bearings B_1 and B_2 is 75 mm. The load factor is 1.4 and the expected life for 90% of the bearings is 10000 hrs. Select suitable ball bearings from Table No. - 1. **[10]**

Fig. 1

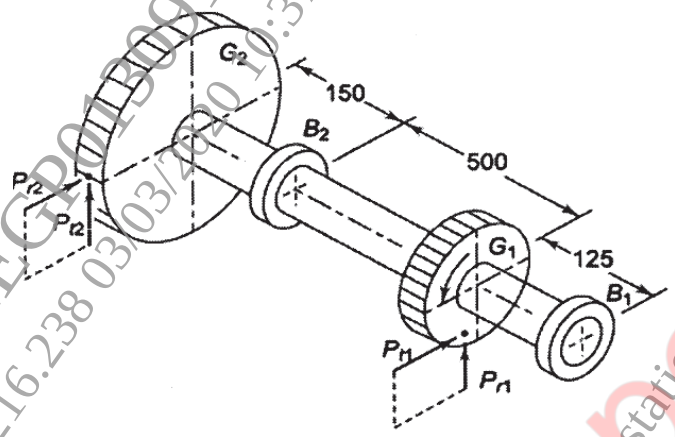

Table No.-1

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	*D*	*B*	*C*	C_o	
75	95	10	12500	9800	61815
	115	13	28600	20000	10615
	115	20	39700	26000	6015
	130	25	66300	40500	6215
	160	37	112000	72000	6315
	190	45	153000	114000	6415