BACHELOR OF TECHNOLOGY (C.B.C.S.) (2014 COURSE)
B.Tech.Sem - VI MECHANICAL : : SUMMER - 2022
SUBJECT : MACHINE DESIGN-II

Day : Monday
Date : 13-06-2022

S-13450-2022

Time : 02:30 PM-06:30 PM
Max. Marks : 60

N. B.:

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Assume suitable data if necessary.

Q.1 What are the principles of Design for Manufacture and Assembly (DFMA)? **(10)**

OR

What are the principles for the design of machined component? **(10)**

Q.2 A pair of spur gears, with a 20° full-depth involute teeth, consists of 25 teeth pinion meshing with 60 teeth gear. An electric motor of 7.5 kW power and 1440 r.p.m. speed is connected to the pinion shaft. Both the pinion and gear are made of plain carbon steel 40C8 with an ultimate tensile strength of 420 N/mm^2. Design the gear pair and determine the surface hardness of gear pair, using the following data: **(10)**

Face width	= 10m
Velocity factor	= 6 / (6 +V)
Lewis form factors, Y_p	= 0.340 and Y_g = 0.421
Service factor	= 1.75
Factor of safety	= 2
Deformation factor, C	= 11400e
For Grade 8, e = 16.00 + 1.25 ϕ where ϕ	= m + 0.25 (d) $^{1/2}$

OR

A spur gear pair is to be used to transmit 3 kW power from an electric motor running at 1440 r.p.m. to a pump running at 720 r.p.m. The center to center distance between the axes of the pinion and gear should be exactly 180 mm. The gear pair is to be made of plain carbon steel 50C4 having permissible bending stress of 100 MPa. The total error in meshing teeth is 10 microns and deformation factor is 11400e, N/mm. Assuming service factor, load distribution factor and factor of safety as one design the gear pair and suggest surface hardness. Use following data : **(10)**

Velocity factor, $K_v = \dfrac{6}{6+v}$

Dynamic load, $F_d = \dfrac{21V\left(bC + F_{t\max}\right)}{21V + \sqrt{bC + F_{t\max}}}$

Standard module in mm :
1, 1.25, 1.5, 2.0, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, 20

P.T.O.

Q.3 A helical pinion having 14 teeth to be made alloy steel 40Ni2Cr1Mo28 (S_{ut} = 800 N/mm^2) is to mesh with a gear to be made of plain carbon steel 55C8 (S_{ut} = 720 N/mm^2). The gear pair is required to transmit 30 kW power from an electric motor running at 720 r.p.m. to a machine running at 225 r.p.m. The application factor and load concentration factor are 1.3 and 1.1 respectively. The required factor of safety in 2.0. The face width is ten times the normal module and tooth system is 20° full-depth involute. The helix angle in 25°. The gears are machined to meet the specifications of grade 7. The deformation factor for gear pair is 11000 e, N/mm. Design the gear pair by using the velocity factor and Buckingham's equation for dynamic load. Suggest the surface hardness for gear pair. **(10)**

OR

A pair of helical gear is used to transmit 10 kW power from an automotive multi-plate clutch to a constant mesh gear box. The clutch rotates at 7200 r.p.m. while the gear box input shaft rotates at 2600 r.p.m. The number of teeth on pinion is 20, the normal pressure angle is 20° and helix angle is 25° the material for gear pair may be taken as plain carbon steel 40C8 with ultimate tensile strength of 600 MPa and surface hardness of 300 BHN. The gear pair is machined to meet the specification of grade 4. The factor of safety and service factor are 2 and 1.5 respectively. Design the gear pair by using velocity factor and Buckingham's equation for dynamic load. Explain how all the types of gear tooth failure are avoided in this case? Use the following data : **(10)**

$$Y = 0.484 - \frac{2.87}{Z^1}$$

For Grade 4, $e = 3.2 + 0.25\ (m + 0.25\sqrt{d})$

$$F_d = \frac{21V\,(bC\cos^2\psi + F_t)}{21V + \sqrt{bC\cos^2\psi\, F_t}}$$

C = 11400 N/mm^2

Q.4 A single-row deep-groove ball bearing is used to support shaft of four speed automobile gear box. It is subjected to following cycles : **(10)**

Gear	Axial Load, 'Fa', 'N'	Radial Load, 'Fr', 'N'	Radial Load Factor, X	Axial Load Factor, Y	% Time Engaged
First	3250	4000	0.56	1.176	1%
Second	500	2750	1	0	3%
Third	50	2750	1	0	21%
Fourth	Nil	Nil	1	0	75%

The shaft is connected to engine shaft and rotate at 1750 r.p.m. Calculate the dynamic load carrying capacity, if expected life of bearing is 4000 hours.

OR

A ball bearing carries a radial load of 400 N at 1760 r.p.m. for 40% time, 600 N at 880 r.p.m. for 30% time, 200 N at 1000 r.p.m. for 10 % time and no load at 1500 r.p.m. for remaining period of the cycle. If the expected life of the bearing is 10,000 hours with 95% reliability, calculate : **(10)**

i) the basic dynamic load capacity of the bearing and

ii) the average speed of bearing operation.

Use following relation for reliability analysis

$$\frac{L}{L_{10}} = \left[9.49 \ln\left(\frac{1}{R}\right)\right]^{\frac{1}{1.17}}$$

Q.5 The hydrodynamic bearing has a diameter and a length of 100 mm. The radial load on the bearing is 30 kN. The journal speed is 1500 r.p.m. and the radial clearance is 100 microns. If the viscosity of the oil is 25 cP, determine : **(10)**

i) the minimum oil film thickness:
ii) the probable coefficient of friction;
iii) the power lost in friction;
iv) the quantity of oil in circulation; and
v) the side leakage.

If the make-up oil is supplied at 30°C, find the average oil temperature. Assume specific gravity of oil as 0.86 and the specific heat as 2.09 kJ/kg°C. use the data given in Table 1

Table 1

$\left(\frac{L}{D}\right)$	$\in$	$\frac{h_o}{c}$	S	ϕ	$\left(\frac{r}{c}\right)f$	$\frac{Q}{rcn_sL}$	$\frac{Q_s}{Q}$	$\frac{P}{P_{max}}$
1	0.4	0.6	0.264	63.10	5.79	3.99	0.497	0.484
	0.6	0.4	0.121	50.58	3.22	4.33	0.680	0.415
	0.8	0.2	0.0446	36.24	1.70	4.62	0.842	0.313
	0.9	0.1	0.0188	26.45	1.05	4.74	0.919	0.247
	0.97	0.03	0.00474	15.47	0.514	4.82	0.973	0.152
	1.0	0	0	0	0	0	1.0	0
	0.2	0.8	0.631	-	12.8	3.59	0.280	1.890
	0.1	0.9	1.33	-	26.4	3.37	0.250	1.852

OR

Following data given for 360° hydrodynamic bearing : **(10)**
Radial load = 10 kN
Journal speed = 1440 r.p.m.
$\frac{l}{d}=1$
Unit bearing pressure = 1000 kPa
Clearance ratio (r/c) = 800
Viscosity of lubricant = 30 mPa-S
Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing calculate :

i) the dimensions of bearing;
ii) the coefficient of friction;
iii) the power lost in friction;
iv) the total flow of oil;
v) the side leakage;
vi) the temperature rise;
vii) the average temperature (inlet temperature is 40° C); and
viii) the maximum pressure (P_{max})

Use the data given in Table 1

Q.6 How wire ropes are designated? Discuss their construction and applications. **(10)**

OR

Explain the procedure for the selection of flat belt from manufacturer's catalogue. **(10)**

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