Total No. of Questions : 12]

SEAT No. :

P2259

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T.E. (Mechanical Engineering)

MACHINE DESIGN - II

(2008 Course) (302047) (Semester - II)

Time : 4 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) *Answer three questions from Section I and three questions from Section II.*
2) *Answers to the two Sections should be written in separate answer books.*
3) *Figures to the right side indicate full marks.*
4) *Neat diagrams must be drawn wherever necessary.*
5) *Use of Electronic Pocket Calculator is allowed.*
6) *Assume suitable data, if necessary, and mention it clearly.*

SECTION - I

Q1) a) A one work cycle consists of following parts

	Part I	Part II
Duration (seconds)	40 s	20 s
P_r (Radial load)	600 N	300 N
P_a (Axial load)	200 N	120 N
speed	1440 rpm	720 rpm

Static load and dynamic load carrying capacities are 695 N and 1430 N, respectively, for the bearing. Calculate the life of bearing in hours. Consider that the inner race of the ball bearing is rotating [Refer Table - 1] **[14]**

b) What is preloading of bearing? Explain any one with sketch. **[4]**

OR

P.T.O.

Q2) a) Select a single row deep groove ball bearing with the operating cycle listed below, which will have a life of 15000 hours. **[12]**

Fraction of cycle	Type of load	Radial (N)	Thrust (N)	Speed(rpm)	Service factor
1/10	Heavy shocks	2000	1200	400	3
1/10	Light shocks	1500	1000	500	1.5
1/5	Moderate Shocks	1000	1500	600	2
3/5	No shock	1200	2000	800	1

Assume radial and axial loads to be 1.0 and 1.5 respectively and inner race rotates.

b) Write a short note on selection of bearing type. **[6]**

Q3) a) The following data is given for a full, hydrodynamic bearing: **[12]**

Journal speed: 1440 rpm, Journal diameter: 60 mm, Bearing length: 60 mm, radial clearance: 0.06mm, radial load: 3 kN, viscosity of lubricant: 30 cP.

Assume that total heat generated due to friction in bearing is carried by the total lubricant flow. Calculate:

i) Coefficient of friction

ii) Minimum oil flim thickness

iii) Flow requirement

iv) Temperature rise

v) Power lost in friction. [Refer- Table - 2].

b) Write a short note on additives for mineral oils. **[4]**

OR

Q4) a) Following data is given for a full hydrodynamic bearing: **[10]**

Radial load: 22 kN, journal speed: 960 rpm, Unit pressure in bearing: 2.4 MPa, 1/d = 1:1, viscosity of lubricant = 20 cP, Ratio of h_o/c = 0.2 = (Minimum oil thickness)/(radial clearance) [Refer Table - 2]

Determine:

i) Dimensions of bearing

ii) Minimum film thickness

iii) Requirements of oil flow.

b) Explain properties and selection of bearing material in sliding contact bearing. **[6]**

Q5) a) What are different modifying factors? Write in details of any three modifying factor and its selection. **[6]**

b) The work cycle of a shaft subjected to completely reverse bending stresses consists of the following three elements: **[10]**

i) $\pm$ 350 N/mm^2 for 85% of time,

ii) $\pm$ 400 N/mm^2 for 12% of time, and

iii) $\pm$ 500 N/mm^2 for remaining time.

The material for shaft is 50C4 (S_{ut} = 660N/mm^2) and the corrected endurance limit of shaft is 280 N/mm^2. Determine life of shaft.

OR

Q6) a) Explain in brief bolted joint under fluctuating load. **[6]**

b) A machine component is subjected to two-dimensional stresses. The tensile stress in the X direction varies from 40 to 100 N/mm^2 while the tensile stress in the Y direction varies from 10 to 80 N/mm^2. The frequency of variation of these stresses is equal. The corrected endurance limit of the component is 270 N/mm^2. The ultimate tensile strength of the material of the component is 660 N/mm^2. Determine the factor of safety used by the designer. **[10]**

SECTION - II

Q7) a) List desirable properties of good friction lining materials for clutches. Also list the different materials. **[4]**

b) Explain self energizing and self locking brakes. **[4]**

c) A single plate clutch consisting of two pairs of contacting surfaces is required to transmit 35 kW at 1440 rpm. The coefficient of friction between the contacting surfaces is 0.3 and intensity of pressure is limited to 0.38 N/mm^2. The outer diameter of friction disc is limited to 290 mm. If service factor is 1.25, determine: **[8]**

i) Inner diameter of friction disc.
ii) Axial force required to engage the clutch.

OR

Q8) a) Draw a neat labeled sketch of internal expanding shoe brake. **[4]**

b) Differentiate between single plate and multiplate clutch. **[4]**

c) A caliper disk brake is to design for sport car. The required braking capacity of each brake is 450 N-m. The inner and outer radia of friction pad are 100 mm and 150 mm resp. The coefficient of friction between the pads and rotating disc is 0.4. While the limiting intensity of pressure is 1.1 N/mm^2. Determine, the required no. of pads if the pads are annular segment with subtended angle 60° per pad at centre of disc. Draw the sketch showing disc and annular pads. **[8]**

Q9) a) What are effect of increasing and decreasing pressure angle in design of gear pair. **[4]**

b) A spur gear pair 20° full depth involute gear profile consist of 18 teeth pinion meshing with 36 teeth gear. The pinion and gear are made of steel with S_{ut} - 600 N/mm^2 and 510 N/mm^2 resp. The module is 5 mm while the face width is 10 × m. The surface hardness of pinion and gear are 330BHN and 280 BHN resp.

Calculate:

i) Beam strength

ii) Wear strength

iii) Rated power that the gear can transmit

iv) Maximum static load on gear.

Assume service factor & factor of safety 1.5 & 2 resp.

Use following data:

- Pinion speed - 1440 rpm

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

- $V = \frac{5.6}{5.6 + \sqrt{V}}$ **[14]**

OR

Q10) a) What is formative no. of teeth in helical gear. Derive the expression for it. **[4]**

b) A helical pinion 14 teeth made of alloy steel with S_{ut}- 800 N/mm^2 mesh with gear made of plain carbon steel with S_{ut}- 720 N/mm^2. The gear is required to transmit 30 kW power from an electric motor running at 720 rpm to machine at 225 rpm. The application factor and load concentration factor are 1.3 and 1.1 resp. While the factor of safety is 2.0. The face width is 10 × normal module & tooth is 20° full depth involute. The deformation factor is 11000 × e N/mm. Design the gear pair by using velocity factor and buckingham's equation for dynamic load. Also suggest the surface hardness for gear pair. Use following data:

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

- $V = \frac{5.6}{5.6 + \sqrt{V}}$

- for grade 7 - e = 11 + 0.9[Mn + 0.25 $\sqrt{d}$] μm.
- K = 0.16 [BHN/100]^2
- Buckingham's eq^n - Pd = $\dfrac{21V\,(bc\cos^2\psi + Pt_{max})\cos\psi}{21V + \sqrt{bc\cos^2\psi + Pt_{max}}}$
- Standard module - 1, 1.25, 2, 3, 4, 5, 6, 8, 10, 12 **[14]**

Q11) a) What are different types of mountings of bevel gear. Explain any one with sketch. **[4]**

b) A pair of bevel gear with 20º full depth involute tooth profile consist of 24 teeth pinion meshing with 48 teeth gear. The axes are right angle to each other. The module at large end of tooth is 6 mm while the face width is 50mm. The gear pair is made of gray cast iron FG 220. The teeths are generated, the surface hardness of gear pair is 250 BHN. The application factor and factor of safety are 1.5 and 2.0 resp. The pinion rotates at 300 rpm. Assume velocity factor accounts for dynamic load.

Determine: **[12]**

i) Beam strength

ii) Wear strength

iii) Maximum static load on gear

iv) Rated power that the gear can transmit

OR

Q12) a) Derive the equation for efficiency of the worm gear. **[3]**

b) A worm gear pair 2/30/10/18 consist of worm gear made of phosphor bronze with S_{ut}- 245 MPa and worm is made of hardened steel with S_{ut}- 700 N/mm^2. The coefficient of friction between worm and worm gear is 0.04 while normal pressure angle is 20º. The wear factor of worm gear teeth is 0.825 MPa. The fan is used for which overall heat transfer coefficient is 22W/m^{2}ºC. The permissible temperature rise for lubricating oil above the atmospheric temperature is 45ºC. The worm rotates at 720 rpm. Assume service factor 1.25. Determine the input power rating based on:

i) Beam strength

ii) Wear strength

iii) Thermal consideration

Also suggest input power that worm gear can take.

Use following data,

$$Y = 0.484 - \frac{2.87}{Z_9}$$

$$C_V = \frac{6}{6 + V_9}$$

Area of housing – A = $1.14 \times 10^{-4} \times a^{1.7} m^2$

where, *a* is centre distance in mm. **[13]**

Table 1 Single-row deep-groove ball bearings

$\frac{P_a}{C_o}$	$\frac{P_a}{VP_r} \le e$		$\left(\frac{P_a}{VP_R}\right) > e$		
	X	Y	X	Y	e
0.014				2.30	0.19
0.028				1.99	0.22
0.056				1.71	0.26
0.084				1.55	0.28
0.11	1	0	0.56	1.45	0.30
0.17				1.31	0.34
0.25				1.20	0.37
0.28				1.15	0.38
0.42				1.04	0.42
0.56				1.00	0.44

Table 2 Various parameters of journal bearing

$\frac{l}{d}$	ξ	$\frac{h_0}{c}$	S	ϕ	$\left(\frac{r}{c}\right)f$	$\frac{Q}{rcn_j l}$	$\left(\frac{Q_s}{Q}\right)$	$\left(\frac{p}{p_{max}}\right)$
∝	0	1.0		70.92	∝	π	0	–
	0.1	0.9	0.240	69.10	4.80	3.03	0	0.826
	0.2	0.8	0.123	67.26	2.57	2.83	0	0.814
	0.4	0.6	0.0636	61.94	1.52	2.26	0	0.764
	0.6	0.4	0.0389	54.31	1.20	1.56	0	0.667
	0.8	0.2	0.021	42.22	0.961	0.760	0	0.495
	0.97	0.03	–	–	–	–	0	–
	1.0	0	0	0	0	0	0	0
1	0	1.0	∝	85	∝	π	0	–
	0.1	0.9	1.33	79.5	26.4	3.37	0.150	0.540
	0.2	0.8	0.631	74.02	12.8	3.59	0.280	0.529
	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	
$\frac{1}{2}$	0	1.0	∝	88.5	∝	π	0	–
	0.1	0.9	4.31	81.62	85.6	3.43	0.173	0.523
	0.2	0.8	2.03	74.94	40.9	3.72	0.308	0.506
	0.4	0.6	0.779	61.45	17.0	4.29	0.552	0.441
	0.6	0.4	0.319	48.14	8.10	4.85	0.730	0.365
	0.8	0.2	0.0923	33.31	3.26	5.41	0.874	0.267
	0.9	0.1	0.0313	23.66	1.60	5.69	0.939	0.206
	0.97	0.03	0.00609	13.75	0.620	5.88	0.980	0.126
	1.0	0	0	0	0	–	1.0	0
$\frac{1}{4}$	0	1.0	∝	89.5	∝	π	0	–
	0.1	0.9	16.2	82.31	322.0	3.45	0.180	0.515
	0.2	0.8	7.57	75.18	153.0	3.76	0.330	0.489
	0.4	0.6	2.83	60.86	61.1	4.37	0.567	0.415
	0.6	0.4	1.07	46.72	26.7	4.99	0.746	0.334
	0.8	0.2	0.261	31.04	8.8	5.60	0.884	0.240
	0.9	0.1	0.0736	21.85	3.50	5.91	0.945	0.180
	0.97	0.03	0.0001	12.22	0.922	6.12	0.984	0.108
	1.0	0	0	0	0	–	1.0	0