Seat No. -

GANPAT UNIVERSITY
B. TECH. SEM. V MECHATRONICS ENGINEERING
REGULAR EXAMINATION NOV./DEC.-2011
MC 503 DESIGN OF MACHINE ELEMENTS

TIME: 3 HOURS **TOTAL MARKS: 70**

Instructions:

(1) All questions are compulsory.
(2) Right figure indicate full marks.
(3) Assume suitable data if necessary.
(4) Only scientific calculator is allowed.

SECTION – I

Que.1 Attempt the followings.

(a) Explain cost and weight considerations in design with proper illustrations. **[3]**

(b) Explain working of hydrostatic bearing with neat sketch and write its applications. **[3]**

(c) The following data is given for the hydrostatic step bearing: **[6]**
Thrust load = 450 kN, Shaft speed = 750 rpm, Shaft radius = 200 mm, Recess diameter = 250 mm, Specific gravity of lubricant = 0.86, Optimum oil film thickness = 0.10 mm, Specific heat of lubricant = 2 kJ/kg °C, Viscosity of lubricant = $30 \times 10^{-9} \frac{N \cdot S}{mm^2}$, Calculate:
(i) Frictional power loss, (ii) pumping power loss; and (iii) Total power loss. Assume that the total power loss is converted into frictional heat.

OR

Que.1 Attempt the following.

(a) Explain the aesthetic considerations in design with suitable illustrations. **[3]**

(b) Prove that the pumping power loss in rolling contact bearing is proportional to the 3 power of fluid film thickness. **[3]**

(c) The following data is given for a hydrostatic step bearing of a vertical turbogenerator: **[6]**
Determine the optimum oil film thickness for the following equation of total power loss:

$$P = \frac{0.84}{h_o} + 1180.805 h_o^3$$

The supply pressure of lubricant = 6 N/mm^2, absolute viscosity of lubricant = 31.25 $\frac{N \cdot S}{mm^2}$, ratio of recess diameter to shaft diameter = 0.6, specific heat of lubricant = 2.09 kJ/kg °C, Specific gravity of lubricant = 0.86, determine: (i) Rate of heat generation in kJ/s, (ii) Flow rate of lubricant in m^3/s, and (iii) temperature rise.

Que.2 Attempt the followings.

(a) Define bearing. Explain the rating life and median life with suitable sketch. **[4]**

(b) A single-row deep-groove ball bearing operates with the following work cycle: **[8]**

Element No.	Element time, %	Radial load, kN	Thrust load, kN	Radial factor	Thrust factor	Race rotating	Service factor	Speed RPM
1	50	3.0	1.0	0.56	1.4	Inner	1.5	720
2	20	2.5	1.0	0.56	1.6	Outer	2.0	1440
3	Remaining	No load	No load	---	---	Outer	---	720

If the expected life of the bearing is 15000 hours with a reliability of 95%, calculate the basic dynamic load rating of the bearing so that it can be selected from the manufacturer's catalogue based on 80 percent reliability. If there are six such bearings in the system, what is the probability that all bearings will survive for 15000 hours.

OR

Que.2 Attempt the followings.

(a) Explain Bearing failures, their causes and remedies in brief. [4]

(b) A single-row deep groove ball bearing is subjected to a radial force of 8000 N and an axial force of 3000 N. The shaft rotates at 1200 rev/min with inner race rotating. The expected life L_{h10} of the bearing is 20000 hrs. The minimum acceptable diameter of the shaft is 75 mm. Use interpolations for finding the thrust factor. Select a suitable ball bearing for this application. If we consider the application factor as 2 then comments on your answer. [8]

Que.3 Attempt the followings.

(a) Define creep. Explain the factors affecting the creep. [2]

(b) Why we are multiplying various factors to the endurance limit of the test specimen to determine the endurance limit of a mechanical component? [2]

(c) A cantilever beam having an ultimate tensile strength of 500 N/mm^2 is subjected to a completely reversing load of 1.2 kN as shown in fig. (A). The notch sensitivity at the fillet is 0.6. Determine the diameter 'd' for a life of 8000 cycles. Assume surface factor as 0.8, size factor as 0.9 and the calculations are expected at 90% reliability, for which the reliability factor is 0.897. For rf /d = 0.15. [7]

D/d	1.02	1.50	3
K_t	1.32	1.50	1.55

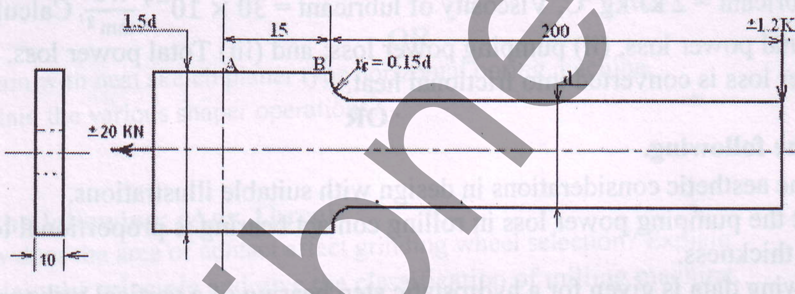

Fig. (A)

SECTION – II

Que:4 Attempt the followings.

(a) It is stated that the speed at which a belt should be run to transmit maximum power is that at which the maximum allowable tension is three times the centrifugal tension in the belt at that speed. Prove the statement. [3]

(b) Explain following parameters with respect to chain design: [3]

(i) Average velocity (ii) Speed ratio

(iii) No. of links and length of chain.

(c) Select a standard V-belt for the following drive condition. [6]

Driver- AC motor, normal torque, Squirrel cage, Motor speed: 1440 rpm, Power: 10 kW, Driven: Fan, Fan speed: 720 rpm. Duty: 8 hrs/day, Centre distance: 1600 mm, Take F_A = 1.1, belt section – B.

OR

Que:4 Attempt the followings.

(a) Derive the equation of belt tension ratio for flat belt drive. [3]

(b) Explain different lays of wire ropes. [3]

(c) A cross belt arrangement has centre distance between pulleys as 1500 mm. The small pulley rotates at 1000 rpm and the bigger pulley rotates at 500 rpm. The flat belt used is 6 mm thick and transmits 7.5 kW power at the belt speed of 13 m/s approximately. The coefficient of friction is 0.3 and the density of the belt material is 950 kg/m^3. If the permissible tensile stress for the belt is not to exceed 1.75 N/mm^2, calculate: [6]

1. Diameter of the pulleys, 2. Length and width of the belt, and
3. Initial tension required in the belts

Que:5 Attempt the followings.

(a) Derive the expression for torque transmitting capacity of cone clutch considering uniform wear condition. **[5]**

(b) The block brake as shown in **fig.-(B)** provides a braking torque of 360 N-m. The diameter of brake drum is 300 mm. The coefficient of friction is 0.3. Find: **[7]**

(i) The force (P) to be applied at the end of the lever for the clockwise and counter clockwise rotation of the brake drum; and

(ii) The location of the pivot or fulcrum to make the brake self locking for the clockwise rotation of the brake drum.

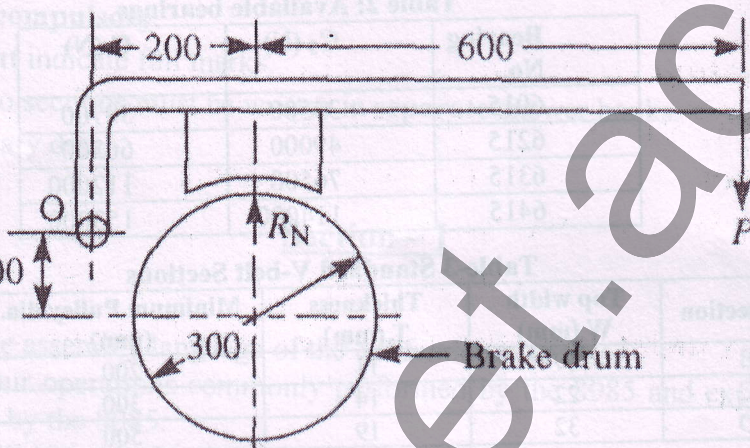

Fig.-(B)

OR

Que:5 Attempt the followings.

(a) What is self locking of brake? Where is it essential? **[2]**

(b) Explain the parameters to be considered for the selection of friction lining for brake. **[3]**

(c) An oil immersed multi-plate clutch, consisting of alternate steel and asbestos linings, is used to transmit 20 kW power at 3080 r.p.m. The coefficient of friction between the contacting surfaces is 0.12 and the intensity of pressure is limited to 0.3 N/mm^2. The radial space restriction limits the outer diameter of the contacting surface to 130 mm. Assuming uniform wear condition, determine: **[7]**

(i) the inner diameter of contacting surfaces,
(ii) the number of steel and bronze plates, and
(iii) the axial force required to engage the clutch.

Que:6 Attempt the followings.

(a) Explain following terms with respect to spur gear. **[3]**
(i) Circular pitch (ii) Clearance (iii) Backlash

(b) Derive the equation for virtual no. of teeth for helical gear. **[3]**

OR

(b) Explain law of gearing with neat sketch. **[3]**

(c) A pair of helical gears consists of a 20 teeth pinion meshing with a 40 teeth gear. The helix angle is 25° and the normal pressure angle is 20°. The normal module is 3 mm. **[5]**
Calculate: (i) the transverse pitch, (ii) the transverse pressure angle, (iii) the axial pitch, (iv) the pitch circle diameters of the pinion and the gear, (v) the centre distance, and (vi) the addendum and dedendum circle diameters of the pinion.

Table 1: Radial and thrust factors for single –row deep groove ball bearing

F_a/C_0	$(F_a/VF_r) \le e$		$(F_a/VF_r) \ge e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.04	1	0	0.56	1.8	0.24
0.07	1	0	0.56	1.6	0.27
0.13	1	0	0.56	1.4	0.31
0.25	1	0	0.56	1.2	0.37
0.5	1	0	0.56	1.0	0.44

Table 2: Available bearings

Bearing No.	C_0 (N)	C (N)
6015	33500	39700
6215	49000	66300
6315	76500	112000
6415	114000	153000

Table-3 Standard V-belt Sections

Belt section	Top width W (mm)	Thickness T (mm)	Minimum Pulley dia. (mm)	Δ (mm)
B	17	11	200	43
C	22	14	300	56
D	32	19	500	79

Table-4 Power ratings of V-belt

Section B	Dia.	125	132	140	150	160	170	180	190	200
	kW_R	2.24	2.46	2.77	3.30	3.6	4.00	4.39	4.77	5.23
Section C	Dia.	200	212	224	236	250	265	280	300	315
	kW_R	6.14	6.81	7.68	8.28	9.4	10.10	11.10	12.10	12.50
Section D	Dia.	350	375	400	425					
	kW_R	15.70	17.50	19.30	20.60					

Table – 5 Correction factor for lengths F_L

Inside length Li (mm)	Belt Section				
	A	B	C	D	E
3048	1.13	1.07	0.97	0.86	-
3150	-	-	0.97	-	-
3251	1.14	1.08	0.98	0.87	-
3404	-	-	0.99	-	-
3658	1.14	1.11	1.00	0.90	-
4013	-	1.13	1.02	0.92	-
4115	-	1.14	1.03	0.92	-
4394	-	1.15	1.04	0.93	-
4572	-	1.16	1.05	0.94	-
4953	-	1.18	1.07	0.96	-

Table-6 Correction factor for arc of contact F_D

Angle of Wrap (deg)	120	123	127	130	133	136	139	140	145	148	151
F_D	0.82	0.83	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93
Angle of Wrap (deg)	154	157	160	163	166	169	171	174	177	180	
F_D	0.93	0.94	0.95	0.96	0.97	0.97	0.98	0.99	0.99	1.00	

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