Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VIII EXAMINATION – WINTER 2015

Subject Code:182004 Date:16/12/2015

Subject Name: Design of Mechanisms-II

Time: 2:30pm to 5:00pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** It is required to design a bush pin type flexible coupling to connect the out put shaft of an electric motor to the shaft of a centrifugal pump.The motor delivers 20 KW power at 720 rpm.The starting torque of the motor can be assumed to be150% of the rated torque.Design the coupling .Show the designed dimensions on the neat sketch of the coupling.Following material and stresses can be used.Assume(i)compressive yield strength to be 1.5 times the tensile yield strength for keys and pins(ii)ultimate shear strength is one half of the ultimate tensile strength for the flanges.The permissible shear stresses for the pin is 35 N/mm^2.The permissible bearing pressure between rubber bush and flange is 1 N/mm^2.The allowable shear stress for pin is 35 N/mm^2. **10**

shaft	40C8(S_{yt}=380 N/mm^2)	FOS=2
keys,pins	30C8(S_{yt}=400 N/mm^2)	FOS=2
flanges	FG200(S_{yt}=200 N/mm^2)	FOS=6

(b) What are the aesthetic considerations to be made in design engineering?Explain with examples. **04**

Q.2 **(a)** A curved link of the mechanism is made from a round steel bar is shown in Fig.1.The material of the link is 30C8(S_{yt}=400 N/mm^2)and factor of safety is 3.5.Determine the dimensions of the link. **07**

(b) In an open flat belt drive, the driver (smaller)and driven pulley(bigger) runs at 1440 and 480 rpm respectively.The centre distance is twice the diameter of bigger pulley.The belt operates at 20 m/s and stresses in the belt should not exceed 2.25 N/mm^2.The density of the leather is 0.95 g/cc and the coefficient of friction is 0.35.The thickness of the belt is 5 mm.Calculate(i)the diameters of pulleys(ii)width of belt(iii)the belt tensions.The drive transmits 15 kW power. **07**

OR

(b) (i)Compare the open and cross belt drive in a tabular format with neat sketch. **02**
(ii)State the step by step procedure of designing a flat belt pulley with neat sketches. **05**

Q.3 **(a)** A shaft is carrying two gears G_1 and G_2 with two bearings B_1 and B_2.The order of these on shaft is B_1,G_1,B_2,G_2 from right to left.The distance between B_1 and G_1 is 125mm,between G_1 and B_2 is 500mm and between B_2 and G_2 is 150mm.The gear tooth forces are: P_{t1}=15915 N , P_{r1}=5793 N , P_{t2}=9549 N,P_{r2}=3476 N.The diameter of the shaft is 75mm.The load factor is 1.4and expected life for 90% of the bearing is 10000 hours.The shaft is rotating in clockwise direction looking from left side.Find the load carrying capacity of the bearings.Sketch neat forces acting at load points on the shaft. The shaft transmits 50 kW power at 125 rpm. **07**

(b) For a single shoe brake briefly discuss the self locking and self energizing conditions with neat sketch and related equations.Also show the free body diagrams. **07**

OR

Q.3 **(a)** Differentiate between simple and band brake.Explain self locking condition for a band brake with neat sketch and related equations .Also show the free body diagram of forces. **07**

(b) Design a full hydrodynamic journal bearing with following specification for machine tool application. **07**
Journal diameter=75 mm,radial load=10KN,journal speed =1440 rpm,minimum oil film

thickness=22.5 microns,inlet temperature =40^0 C.Determine the length of bearing and show how to select suitable oil for this application.The permissible bearing pressure is 2 N/mm^2. Refer the table given below.

$\left(\frac{l}{d}\right)$	ε	$\left(\frac{h_o}{c}\right)$	S	ϕ	$\left(\frac{r}{c}\right)f$	$\left(\frac{Q}{rcn_s l}\right)$	$\left(\frac{Q_s}{Q}\right)$	$\left(\frac{p}{p_{max.}}\right)$
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	0

Q.4 **(a)** Briefly discuss the 'beam strength of the gear tooth' giving related equations and figures. **07**

(b) It is required to design a pair of spur gears with 20^0 full depth involute teeth based on the beam strength equation.The pinion shaft is connected to a 10KW,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 40C8(S_{ut}=600N/mm^2)The factor of safety can be taken as 1.5.Design the gears and specify the hardness.The form factor for z=18 is 0.308.Assume pitch line velocity to be 5 m/s.For reference the standard modules are: 5.0,6.0,7.0,8.0,9.0,10.0,11.0,12.0,14.0,16.0,18.0(underlined are second choice)Take b/m as 10. **07**

OR

Q.4 **(a)** What are the major design considerations for a spur gear ? Explain briefly with steps. **07**

(b) A pair of spur gears are to be designed having 20^0 full depth involute profile having 20 teeth pinion meshing with a 50 teeth gear.The pinion shaft is connected to a 22.5 KW,1450 rpm motor. The starting torque of the motor is 150% of the rated torque.The material for pinion is Fe 410(S_{ut}=410 N/mm^2)and for gear it is FG200.The factor of safety is 3.0 Design the gears based on beam strength.The pitch line velocity is 5 m/s.The form factors for 20 and 50 teeth are 0.32 and 0.408 respectively. For reference the standard modules are: 5.0,6.0,7.0,8.0,9.0,10.0,11.0,12.0,14.0,16.0,18.0(underlined are second choice).Take b/m as 10. **07**

Q.5 **(a)** Briefly discuss the stresses in wire ropes with related equations. **07**

(b) A plate made of steel 20C8(S_{ut}=440 N/mm^2) is subjected to a completely reversed axial load of 30 KN.The notch sensitivity factor is 0.8 and expected reliability is 90%.Take K_a=0.67,K_b=0.85,K_c=0.897,K_t=2.51,FOS=2.The plate is 50 mm wide and has a hole of 10mm.Determine the plate thickness for finite life. **07**

OR

Q.5 **(a)** It is required to select a 6x19 wire rope with 1570 as tensile designation for a hoist on the basis of long life.The weight of the hoist along with the material is 5 KN.It is to be raised from a depth of 100m.The maximum speed of 5 m/s is attained in 5 seconds.Determine the size of the wire rope on fatigue basis.Assume mass of rope as 40 Kg per 100m length. **07**

(b) Explain(i)fluctuating,repeated and reversed stresses(ii)Low and high cycle fatigue with neat sketches and related equations. **07**

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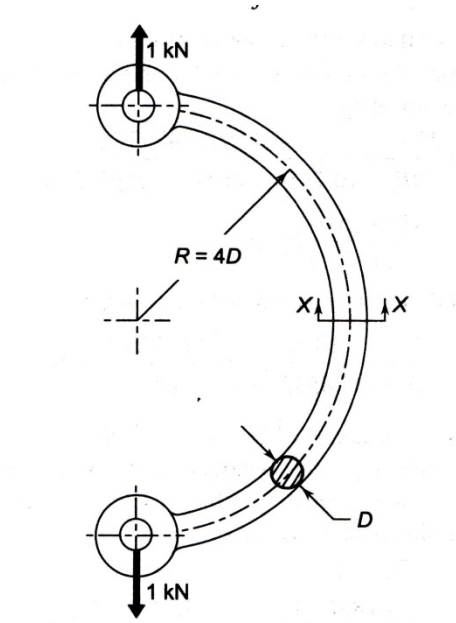

$$R_N = \frac{\left(\sqrt{R_o} + \sqrt{R_i}\right)^2}{4}$$

Fig. 1 for Q.2 (a)

$$Y_p = 0.154 - \frac{0.912}{Z_p} \quad (full\ depth)$$

$$Y_p = 0.175 - \frac{0.841}{Z_p} \quad (stub\ gear)$$

$$F_s = f_b \times b \times Y_p \times \pi \times m$$

$$C = 11860 \times e$$

$$e = 0.025$$

$$F_d = F_t + \frac{21v(cb + F_t)}{21v + (cb + F_t)^{1/2}}$$

$$Q = \frac{2Z_g}{Z_g + Z_p}$$

$$k = \frac{f_{es}^2 sin\varphi}{1.4}\left[\frac{1}{E_p} + \frac{1}{E_g}\right]$$

$$F_w = D_p \times Q \times k \times b$$

$$m = \left[\frac{60 \times 10^6}{\pi}\left\{\frac{(kW)C_s(FOS)}{z_g n_g C_v \left(\frac{b}{m}\right)\left(\frac{S_{ut}}{3}\right)Y}\right\}\right]^{1/3}$$

Gear Design Formulae for Q.4 (b) and Q.4(b) OR