Seat No.: _____  Enrolment No. 

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–VIII(NEW) EXAMINATION – SUMMER 2019**

**Subject Code:2182004** **Date:20/05/2019**

**Subject Name:Design of Mechanisms - II**

**Time:10:30 AM TO 01:00 PM** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Use of PSG design data book is permitted**

**Q.1** **(a)** Explain static and dynamic load carrying capacity of rolling element bearing. **03**

**(b)** Answer the following questions **04**

1. What is stress concentration?
2. Differentiate straight beam and curved beam.
3. What is the condition for self-locking block brake?
4. Explain the importance of reliability factor in design of machine component?

**(c)** Explain steps to select appropriate deep groove ball bearing for a shaft transmitting power through flat belt and gear pair. **07**

**Q.2** **(a)** What do you understand by hydrodynamic lubrication and hydrostatic lubrication? Discuss different stages of hydrodynamic lubrication. **03**

**(b)** Prove that a differential band brake can never be self-locking for both direction of rotations of the drum. **04**

**(c)** Explain design steps to design split muff coupling and flange coupling. **07**

**OR**

**(c)** Explain design steps with necessary equation for flexible coupling. **07**

**Q.3** **(a)** The following data is given for a 360° hydrodynamic bearing: **03**

radial load = 3.2 kN
journal speed = 1490 rpm
journal diameter = 50 mm
bearing length = 50 mm
radial clearance = 0.05 mm
viscosity of lubricant = 25 cP

Assuming that the total heat generated in the bearing is carried by the total oil flow in bearing, calculate performance parameters.

| $\left(\frac{l}{d}\right)$ | $\varepsilon$ | $\left(\frac{h_o}{c}\right)$ | $S$ | $\phi$ | $\left(\frac{r}{c}\right)f$ | $\left(\frac{Q}{rcn_s l}\right)$ | $\left(\frac{Q_s}{Q}\right)$ | $\left(\frac{p}{p_{max.}}\right)$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1.0 | ∞ | (85) | ∞ | $\pi$ | 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 |

**(b)** Calculate following parameters for journal bearing, data provided in Q.3 (a). **04**

1. coefficient of friction;
2. power lost in friction;
3. minimum oil fi lm thickness;
4. flow requirement in 1itres/min.

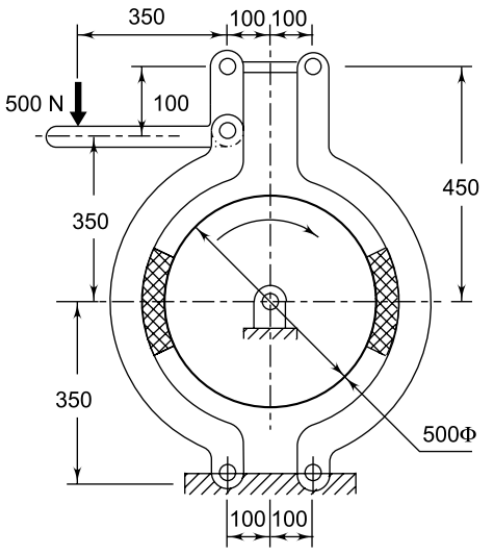
**(c)** Explain steps to determine dimensions of flat belt and cast iron pulley for power transmission. **07**

**OR**

**Q.3** **(a)** Classify rolling contact bearings based on their load carrying capacity. **03**

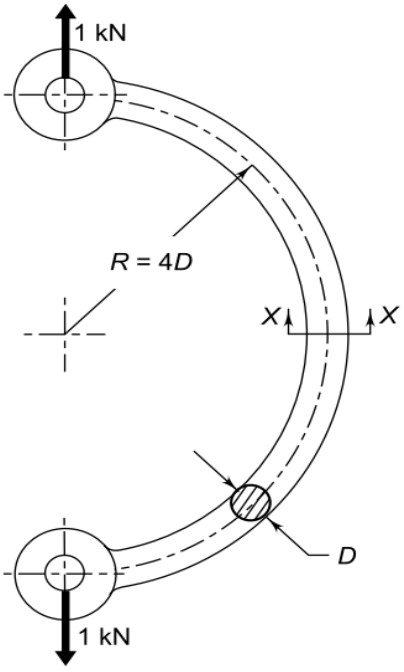
**(b)** Explain importance of ergonomics and system design. **04**

**(c)** A double block brake is shown in following figure. The brake drum rotates in a clockwise direction and the actuating force is 500 N. The coefficient of friction between the blocks and the drum is 0.35. Calculate the torque absorbing capacity of the brake. **07**

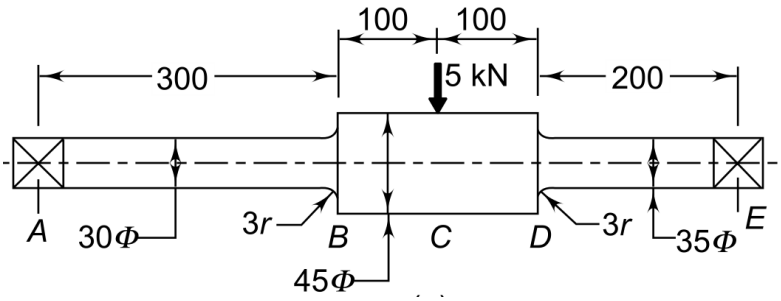



**Q.4** **(a)** Discuss different load acting on wire rope of hoisting mechanisms. **03**

**(b)** A curved link of the mechanism made from a round steel bar is shown in following figure. The material of the link is plain carbon steel 30C8 ($S_{yt}$ = 400 N/mm$^2$ ) and the factor of safety is 3.5.Determine the dimensions of the link. **04**



**(c)** A rotating shaft, subjected to a nonrotating force of 5 kN and simply supported between two bearings A and E is shown in following figure. The shaft is machined from plain carbon steel 30C8 ($S_{ut}$= 500 N/mm$^2$). What is the life of the shaft? Take $k_a$ = 0.79, $k_b$ = 0.85, $k_c$ = 0.897, $k_t$ = 1.72 , q = 0.78. **07**




**OR**

**Q.4** **(a)** A sheave tackle having two pulleys in each block is designed for 10 kN suspended downward load through hook. **03**
Determine dimension of crane hook having trapezoidal cross section.
For trapezoidal cross section

$$R_n = \frac{(1/2)b_i h}{\frac{b_i r_o}{r_o - r_i}\log_e \frac{r_o}{r_i} - b_i}$$

**(b)** Suggest suitable wire rope for above application. **04**

**(c)** A sheave tackle having two pulleys in each block is designed for 10 kN suspended downward load through hook. Permissible stresses for cross block and central pin in shear and tension are 50 MPa and 100 MPa respectively. Determine dimensions of central pin and cross block. **07**

**Q.5** **(a)** Following data is given for a steel spur gear transmitting 7.5 kW power running at 1440 rpm to a machine running at 480 rpm. Approximate center distance = 240 mm, Allowable bending stress for pinion and gear are 200 and 160 respectively. Surface hardness is 450 BHN. Tooth system is 20º full depths involutes. **03**
Which component of this gear pair (pinion or gear) is weaker? Determine its beam strength.

**(b)** Determine dynamic load carrying capacity of gear pair for data provided in Q : 5(a). **04**

**(c)** Determine wear strength of gear pair for data provided in Q : 5(a). **07**

$$Yp=0.154-\frac{0.912}{Z_p}\text{ (full depth)}$$

$$Yp=0.175-\frac{0.841}{Z_p}\text{ (stub gear)}$$

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

$$C = 11860 \times e$$

$$e = 0.025$$

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

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

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

$$f_{es} = 2.7459 \times BHN - 68.65\ MPa$$

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

**OR**

**Q.5** **(a)** A pair of a carefully cut spur gear with $20^o$ full depth involute teeth consists of 19 teeth pinion meshing with 40 teeth gear. The pinion shaft is directly coupled to a single cylinder diesel engine developed power 8 kW at 1500 rpm. The gear shaft is transmitting a power to a two stage reciprocating air compressor. There service factor and factor of safety are 1.5 and 3 respectively. The pinion as well as gear are made of plain carbon steel 45C8 ($f_{ut}$= 600 N/mm$^2$). The module and face width are 3 mm and 50 mm respectively. The gears are heat treated to a surface hardness of 450 BHN. **03**

Which component of this gear pair (pinion or gear) is weaker?

**(b)** Determine beam strength of weaker component and dynamic load carrying capacity of gear pair for data provided in Q:5(a). **04**

**(c)** Find factor of safety based on dynamic load carrying capacity and wear strength of gear pair for data provided in Q:5 (a). **07**



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