

B E MECHANICAL ENGINEERING EXAMINATION, 2017

(3rd Year, 2nd Semester)

Machine Design III

Time: Three hours

Full Marks: 100

Missing data, if any, may be assumed.

Answer Question No 1 and any Five from the rest.

1. a) State four advantages of gear drive over chain or belt drives.
b) What is a hunting tooth?
c) What is the main disadvantage of single helical gear? What is the remedy?
d) State the bore diameter and load range (low/medium/high) of the bearing 6203ZZ.
e) State the four important parameters required to specify worm gear drive.
f) What are Crown Gear and Miter Gears?
g) State the advantages and disadvantages of angular contact bearings.
h) State and explain load-life relationship for rolling contact bearings.
i) Explain silent chain.
j) State the types of failures of roller chains. 2 x 10

2. A pair of spur gears with 20⁰ full-depth involute teeth is to be designed based on Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 10 kW, 1440 rpm electric motor. The starting torque of the motor can be taken as 150% of the rated torque. The speed reduction is 4:1. The material for the pinion and the gear is plain carbon steel 40C8 ($S_{01}=600 \text{ N/mm}^2$). The factor of safety can be taken as 1.5. Design the gears, specify their dimensions and suggest suitable surface hardness for the gears. Lewis form factor Y (z: no of teeth) for 20⁰ full-depth involute system can be taken from the following Table. 16

z	Y	z	Y	z	Y
15	0.289	27	0.348	55	0.415
16	0.295	28	0.352	60	0.421
17	0.302	29	0.355	65	0.425
18	0.308	30	0.358	70	0.429
19	0.314	32	0.364	75	0.433
20	0.320	33	0.367	80	0.436
21	0.326	35	0.373	90	0.442
22	0.330	37	0.380	100	0.446
23	0.333	39	0.386	150	0.458
24	0.337	40	0.389	200	0.463
25	0.340	45	0.399	300	0.471
26	0.344	50	0.408	Rack	0.484

3. a) Explain the construction and working principle of a chain drive system, appending neat sketches of the components of the drive system.
- b) With the help of a sample table, explain the specification of a power transmission chain. Why is the number of pitch selected as an even number and how is the distance between the axes of the two sprockets evaluated?
- c) What are the factors influencing the determination of design power of a chain drive system? Briefly discuss about the factors. 5+6+5
4. a) What is static load carrying capacity of rolling element bearings? Derive Stribeck's equation for the same.
- b) A ball bearing is subjected to a radial load of 2500 N and an axial load of 1000 N at 720 rpm of the shaft. The dynamic load carrying capacity of the bearing is 7350 N. The values of X and Y factors are 0.56 and 1.6 respectively. Calculate the life of the bearing. 8+8

5. a) A steel disk ($\sigma_y = 350 \text{ N/mm}^2$, $E = 210 \text{ kN/mm}^2$, $\nu = 0.28$) of uniform thickness having inner and outer radii of 100 mm and 500 mm respectively is shrink fitted on a shaft with a shrink fit allowance of 1 part in 1000. If the material of the disk and shaft is same, determine the induced stresses in the disk due to shrink fit. At what rotational speed would the shrink fit loosen up and what would be the induced stresses at that speed?
- b) Prove that for uniform radial and tangential stress distribution in a disk, rotating at a uniform angular velocity ω , it should be manufactured with a thickness variation $h = C \exp(-\rho\omega^2 r^2 / 2\sigma)$, where $C =$ a constant, $\rho =$ density of disk material and $\sigma =$ the allowable uniform strength 8+8
6. A pair of bevel gears, with 20° pressure angle, consists of a 20 teeth pinion meshing with a 30 teeth gear. The module is 4 mm, while the face width is 20 mm. The material for the pinion and gear is steel 50C4 ($S_{ut}=750 \text{ N/mm}^2$). The gear teeth are lapped and ground (class-3) for which maximum expected error between two meshing teeth is 0.0125 mm and the surface hardness is 400 BHN. The pinion rotates at 500 rpm and receives 2.5 kW power from the electric motor. The starting torque of the motor is 150% of the rated torque. Determine the factor of safety against bending failure and pitting failure. 16
7. A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720 rpm. The normal pressure angle is 20° , the helix angle is 25° . The face width is 40 mm and the normal module is 4 mm. The pinion as well as gear is made of steel 40C8 ($S_{ut}=600 \text{ N/mm}^2$) and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively. Assume that the velocity factor accounts for the dynamic load. Calculate the power transmitting capacity of gears. 16
8. Write short notes on: a) Polygonal effect in chain drive b) Material selection for worm and worm wheel c) Gear tooth failures d) Mounting of bearings 4 x 4