# 337611(37)

## B. E. (Sixth Semester) Examination 2020

### (Old Scheme)

### (Branch : Mech., Mechatronics)

## MACHINE DESIGN - II

*Time Allowed : Four hours*

*Maximum Marks : 80*

*Minimum Pass Marks : 28*

*Note : Assume suitable data if required. Design data book by PSG and ISI data sheets are allowed.*

1. (a)   What is surge in spring?                    2

Solve any **two** among part (b), (c) and (d).

(b)   A helical compression spring is used to absorb the

shock. The initial compression of the spring is 30 mm and it is further compressed by 50 mm while absorbing the shock. The spring is to absorb 250 J of energy during the process. The spring index can be taken as 6. The spring is made of patented and cold drawn steel wire with ultimate tensile strength of 1500 N/mm² and modulus of rigidity of 81370 N/mm². The permissible shear stress for the spring wire should be taken as 30% of the ultimate tensile strength. Design the spring and calculate :

(i)  Wire diameter

(ii) Mean coil diameter

(iii) Number of active turns

(iv) Free length; and

(v)  Pitch of the turns                                            7

(c)  A direct reading tension spring balance consists of a helical spring, that is attached to a rigid support at one end and carries masses at the other free end. The pointer attached to the free end moves on a scale and indicates the mass. The length of the scale is 100 mm, that is divided into 50 equal divisions. Each division on the scale indicates 0·5

kg. The maximum ca₁ ₋city of the spring balance is 25 kg. The spring index is 6. The spring is made of an oil-hardened and tempered steel wire of Grade-SW ($G = 81370$ N/mm$^2$). The permissible shear stress in the spring wire is recommended as 50% of the ultimate tensile strength. Design the spring and give its specifications.     7

(d) A semi-elliptic multi leaf spring is used for the suspension of the rear axle of a truck. It consists of two extra full length leaves and ten graduated length leaves including the master leaf. The centre to centre distance between the spring eyes is 1·2 m. The leaves are made of steel 55Si2M$_0$90 ($S_{yt}$ = 1500 N/mm$^2$ and $E = 207000$ N/mm$^2$) and the factor of safety is 2·5. The spring is to be designed for a maximum force of 30 kN. The leaves are pre-stressed so as to equalize stresses in all leaves. Determine :

(i) the cross-section of leaves; and

(ii) the deflection of the end of the spring.     7

2. (a) State any two disadvantages of gear drive over other types of drives.     2

(b) A pair of spur gear with 20° full-depth involute teeth consists of a 19 teeth pinion meshing with a 40 teeth gear. The pinion is mounted on a crank-shaft of 7·5 kW single cylinder diesel engine running at 1500 rpm. the driven shaft is connected to a two-stage compressor. Assume the service factor as 1·5. The pinion as well as the gear is made of steel 40C8 ($S_{ut}$ = 600 N/mm²). The module and face width of the gear are 4 and 40 mm respec-tively.

    (i) Using the velocity factor to account for the dynamic load, determine the factor of safety.

    (ii) If the factor of safety is two for pitting failure, recommend surface hardness for the gears.

    (iii) If the gears are machined to meet the specifications of grade 8. determine the factor of safety for bending using Buckingham's equation.

    (iv) Is the gear design satisfactory? If not, what is the method of satisfy the design conditions?    14

**Or**

It is required to design a spur gear speed reducer for a compressor running at 250 rpm driven by a

7·5 kW, 1000 rpm electric motor. The centre distance between the axes of the gear shafts should be exactly 250 mm. The starting torque of the motor can be assumed to be 150% of the rated torque. The gears are made of carbon steel 50 C4 ($S_{ut}$ = 700 N/mm$^2$). The pressure angle is 20°. The factor of safety is 2 for preliminary designed based on the use of velocity factor :

(i) Design the gears and specify their dimensions.

(ii) Assume that the gears are manufactured to meet the requirements of Grade-6 and calculate the dynamic load by using Buckingham's equation.

(iii) Calculate the effective load.

(iv) What is the actual factor of safety against bending failure?

(v) Using the same factor of safety again pitting failure, specify suitable surface hardness for the gears.                                14

3. (a) What is relationship between transverse and normal pressure angles and the helix angle?                       2

(b) A pair of parallel helical gears consists of 24 teeth pinion rotating at 5000 rpm and supplying 2·5

kW power to gear. The speed reduction is 4 : 1. The normal pressure angle and helix angle are 20° and 25° respectively. Both gears are made of hardened steel ($S_{ut}$ = 750 N/mm²). The service factor and the factor of safety are 1·5 and 2 respectively. The gears are finished to meet the accuracy of Grade-4.

(i)  In the initial stages of gear design, assume that the velocity factor accounts for the dynamic load and that the face width is ten times the normal module. Assuming the pitch line velocity to be 10 m/s, estimate the normal module.

(ii)  Select the first preference value of the normal module and calculate the main dimensions of the gears.

(iii)  Determine the dynamic load using Buckingham's equation and find out the effective load for the above dimensions. What is the correct factor of safety for bending?

(iv)  Specify surface hardness for the gears, assuming a factor of safety of 2 for wear consideration.   14

**Or**

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, white the face width is 20 mm. The material for the pinion and gear is steel 50 C4 ($S_{ut}$ = 750 N/mm²). The gear teeth are lapped and ground 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 against pitting failure.

4. (a) What is SAE? 2

(b) A single row deep groove ball bearing is used to support the lay shaft of a four speed automobile gear box. It is subjected to following loads in respective speed ratios :

| Gear | Axial load (N) | Radial load (M) | % time engaged |
|---|---|---|---|
| First Gear | 3250 | 4000 | 1% |
| Second Gear | 500 | 2750 | 3% |
| Third Gear | 50 | 2750 | 21% |
| Fourth Gear | Nil | Nil | 75% |

The lay shaft is fixed to the engine shaft and rotates at 1750 rom. The static and dynamic load carrying capacities of the bearing are 11600 and 17600 N respectively. The bearing is expected to be in use for 4000 hr. of operation. Find out the reliability with which the life could be expected. 14

### Or

Design a full hydrodynamic journal bearing with following specifications for machine tool application :

Journal diameter = 75 mm

Radial load = 10 kN

Journal speed = 1440 rpm

Minimum oil film thickness = 22·5 microns

Inlet temperature = 40°C

Bearing material = Babbitt

Determine the length of the bearing and select suitable oil for this application. 14

5. (a) Write assumptions of uniform pressure theory. 2

(b) An automotive plate clutch consists of two pairs of contacting surfaces with asbestos friction lining. The maximum engine torque is 250 N-m. The

coefficient of friction is 0·35. The inner and outer diameters of friction lining are 175 and 250 mm respectively. Clamping force is provided by nine springs, each compressed by 5 mm to give a force of 800 N, when the clutch is new.

(i) What is the factor of safety with respect to slip page when the clutch is brand new?

(ii) What is the factor of safety with respect to slip page after initial wear has occured?

(iii) How much wear of friction lining can take place before the clutch will slip?                    14

**Or**

It is required to select a V-belt drive to connect a 15 kW, 2880 rpm normal torque A.C. motor to centrifugal pump, running at approximately 2400 rpm, for a service of 18 hr per day. The centre distance should be approximately 400 mm. Assume that the pitch diameter of driving pulley is 125 ·mm.                    14