Subject Code: PROD/PC/B/T/324)

B.PRODUCTION ENGINEERING EXAMINATION, 2024

(3RD Year, 2nd Semester)

DESIGN OF ENGINEERING SYSTEM – II

Time: 3 hours **Full marks : 100**

(Answer questions not exceeding 100 marks)

1. A machine component is subjected to fluctuating stress that varies from 40 to 100 N/mm^2 . The endurance limit stress for the machine component is 270 N/mm^2 . The ultimate tensile strength and yield strength of material are 600 and 450 N/mm^2 respectively. Find the factor of safety using Soderbergs line as failure criteria. (20)
2. A plate clutch consists of one pair of contacting surfaces and transmits 20 KW power at 750 rpm. The ratio of outer diameter to inner diameter is 2. The coefficient of friction 0.2 and the permissible intensity of pressure is 1 N/mm^2 . Calculate the inner and outer diameters of the clutch using uniform pressure theory. (20)
3. A single-row deep groove ball bearing is subjected to a radial force of 8 KN and a thrust force of 3 KN. The shaft rotates at 1200 rpm. The expected life L_{10h} of the bearing is 20,000 hrs. The minimal acceptable diameter of the shaft is 75 mm. Determine the dynamic load capacity of the bearing. Consider the X and Y factors to be 0.56 and 1.8 respectively. (20)
4. A single-start square threaded screw as shown in Fig.1, is used in a positioning device to raise a load of 50 KN. When the screw

is fully extended, the supported length of the screw is 400 mm. The screw can be assumed as fixed at the nut and free at the other end. The nut is made of phosphor bronze (Grade 1) having S_{ut} = 190 N/mm^2. It is fixed to the wheel of bevel gears. The pinion shaft is connected to the electric motor. A low friction thrust ball bearing is used in the mechanism and collar friction can be neglected. The efficiency of bevel gear drive is 90%.

The screw is made of oil hardened and tempered alloy steel 40Ni14 (S_{yt} = 550 N/mm^2 and E = 207000 N/mm^2) and the factor of safety is 4 on the basis of strength. The permissible bearing pressure between contacting surfaces of screw and nut is 5 to 10 MPa for a speed of 6 to 12 m/min. The coefficient of friction at the thread surface between steel screw and bronze nut can be taken as 0.14.

i) Determine the size of screw from buckling consideration, assuming a factor of safety of 2 for critical load.

ii) Check the design from strength consideration.

Design the screw and nut on the basis of bearing pressure. Calculate the length of nut. **(30)**

5. A railway wagon moving at a velocity of 1.5 m/sec is brought to rest by a bumper consisting of two helical springs arranged in parallel. The mass of the wagon is 1500 Kg. The springs are compressed by 150 mm in bringing the wagon to rest. The spring index can be taken as 6. The springs are made of oil-hardened and tempered steel wire of SW grade (G= 81370 N/mm^2). The constants A and m for evaluating ultimate tensile strength (S_{ut} = A/d^m) can be taken as 1855 and 0.187 respectively. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength.

Design the spring and calculate,

i) Wire diameter,

ii) Mean coil diameter,

iii) Number of active coils,
iv) Total number of coils,
v) Solid length,
vi) Free length. (30)

6. Design an open type flat belt drive for a compressor running at 720 rpm, which is driven by a 25 KW 1440 rpm electric motor. Space is available for a centre distance of 3 m. Consider an overload factor of 30%, belt velocity 18 m/sec and power rating of belt 0.0438 KW.
Determine,
i) Smaller and bigger pulley diameters. Pulley diameters are round up for 50 mm steps.
ii) Belt width and number of plies.
iii) Belt length. (30)

7. 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 50C4 (S_{ut} = 700 N/ mm^2). The pressure angle is 20°. The factor of safety is 2 for preliminary design based on the use of velocity factor.
Determine,
i) Module , pitch circle diameters, width and number of teeth of the gears.
ii) Calculate the dynamic load by using Buckingham's equation. Take e = 8 + 0.63 Φ , where e = e_p + e_g deformation factor C = 11400 N/ mm^2 .
iii) Find the effective load.
iv) Determine surface hardness of gears. (40)

8. A pair of parallel helical gears consist of 24 teeth pinion rotating at 5000 rpm and supplying 2.5 KW power to a gear.

The speed reduction is 4:1. The normal pressure angle and helix angle are 20° and 23° respectively. Both gears are made of hardened steel (S_{ut} = 750 N/ mm^2). The service factor and the factor of safety are 1.5 and 2 respectively. Gears are finished with Grade 4 accuracy for which e = 3.20 + 0.25 Φ , where Φ = m_n + 0.25 $\sqrt{d}$.

i) Estimate the normal module assuming the pitch line velocity to be 10 m/ sec.

ii) 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. Consider deformation factor C = 11400 N/ mm^2 .

iv) Specify surface hardness for the gears assuming factor of safety of 2 for wear consideration. (40)

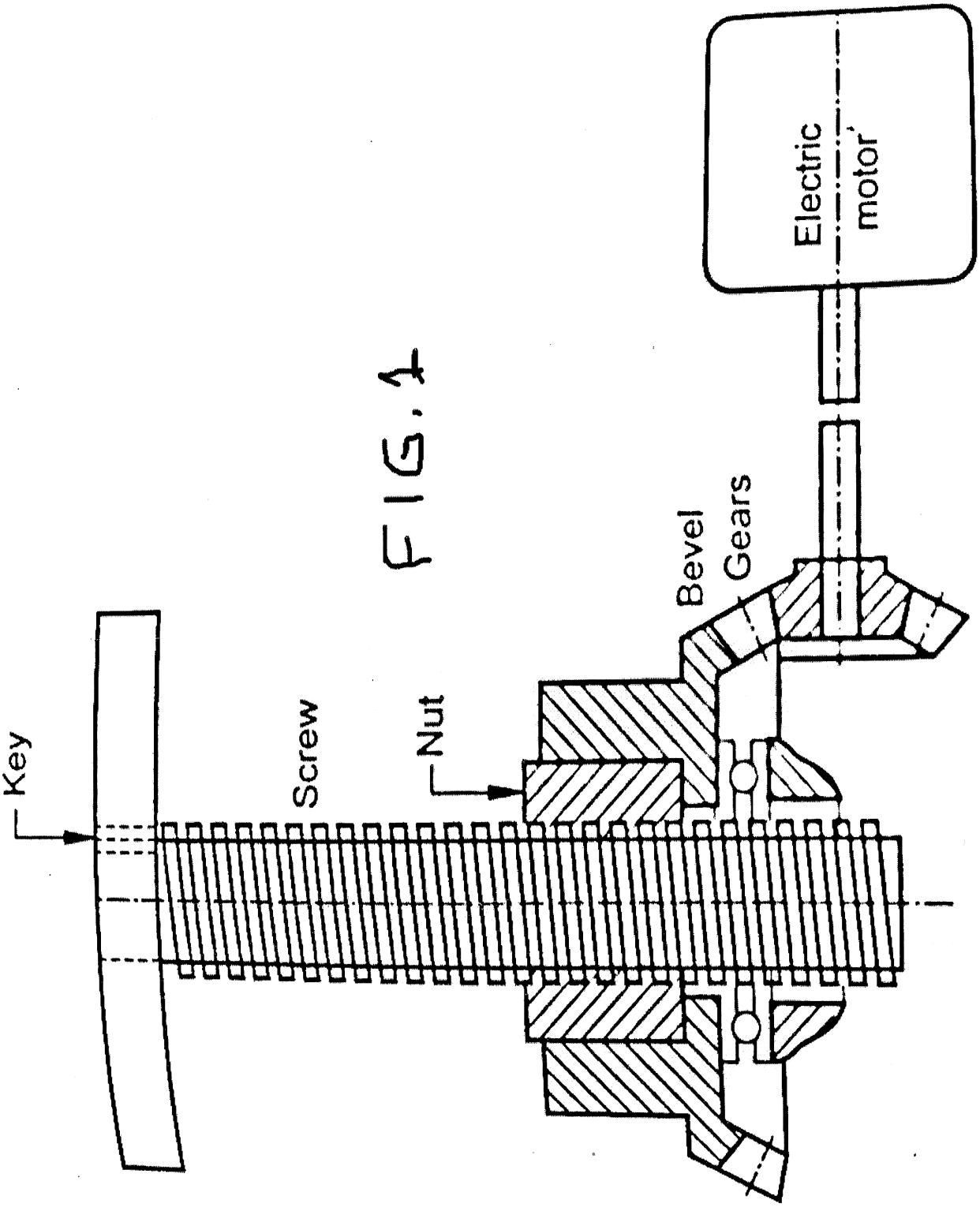

FIG. 1