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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — OCTOBER, 2019

DESIGN OF MACHINE ELEMENTS

[*Time* : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. Define factor of safety.
2. List various types of keys.
3. What type of stresses are induced in shafts ?
4. What do you mean by bearing modulus ?
5. Give any two disadvantages of chain drive over belt drive. (5×2 = 10)

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. Briefly explain the concept of bolts of uniform strength.
2. A shaft running at 400 r.p.m. transmits 10 kW. Assuming allowable shear stress in shaft as 40 MPa, find the diameter of the shaft.
3. A shaft is required to transmit 1 MW power at 240 r.p.m. The shaft must not twist more than 1 degree on a length of 15 diameters. If the modulus of rigidity for material of the Shaft is given by 80 GPa, find the diameter of the shaft and shear stress induced.
4. Explain the following terms with respect to cam profile with the help of a diagram. (a) Trace Point, (b) Pressure angle, (c) Pitch point, (d) Pitch circle, (e) Pitch curve, (f) Prime circle.
5. Illustrate the principle of working of porter governor with the help of a diagram.
6. An engine, running at 160 rpm, drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 375 mm. A 900 mm diameter pulley on the line shaft drives a 180 mm diameter pulley keyed to a dynamo shaft. Find the speed of the dynamo shaft, when (a) there is no slip and (b) there is a slip of 2% at each drive.
7. Explain epicyclic gear train with the help of a diagram. (5×6 = 30)

Marks

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

UNIT — I

III (a) A steam engine cylinder has an effective diameter of 340 mm and the maximum steam pressure acting on the cylinder cover is 1.25 N/mm^2. Calculate the number and size of studs required to fix the cylinder cover, assuming the permissible stress in the studs as 30 Mpa. 8

(b) Differentiate between analytical and empirical design methods based on the design of a rectangular sunk key. 7

OR

IV (a) A steel shaft has a diameter of 25 mm. The shaft rotates at a speed of 600 r.p.m. and transmits 7 kW through a gear. Design a suitable key for the gear. The allowable shear and tensile stress for the material of the key can be taken as 60 MPa and 120 MPa respectively. Assume the same material for both shaft and key. 8

(b) An electric motor driven power screw moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm/min. The screw has a single square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at screw threads is 0.1. Estimate power of the motor. 7

UNIT — II

V (a) Compare the weight, strength and stiffness of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length. 8

(b) Design a muff coupling which is used to connect two steel shafts transmitting 25 kW power at 360 r.p.m. The shafts and key are made of plain carbon steel 30C8 ($\sigma_{yt} = \sigma_{yc}$ = 400 N/mm^2). The sleeve is made of grey cast iron FG200 (σ_{ut} = 200 N/mm^2). The factor of safety for the shafts and key is 4. For sleeve, the factor of safety is 6 based on ultimate strength. 7

OR

VI (a) Design a cast iron protective type flange coupling to transmit 15 kW at 900 r.p.m. from an electric motor to a compressor. The maximum torque is 1.35 times the mean torque. The following permissible stresses may be used :

Shear stress for shaft, bolt and key material = 40MPa

Crushing stress for bolt and key = 80 MPa

Shear stress for cast iron = 8 MPa

Draw a neat sketch of the coupling. 8

(b) A hollow steel shaft transmits 600 kW at 500 r.p.m. The maximum shear stress is 62.4 MPa. Find the outside and inside diameter of the shaft, if the outer diameter is twice of inside diameter, assuming that the maximum torque is 20% greater than the mean torque. 7

Marks

UNIT — III

VII (a) A cam with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower with the following motion :

(i) To raise the valve through 50 mm during 120° rotation of the cam ;

(ii) To keep the valve fully raised through next 30°,

(iii) To lower the valve during next 60°, and

(iv) To keep the valve closed during rest of the revolution.

The diameter of the roller is 20 mm. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Draw the displacement, diagram and the profile of the cam when the line of stroke of the valve rod passed through the axis of the cam shaft. 8

(b) Explain the following terms with respect to a governor. (i) Height of governor, (ii) Equilibrium Speed, (iii) Sensitiveness, (iv) Hunting. 7

OR

VIII (a) The load on the journal bearing is 150 kN due to turbine shaft of 300 mm diameter running at 1800 r.p.m. Determine the following :

(i) Length of the bearing if the allowable bearing pressure is 1.6 N/mm^2, and

(ii) Amount of heat to be removed by the lubricant per minute.

The bearing temperature can be taken as 60°C and viscocity of the oil at 60°C is 0.02 kg/m.s. and the bearing clearance is 0.25 mm. 8

(b) Explain the turning moment diagram for a single cylinder four stroke internal combustion engine with the help of a diagram. 7

UNIT — IV

IX (a) Two pulleys, one 450 mm diameter and the other 200 mm diameter are on parallel shafts 1.95m apart and are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200 rev/min, if the maximum permissible tension in the belt is 1 kN, and the coefficient of friction between the belt and pulley is 0.25 ? 8

(b) Illustrate the nomenclature of spur gear teeth with the help of a diagram and define (i) Addendum, (ii) Dedendum, (iii) Tooth thickness and (iv) Tooth space. 7

OR

X (a) A shaft rotating at 200 r.p.m. drives another shaft at 300 r.p.m. and transmits 6 kW through a belt. The belt is 100 mm wide and 10 mm thick. The distance between the shafts is 4m. The smaller pulley is 0.5 m in diameter. Calculate the stress in the belt, if it is an open belt drive. Take $\mu = 0.3$. 8

(b) Explain reverted gear train with the help of a diagram. Also find its velocity ratio. 7