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B TECH
(SEM VI) THEORY EXAMINATION 2017-18
MACHINE DESIGN-II

Time: 3 Hours ***Total Marks: 100***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.
2. Standard design data book is allowed.

SECTION A

1. Attempt *all* questions in brief. 2 x10 = 20

a) Explain the phenomenon of interference in involute gears.
b) What condition must be satisfied in order that a pair of spur gears may have a constant velocity ratio?
c) What is Tredgold's approximation about the formative number of teeth on bevel gear?
d) Sketch neatly the working drawing of bevel gears in mesh.
e) What is a herringbone gear? Where they are used?
f) Explain the terms used in helical gears (*a*) Helix angle; (*b*) normal pitch.
g) Write the equation for the efficiency of the worm gear with nomenclature. Write down the condition for maximum efficiency.
h) What is meant by hydrodynamic lubrication in bearings?
i) Explain the terms as applied to journal bearings (*a*) Bearing characteristic number and (*b*) Bearing modulus.
j) At what angle of the crank, the twisting moment is maximum in the crankshaft? Explain.

SECTION B

2. Attempt any *three* of the following: 10 x 3 = 30

a) What are the various terms used in Hydrodynamic Journal Bearing? Explain each term with neat sketch.
b) The load on the journal bearing is 150 KN due to turbine shaft of 300 mm diameter running at 1800 rpm. Determine the length of the bearing if the allowable bearing pressure is 1.6 N/mm2, and amount of heat to be removed by the lubricant per minute if the bearing temperature is 60°C and viscosity of the oil at 60°C is 0.02 kg/m-s and the bearing clearance is 0.25 mm.
c) The ball bearings are to be selected for an application in which the radial load is 2500 N during 90 % of the time and 7000 N during the remaining 10 %. The shaft is to rotate at 150 rpm. Determine the minimum value of the basic dynamic load rating for 5000 hours of operation with not more than 10 % failures.
d) A pair of helical gears with 35° helix angle is used to transmit 17 kW at 12000 rpm of the pinion. The velocity ratio is 5:1. Both the gears are to be made of hardened steel of static strength 120 N/mm^2. The gears are 20° stub and the pinion is to have 24 teeth. The face width may be taken as 12 times the module. Find the module and face width from the standpoint of strength and check the gears for wear.
e) Write down the step by step procedure to design a crankshaft. Also explain each parameter with nomenclature and relevant mathematical relations.

SECTION C

3. Attempt any *one*part of the following: 10 x 1= 10

a) A bronze spur pinion rotating at 800 rpm drives a cast iron spur gear at a transmission ratio of 4:1. The allowable static stresses for the bronze pinion and cast iron gear are 90 MPa and 110 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 85 mm. Find the power that can be transmitted from the standpoint of strength.

b) A pair of bevel gears is required to transmit 11 kW at 500 rpm from the motor shaft to another shaft, the speed reduction being 3:1. The shafts are inclined at 60º. The pinion is to have 24 teeth with a pressure angle of 20º and is to be made of cast steel having a static stress of 80 MPa. The gear is to be made of cast iron with a static stress of 55 MPa. The tooth form factor may be taken as $y = 0.154 - 0.912/T_E$, where T_E is formative number of teeth. The velocity factor may be taken as $3/(3 + v)$, where v is the pitch line velocity in m/s. The face width may be taken as $1/4^{th}$ of the slant height of the pitch cone. The mid-plane of the gear is 100 mm from the left hand bearing and 125 mm from the right hand bearing. The gear shaft is to be made of colled-rolled steel for which the allowable tensile stress may be taken as 80 MPa. Design the gears and the gear shaft.

4. Attempt any *one*part of the following: 10 x 1 = 10

a) A worm drive transmits 20 kW at 2500 rpm to a machine carriage at 70 rpm. The worm is triple threaded and has 60 mm pitch diameter. The worm gear has 85 teeth of 6 mm module. The tooth form is to be 20° full depth involute. The coefficient of friction between the mating teeth may be taken as 0.10. Calculate the tangential force acting on the worm and axial thrust and separating force on worm. Also calculate the efficiency of the worm drive.

b) A four-stroke diesel engine has the following specifications: Brake power 7kW; Speed 1500rpm; Indicated mean effective pressure 0.35N/mm^2;Mechanical efficiency 80%.Determine: **1**. Bore and length of the cylinder;**2**. Thickness of the cylinder head; and **3.**Size of studs for the cylinder head.

5. Attempt any *one* part of the following: 10 x 1 = 10

a) What are the materials used for Sliding Contact Bearings.A journal bearing 60 mm is diameter and 90 mm long runs at 450 rpm. The oil used for hydrodynamic lubrication has absolute viscosity of 0.06 kg/m-s. If the diametric clearance is 0.1 mm, find the safe load on the bearing.

b) A single stage helical gear reducer is to receive power from a 1440 rpm, 25 kW induction motor. The gear tooth profile is involute full depth with 20° normal pressure angle. The helix angle is 23°, number of teeth on pinion is 20 and the gear ratio is 3. Both the gears are made of steel with allowable beam stress of 90 MPa and hardness 250 BHN. (*a*) Design the gears for 20% overload carrying capacity from standpoint of bending strength and wear. (*b*) If the incremental dynamic load of 8 KN is estimated in tangential plane, what will be the safe power transmitted by the pair at the same speed?

6. Attempt any *one* part of the following: 10 x 1 = 10

a) A connecting rod is required to be designed for a high speed, four stroke I.C. engine. The following data are available. Diameter of piston 88 mm; Mass of reciprocating parts 1.6 kg; Length of connecting rod (centre to centre) 300 mm; Stroke 125 mm; RPM 2200 (when developing 50 kW); Possible over speed 3000 rpm; Compression ratio 6.8: 1; Probale maximum explosion pressure (assumed shortly after dead centre, say at about 3°) 3.5 N/mm^2.

b) Design a cast iron piston for a single acting four stroke engine for the following data: Cylinder bore = 150 mm; Stroke = 120 mm; Maximum gas pressure = 5.5N/mm^2; Indicated mean effective pressure 0.75 N/mm^2; Mechanical efficiency = 85%; Fuel consumption 0.15 kg per brake power per hour; Higher calorific value of fuel 42×10^3kJ/kg; Speed = 2000 rpm. Any other data required for the design may be assumed.

7. Attempt any *one* part of the following: 10 x 1 = 10

a) Write short note on the following:
   (i) Cycloidal and involute teeth of gears with neat sketch.
   (ii) Dynamic, static and wear tooth load in gears and causes of gear tooth failure.

b) A motor shaft rotating at 1200 rpm has to transmit 18 kW to a low speed shaft with a speed reduction of 3:1. The teeth are $14^1/_2$°involute with 24 teeth on the pinion. Both the pinion and gear are made of steel with a maximum safe stress of 200 MPa. A safe stress of 45 MPa may be taken for the shaft on which the gear is mounted and for the key. Design a spur gear drive to suit the above conditions. Assume starting torque to be 30% higher than the running torque.