SP–7 C (ME-6)

B. Tech.
(SEM. VI) EVEN SEMESTER THEORY EXAMINATION, 2015-16
MACHINE DESIGN-II

Time : 3 Hours   **Max. Marks : 100**

Section – A

1. Attempt all questions :   (2 × 10 = 20)

a. 20-tooth 8 pitch 2.54 mm wide 20° pinion transmits 5 kW at 1725 rpm to a 60-tooth gear. Determine driving force, separating force, and resultant force that would act on mounting shafts.

Ans. Refer Q. 1.14, Page SQ–3C, 2 Marks Questions, Unit-1.

b. What do you understand by beam strength of gear tooth ?

Ans. Refer Q. 1.10, Page SQ–2C, 2 Marks Questions, Unit-1.

c. Define worm gearing with applications.

Ans. Refer Q. 2.11, Page SQ–6C, 2 Marks Questions, Unit-2.

d. Classify the sliding contact bearing in terms of thickness of layer of the lubricant between the bearing and journal.

Ans. Refer Q. 3.4, Page SQ–8C, 2 Marks Questions, Unit-3.

e. Why is piston made light weight ?

Ans. Refer Q. 5.7, Page SQ–15C, 2 Marks Questions, Unit-5.

f. What kind of contact occurs between worm and worm wheel ? How does it differ from other types of gears ?

Ans. Refer Q. 2.12, Page SQ–7C, 2 Marks Questions, Unit-2.

g. What is SAE ?

Ans. Refer Q. 5.3, Page SQ–14C, 2 Marks Questions, Unit-5.

h. Define L_{10} and L_{50} life for bearings.

Ans. Refer Q. 4.7, Page SQ–11C, 2 Marks Questions, Unit-4.

i. What is the purpose of valve springs ?

Ans. Refer Q. 5.4, Page SQ–14C, 2 Marks Questions, Unit-5.

j. What is herringbone helical gear ?

Ans. Refer Q. 1.17, Page SQ–4C, 2 Marks Questions, Unit-1.

2. Attempt any five questions. $(10 \times 5 = 50)$

a. A pair of straight teeth spur gears is to transmit 25 kW when pinion rotates at 300 rpm. The velocity ratio is 1 : 3. The allowable static stresses for the pinion and gear materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its face width is 15 times the module. Determine the module, face width and pitch circle diameters of both the pinion and the gear from standpoint of strength only, taking into consideration the effect of dynamic loading. Assume 20° full depth involute pair with ordinary cutting.

Ans. Refer Q. 1.18, Page 1–20C, Unit-1.

b. A steel pinion with 20° full depth involute teeth is transmitting 7.5 kW power at 1000 rpm from an electric motors. The starting torque of the motor is twice the rated torque. The number of teeth on the pinion is 25, while the module is 4. The face width is 45 mm. Assuming that velocity factor accounts for the dynamic load, calculate

i. Effective load on the gear tooth, and

ii. Bending stress in the gear tooth.

Ans. Refer Q. 1.19, Page 1–20C, Unit-1.

c. A pair of 20° stub teeth spur gears is to transmit 20 kW. The pinion rotates at 500 rpm and the VR is 1 : 4. The allowable static stress for gear and pinion are 100 MPa and 120 MPa respectively. The pinion has 20 teeth and face width is 10 times the module. Design the gear for static strength.

Ans. Refer Q. 1.20, Page 1–21C, Unit-1.

d. Give the terminology of helical gears with suitable diagram. Also explain the forces on a helical gear tooth.

Ans. Refer Q. 1.24, Page 1–26C, Unit-1.

e. A journal bearing has a journal diameter of 50 mm and the diameter of bushing is 50.1 mm. The bushing is 50 mm long and has to support a load of 1 kN at a speed of 1200 rpm. Determine the minimum oil film thickness and power loss for SAE 10 oil, assuming the oil film temperature to be 70 °C.

Ans. Refer Q. 3.22, Page 3–21C, Unit-3.

f. A pair of helical gears is used to transmit 15 kW at 3000 rpm of the pinion. The teeth are 20° stub in diametric plane and the helix angle is 45°. The gear and pinion have a pitch diameter of 320 and 80 mm respectively. Both the

gears are made of cast steel with an allowable stress of 100 MPa. The modulus of elasticity for cast steel is 2×10^5 MPa and its surface endurance strength is 618 MPa. Suggest a suitable module and face width for gear pair and check the strength of the gear pair in wear.

Ans. Refer Q. 1.30, Page 1–32C, Unit-1.

g. The bore of a cylinder of the four stroke diesel engine is 150 mm. The maximum gas pressure inside the cylinder is limited to 3.5 MPa. The cylinder head is made of grey cast iron FG 200 ($\sigma_{ut} = 200$ N/mm^2) and the FOS is 5. Determine the thickness of the cylinder head. Studs is made of steel FeE 250 ($\sigma_{yt} = 250$ N/mm^2) and the FOS is 5. Calculate :

  i. Number of studs,

  ii. Nominal diameter of studs, and

  iii. Pitch of studs.

Ans. Refer Q. 5.5, Page 5–6C, Unit-5.

h. Determine the dimensions of cross sections of the connecting rod (*I*-section) for a diesel engine with the following data :

  i. Cylinder bore = 100 mm

  ii. Length of connecting rod = 320 mm

  iii. Maximum gas pressure = 2.45 MPa

  iv. FOS against buckling failure = 5

Ans. Refer Q. 5.15, Page 5–21C, Unit-5.

Section-C

Note : Attempt two question. $(15 \times 2 = 30)$

3. The following data is given for a pair of parallel helical gears made of steel :
   Power transmitted = 20 kW, N_P = 720 rpm, T_P = 35, T_G = 70, centre distance = 285 mm, normal module = 5 mm, b = 50 mm, normal pressure angle = 20°, σ_{ut} = 600 N/mm^2, surface hardness number = 300 BHN, grade of matching = 6, service factor = 1.25. Calculate :

  i. The helix angle,

  ii. Beam strength,

  iii. Wear strength,

  iv. Static load,

  v. The dynamic load by Buckingham's equation, and

  vi. Effective factor of safety against bending failure.

Ans. Refer Q. 1.31, Page 1–33C, Unit-1.

4. Design a high efficiency worm gear speed reducer to transmit continuously the rated power output of 15 kW

motor running at 1750 rpm. The steel worm having hardness 250 BHN is integral with the motor shaft. The speed ratio is 10, while the phosphor bronze gear should not have less than 40 mm.

Ans. Refer Q. 2.23, Page 2–29C, Unit-2.

5. Answer following in brief.
i. Virtual number of teeth in helical gear.

Ans. Refer Q. 1.26, Page 1–28C, Unit-1.

ii. Hydrostatic versus hydrodynamic bearing.

Ans. Refer Q. 3.12, Page 3–12C, Unit-3.

iii. Reliability of antifriction bearings.

Ans. Refer Q. 4.16, Page 4–15C, Unit-4.

☺☺☺

B. Tech.
(SEM. VI) EVEN SEMESTER THEORY
EXAMINATION, 2016-17
MACHINE DESIGN-II

Time : 3 Hours   **Max. Marks : 100**

Section-A

1. Attempt **all** of the following questions :   (2 × 10 = 20)

   a. **Explain wedge film and squeeze film journal bearings.**
   Ans. Refer Q. 3.5, Page SQ–8C, 2 Marks Questions, Unit-3.

   b. **Explain the following terms as applied to journal bearings :**
   i. **Bearing characteristics number, and**
   ii. **Bearing modulus.**
   Ans. Refer Q. 3.10, Page SQ–9C, 2 Marks Questions, Unit-3.

   c. **How do you express the life of a bearing ? What is an average or median life ?**
   Ans. Refer Q. 4.8, Page SQ–12C, 2 Marks Questions, Unit-4.

   d. **Explain the different causes of gear tooth failures and suggest possible remedies to avoid such failures.**
   Ans. Refer Q. 1.13, Page SQ–2C, 2 Marks Questions, Unit-1.

   e. **What is a herringbone gear ? Where they are used ?**
   Ans. Refer Q. 1.17, Page SQ–4C, 2 Marks Questions, Unit-1.

   f. **What are the various forces acting on worm and worm gears ?**
   Ans. Refer Q. 2.13, Page SQ–7C, 2 Marks Questions, Unit-2.

   g. **Explain the various types of cylinder liners.**
   Ans. Refer Q. 5.2, Page SQ–14C, 2 Marks Questions, Unit-5.

   h. **Explain the various forces induced in the connecting rod.**
   Ans. Refer Q. 5.12, Page SQ–15C, 2 Marks Questions, Unit-5.

   i. **What is the function of a connecting rod of an internal combustion engine ?**
   Ans. Refer Q. 5.11, Page SQ–15C, 2 Marks Questions, Unit-5.

j. Explain the following terms used in helical gears :

i. Helix angle, and

ii. Normal pitch.

Ans. Refer Q. 1.15, Page SQ-3C, 2 Marks Questions, Unit-1.

Section-B

2. Attempt any five of the following questions :   (10 × 5 = 50)

a. A 80 mm long journal bearing supports a load of 2800 N on a 50 mm diameter shaft. The bearing has a radial clearance of 0.05 mm and the viscosity of the oil is 0.021 kg/m-s at the operating temperature. If the bearing is capable of dissipating 80 J/s, determine the maximum safe speed.

Ans. Refer Q. 3.23, Page 3-23C, Unit-3.

b. The thrust of propeller shaft is absorbed by 6 collars. The rubbing surfaces of these collars have outer diameter 300 mm and inner diameter 200 mm. If the shaft runs at 120 rpm, the bearing pressure amounts to 0.4 N/mm². The coefficient of friction may be taken as 0.05. Assuming that the pressure is uniformly distributed. Determine the power absorbed by the collars.

Ans. Refer Q. 3.27, Page 3-26C, Unit-3.

c. A shaft rotating at constant speed is subjected to variable load. The bearings supporting the shaft are subjected to stationary equivalent radial load of 3 kN for 10 percent of time, 2 kN for 20 percent of time, 1 kN for 30 percent of time and no load for remaining time of cycle. If the total life expected for the bearing is 20 × 10⁶ revolutions at 95 % reliability, calculate dynamic load rating of the ball bearing.

Ans. Refer Q. 4.17, Page 4-15C, Unit-4.

d. A bronze spur pinion rotating at 600 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 84 MPa and 105 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm. Find the power that can be transmitted from the standpoint of strength.

Ans. Refer Q. 1.17, Page 1-19C, Unit-1.

e. A pair of helical gears are to transmit 15 kW. The teeth are 20° stub in diametral plane and have a helix angle of 45°. The pinion runs at 10000 rpm and has 80 mm pitch diameter. The gear has 320 mm pitch diameter. If the gear are made of cast steel having allowable static strength of 100 MPa;

determine a suitable module and face width from static strength considerations and check the gears for wear, given σ_{es} = 618 MPa.

ANS. Refer Q. 1.29, Page 1–31C, Unit-1.

f. A worm drive transmits 15 kW at 2000 rpm to a machine carriage at 75 rpm. The worm is triple threaded and has 65 mm pitch diameter. The worm gear has 90 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 : 1 tangential force acting on the worm; 2. axial thrust and separating force on worm; and 3. efficiency of the worm drive.

ANS. Refer Q. 2.20, Page 2–24C, Unit-2.

g. A four stroke diesel engine has the following specifications : Brake power = 5 kW; Speed = 1200 rpm; Indicated mean effective pressure = 0.35 N/mm²; 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.

ANS. Refer Q. 5.4, Page 5–5C, Unit-5.

h. Derive the following expression as applied to rolling contact bearings subjected to variable load cycle

$$W_e = 3\sqrt{\frac{N_1(W_1)^3 + N_2(W_2)^3 + N_3(W_3)^3 + ...}{N_1 + N_2 + N_3 + ...}}$$

W_e = Equivalent cubic load.
W_1, W_2, W_3 = Loads acting respectively for $N_1, N_2, N_3...$

ANS. Refer Q. 4.14, Page 4–13C, Unit-4.

Section-C

Attempt any two of the following questions :   (15 × 2 = 30)

3. A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 N/mm². The speed of the journal is 900 rpm and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75 °C may be taken as 0.011 Kg/m-s. The room temperature is 35 °C.
Find : 1. The amount of artificial cooling required, and 2. The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10 °C. Take specific heat of the oil as 1850 J/kg/ °C.

Ans. Refer Q. 3.20, Page 3–18C, Unit-3.

4. A pair of 20° full depth involute teeth bevel gears connect two shafts at right angles having velocity ratio 3 : 1. The gear is made of cast steel having allowable static stress as 70 MPa and the pinion is of steel with allowable static stress as 100 MPa. The pinion transmits 37.5 kW at 750 rpm. Determine : (a) Module and face width; (b) Pitch diameters; and (c) Pinion shaft diameter.
Assume tooth form factor,

$$y = 0.154 - \frac{0.912}{T_E}$$

Where T_E is the formative number of teeth, width = 1/3 rd the length of pitch cone, and pinion shaft overhangs by 150 mm.

Ans. Refer Q. 2.6, Page 2–7C, Unit-2.

5. Design a cast iron piston for a single acting four stroke engine for the following data : Cylinder bore = 100 mm; Stroke = 125 mm; Maximum gas pressure = 5 N/mm²; Indicated mean effective pressure = 0.75 N/mm²; Mechanical efficiency = 80 %; Fuel consumption = 0.15 kg per brake power per hour; Higher calorific value of fuel = 42 × 10³ kJ/kg; speed = 2000 rpm. Any other data required for the design may be assumed.

Ans. Refer Q. 5.9, Page 5–12C, Unit-5.

☺☺☺

B. Tech.
(SEM. VI) EVEN SEMESTER THEORY
EXAMINATION, 2017-18
MACHINE DESIGN-II

Time : 3 Hours   **Max. 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. $(2 \times 10 = 20)$
   a. Explain the phenomenon of interference in involute gears.
   Ans. Refer Q. 1.8, Page SQ–2C, 2 Marks Questions, Unit-1.

   b. What condition must be satisfied in order that a pair of spur gears may have a constant velocity ratio ?
   Ans. Refer Q. 1.5, Page SQ–1C, 2 Marks Questions, Unit-1.

   c. What is Tredgold's approximation about the formative number of teeth on bevel gear ?
   Ans. Refer Q. 2.9, Page SQ–6C, 2 Marks Questions, Unit-2.

   d. Sketch neatly the working drawing of bevel gears in mesh.
   Ans. Refer Q. 2.3, Page SQ–5C, 2 Marks Questions, Unit-2.

   e. What is a herringbone gear ? Where they are used ?
   Ans. Refer Q. 1.17, Page SQ–4C, 2 Marks Questions, Unit-1.

   f. Explain the terms used in helical gears
   a. Helix angle, and
   b. Normal pitch.
   Ans. Refer Q. 1.15, Page SQ–3C, 2 Marks Questions, Unit-1.

   g. Write the equation for the efficiency of the worm gear with nomenclature. Write down the condition for maximum efficiency.
   Ans. Refer Q. 2.14, Page SQ–7C, 2 Marks Questions, Unit-2.

   h. What is meant by hydrodynamic lubrication in bearings ?
   Ans. Refer Q. 3.7, Page SQ–9C, 2 Marks Questions, Unit-3.

i. Explain the terms as applied to journal bearings

a. Bearing characteristic number, and

b. Bearing modulus.

Ans. Refer Q. 3.10, Page SQ-9C, 2 Marks Questions, Unit-3.

j. At what angle of the crank, the twisting moment is maximum in the crankshaft ? Explain.

Ans. Refer Q. 5.15, Page SQ-16C, 2 Marks Questions, Unit-5.

Section-B

Attempt any three of the following :　　　　　　　(10 × 3 = 30)

2.

a. What are the various terms used in hydrodynamic journal bearing ? Explain each term with neat sketch.

Ans. Refer Q. 3.11, Page 3–11C, Unit-3.

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.

Ans. Refer Q. 3.18, Page 3–17C, Unit-3.

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.

Ans. Refer Q. 4.15, Page 4–14C, Unit-4.

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/mm². 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.

Ans. Refer Q. 1.32, Page 1–35C, Unit-1.

e. Write down the step by step procedure to design a crankshaft. Also explain each parameter with nomenclature and relevant mathematical relations.

Ans. Refer Q. 5.18, Page 5–27C, Unit-5.

Section-C

3. Attempt any **one** part of the following :   (10 × 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.

   Ans. Refer Q. 1.21, Page 1–21C, Unit-1.

   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 60°. The pinion is to have 24 teeth with a pressure angle of 20° 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 1/4th 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 coiled-rolled steel for which the allowable tensile stress may be taken as 80 MPa. Design the gears and the gear shaft.

   Ans. Refer Q. 2.7, Page 2–10C, Unit-2.

4. Attempt any **one** part of the following :   (10 × 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.

   Ans. Refer Q. 2.19, Page 2–23C, Unit-2.

   b. A four-stroke diesel engine has the following specifications : Brake power 7 kW; Speed 1500 rpm; Indicated mean effective pressure 0.35 N/mm²: 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.

Ans. Refer Q. 5.6, Page 5–8C, Unit-5.

5. Attempt any one part of the following :   (10 × 1 = 10)
a. What are the materials used for sliding contact bearings ? A journal bearing 60 mm in 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.

Ans. Refer Q. 3.15, Page 3–14C, Unit-3.

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 ?

Ans. Refer Q. 1.33, Page 1–37C, Unit-1.

6. Attempt any one part of the following :   (10 × 1 = 10)
a. A connecting rod is required to be designed for a high speed, four stroke IC 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; Probable maximum explosion pressure (assumed shortly after dead centre, say at about 3°) 3.5 N/mm^2.

Ans. Refer Q. 5.17, Page 5–26C, Unit-5.

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 = 5.5 N/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^{3}kJ/kg; Speed = 2000 rpm. Any other data required for the design may be assumed.

Ans. Refer Q. 5.11, Page 5–16C, Unit-5.

7. Attempt any **one** part of the following : $(10 \times 1 = 10)$

a. Write short note on the following :

i. Cycloidal and involute teeth of gears with neat sketch.

Ans. Refer Q. 1.3, Page 1–4C, Unit-1.

ii. Dynamic, static and wear tooth load in gears and causes of gear tooth failure.

Ans. Refer Q. 1.12, Page 1–14C, Unit-1.

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 14½°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.

Ans. Refer Q. 1.22, Page 1–21C, Unit-1.

☺☺☺