QP Code : 29902

(4hours)   Max.Marks: 100
                                                             Duration : 4 Hrs.

Instructions: 1) Question *No. 1* is compulsory
                2) Answer any *four* from the remaining six questions
                3) Use of recommended *PSG Design data book* is permitted.
                4) Use your judgment for unspecified data, if any.

Q.1. Answer any *four* of the followings :   (4 x 5 = 20)
   a) Explain briefly the modes of gear teeth failures.
   b) Explain the significance of the following terms used in hydrodynamic bearings :
       i) L/D ratio   ii) minimum film thickness
       iii) flow variable in bearing
   c) Explain how the following factors influence the life of bearing:
       i) load   ii) speed   iii) temperature   iv) reliability
   d) How the worm and worm gears are specified?. And why they are more preferred over
       other gears in some specific applications.
   e) What is service factor? How did you decide it in various applications?

Q.2(a) The pitch circle diameters of the spur pinion and gear are 110 mm and 280 mm
   respectively. The pinion is made of plain carbon steel 40C8(S_{ut}= 600 N/mm^2) while gear
   is made of gray cast iron FG 350. The gear pair is generated by hobbing. The pinion
   receives 5.5 kW power at 600 rpm through its shaft. The service factor and factor of
   safety can be taken as 1.2 each. The face width of the gear can be taken as ten times the
   module. If the velocity factor accounts for the dynamic load, calculate the module and the
   number of teeth on pinion and gear. Specify the surface hardness for a gear pair.   (10)

   b) A compressor running at 340 rpm is driven by a 140 kW, 1440 rpm motor through a pair
   of 20^0 full depth helical gears having helix angle of 25^0.The centre distance is
   approximately 350 mm. The motor pinion is to be forged steel and the driven gear is to be
   cast steel. Assume medium shock conditions, design the gear pair considering strength and
   check the gears of wear.   (10)

Q.3 A rotary plate cam and central translator roller follower has following follower motion:
   Outward motion of 25 mm in 90^0 rotation of cam with parabolic motion, return to normal
   position with SHM in 100^0 rotation of cam and dwell for the remaining period. Mass of the
   follower is 1.25 kg, cam shaft speed 450 RPM, maximum pressure angle 25^0 during forward
   stroke, external force during forward stroke 325 N and during return stroke 45 N.
       i)   Design the cam, follower and spring.   (9)
       ii)   Draw cam profile to scale.   (5)
       iii) Determine camshaft diameter.   (3)
       iv)   Calculate the maximum cam shaft torque.   (3)

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Q.4 The following data refers to centrifugal pump for pumping water .
   i) length of suction head = 2.8 m
   ii) static delivery head = 16 m
   iii) discharge = 1100 liters per minute
   iv) length of delivery pipe = 29 m
   v) working fluid – water at 30^0
   Design completely a centrifugal pump f or given application which includes the design of impeller, shaft, bearing, casing. Also, draw suitable layout for this pump.   (20)

Q.5(a) The following data is given for a 360^0 hydrodynamic bearing:
   i) radial load   = 10 kN
   ii) journal speed   = 1440rpm
   iii) l/d ratio   = 1
   iv) bearing length   = 45 mm
   v) radial clearance   = 20 microns
   vi) eccentricity   =15 microns
   vii) specific gravity of lubricant = 0.86
   viii) specific heat of lubricant =2.09 kJ/kg^{0}C
   Calculate: (1) minimum oil film thickness; ii) the coefficient of friction; iii) the power lost in friction; (iv) the viscosity of lubricant in cP; v) the total flow rate of the lubricant in l/min; vi) the side leakage; vii) the average temperature, if makeup oil is supplied at 30^0 C.   (15)

(b) What are the assumptions made in Lewis equation applied to gear design and justify them.
                    (5)

Q.6 Design completely the Snatch Block assembly used in EOT crane which should include
   i) selection of rope selection of suitable type, power and speed of motor used for hoisting
   mechanism,   (3)
   ii) sheave,   (2)
   iii) hook,   (4)
   iv)bearing for hook,   (2)
   vi) cross piece,   (3)
   vii) axle for sheave and   (3)
   ix) shackle plate,   (3)
   Use the following specifications of the EOT crane as an input to its design .
   Application   : class II
   Load to be lifted   : 250 kN
   Hoisting speed   : 4.5 m/min
   Maximum lift   : 13 m

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Q.7(a) A ball bearing operates on a work cycle consisting of three parts:

i) Radial load of 3000 N at 720 rpm for 30 % of the cycle

ii) radial load of 7000 N at 1440 rpm for 40 % of the cycle

iii) radial load of 5000 N at 900 rpm for the remaining part of the cycle.

The basic dynamic capacity of the bearing is 30700 N. Calculate :

    i)   The rating life of the bearing in hours; (5)

    ii)   The average speed of rotation; and (2)

    iii)   The life of the bearing with 95% reliability. (3)

(b) A pair of straight bevel gear consists of a 24 teeth pinion meshing with a 48-teeth gear. The module at outside diameter is 6 mm, while the face width is 50 mm. The gears are made of grey C. I. FG220 (S_{ut} = 220 N/mm^2) . The pressure angle is 20⁰. The pinion rotates at 300 rpm and the service factor is 1.5 . Calculate:

i) the beam strength of the tooth (4)

ii) the static load that the gears can transmit with a factor of safety of 2 for bending

    consideration, and (3)

iv) the rated power that the gears can transmit. (3)