

QP Code : 2367

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 **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 various gear teeth failures.
 b) Explain the significance of the following terms:
 i) Sommerfeld number ii) coefficient of friction variable
 iii) flow variable
 c) Explain how the following factors influence the life of bearing:
 i) load ii) speed iii) temperature iv) reliability
 d) What are the four important parameters that are required to specify the worm gear drive?. And explain why are the worm gear reduction units not preferred over other types of gearboxes for transmitting large powers?.
 e) what do you mean by experience or service factor ? how is it decided in different applications.

Q.2(a) The pitch circle diameters of the spur pinion and gear are 100 mm and 300 mm respectively. The pinion is made of plain carbon steel 40C8 ($S_{ut} = 600 \text{ N/mm}^2$) while gear is made of gray cast iron FG300. The gear pair is generated by hobbing. The pinion receives 5 kW power at 500 rpm through its shaft. The service factor and factor of safety can be taken as 1.5 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 360 rpm is driven by a 150 kW, 1440 rpm motor through a pair of 20° full depth helical gears having helix angle of 25° . The centre distance is approximately 400 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)

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Q.3 A rotary plate cam and central translator roller follower has following follower motion:

Outward motion of 25 mm in 90° rotation of cam with parabolic motion, return to normal position with SHM in 100° 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° 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)

Q.4 The following data refers to centrifugal pump for pumping water .

- i) length of suction head = 2.5 m
- ii) static delivery head = 15 m
- iii) discharge = 1200 liters per minute
- iv) length of delivery pipe = 30 m
- v) working fluid – water at 32°

Design completely a centrifugal pump for 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° hydrodynamic bearing:

- i) radial load = 10 kN
- ii) journal speed = 1450 rpm
- iii) l/d ratio = 1
- iv) bearing length = 50 mm
- v) radial clearance = 20 microns
- vi) eccentricity = 15 microns
- vii) specific gravity of lubricant = 0.86
- viii) specific heat of lubricant = $2.09 \text{ kJ/kg}^\circ\text{C}$

Calculate: (i) 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°C . (15)

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

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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	: 270 kN
Hoisting speed	: 4.5 m/min
Maximum lift	: 15 m

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

- i) Radial load of 1000 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 ($S_{ut} = 220 \text{ N/mm}^2$) . The pressure angle is 20° . 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)