

Total No. of Questions :10]

SEAT No. :

**P3677**

**[4959]-1043**

[Total No. of Pages :4

**B.E. (Mechanical)**

**MECHANICAL SYSTEM DESIGN**

**(2012 Course) (End - Semester) (402048)**

*Time : 2½ Hours]*

*[Max. Marks :70*

*Instructions to the candidates:*

- 1) *Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6,Q.7 or Q.8, Q.9 or Q.10.*
- 2) *Neat diagrams must be drawn wherever necessary.*
- 3) *Figures to the right side indicate full marks.*
- 4) *Assume suitable data, if necessary.*

**Q1) a)** What are the different parameters considered in kinematic design of multi speed gear box? Explain any two in brief. **[4]**

b) Define the following terms: **[6]**

- i) Population
- ii) Sample
- iii) Random variables

Also explain the concept of reliability based design.

OR

**Q2) a)** Write advantages and disadvantages of arithmetic, geometric and Harmonic progression. **[4]**

b) A particular type of rolling contact bearing has a normally distributed time to failure, with a mean of 10,000 hrs and a standard deviation of 750h. If there are 100 such bearings fitted at a time, how many may be expected to fail within the first 11000 h?

(Area below normal curve from  $Z = 0$  to  $Z = 1.35$  is given below) **[6]**

Z	0	1	2	3	4	5
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115

**P.T.O.**

- Q3) a)** What do you understand by take up device in belt conveyors? State different types of take up devices used in belt conveyors. Explain any one? [4]
- b) A three idler, troughed belt, horizontal conveyor is to be used for transporting 500 ton of iron per hour having mass density of iron ore is  $1700 \text{ kg/m}^3$ . If the belt speed is  $2 \text{ m/sec}$ , determine the required effective belt width. Take surcharge factor = 0.1. [6]

OR

- Q4) a)** Why idlers are used in belt conveyors? Also draw different types of idlers used in belt conveyors. [4]
- b) A belt conveyor is to be designed to carry the iron ore at the rate of 350 ton/hour with following details: [6]

Weight density of material =  $16700 \text{ N/m}^3$

Angle of repose of material =  $15^\circ$

Belt speed =  $120 \text{ m/min}$

Material factor for plies  $k_1 = 2.0$

Belt tension and arc of contact factor =  $k_2 = 70$

No. of plies for belt = 4 (Take :  $C = 0.075$ ,  $S = 80 \text{ mm}$ ).

Determine

- i) Width for belt.
- ii) Diameter and length of drive pulley.
- Q5) a) i)** What is autofrettage? Explain any one method of prestressing the cylinders. [4]
- ii) Derive Birnie's equation. Explain under what conditions it is used. [4]
- b) Explain the basic principle of the area compensation method. Also explain area compensation for nozzle with its equations. [10]

OR

**Q6) a) i)** The piston rod of a hydraulic cylinder exerts an operating force of 12kN. The friction due to piston packing and stuffing box is equivalent to 10% of the operating force. The pressure in the cylinder is 10 MN/m<sup>2</sup>. The cylinder is made of cast iron FG 200 and factor of safety is 5. Determine the diameter and thickness of cylinder. **[4]**

ii) A hydraulic cylinder with closed ends is subjected to an internal pressure of 15 MPa. The inner and outer diameters of the cylinder are 200 mm and 240 mm respectively. The cylinder material is cast iron FG 300. Determine the factor of safety used in design. If the cylinder pressure is further increased by 50%, what will be the factor of safety? **[4]**

b) A pressure vessel consists of cylinder shell with 2m inside diameter and 10 mm thickness. It is subjected to design pressure 0.75 MN/m<sup>2</sup> and having nozzle of inner diameter 300 mm and wall thickness of 10mm. The corrosion allowance is 2 mm and weld efficiency is 0.85. The extension of nozzle inside and outside the shell is 15mm.

Take  $S_{yt} = 210$  MPa. A reinforcing pad of 10mm thick plate is provided for opening. Factor of safety = 1.5. Determine the dimensions of reinforcing pad. **[10]**

**Q7) a)** Explain the step by step procedure for designing of cylinder of IC engine. **[6]**

b) Determine the dimensions of the cross section of the connecting rod for a diesel engine with following data: **[10]**

Cylinder bore = 95 mm

$$\sigma_c = 298 \text{ N/mm}^2$$

Length of connecting rod = 350 mm

Maximum gas pressure = 4 MPa

Factor of safety = 6

OR

**Q8) a)** Explain the step by step procedure for designing of crank shaft of IC engine. **[6]**

b) Cylinder of four stroke diesel engine has following specifications: [10]

Cylinder bore = 145 mm                      Factor of safety =5

Cylinder material = FG200                      Poisson's ratio = 0.25

Maximum gas pressure = 3.5 MPa              Reboaring allowance = 5mm

Determine thickness of cylinder wall and calculate stresses in the cylinder wall.

**Q9) a)** Explain the procedure of solving optimum design problems with redundant specifications. [6]

b) A tensile bar of length 400mm is subjected to constant tensile force of 3000N. If the factor of safety is 2, design the bar diameter, using Johnson's method, with the objective of minimizing material weight using optimum material from the list given in Table 1. [10]

Material	Density ( $\rho$ ) Kg/m <sup>3</sup>	Cost (c) Rs/Kg	Syt N/mm <sup>2</sup>
Steel	7800	28	400
Aluminum alloy	2800	132	150
Titanium Alloy	4500	2200	800

Table 1

OR

**Q10)a)** Explain the design considerations for design of castings. [6]

b) In lightweight equipment, a shaft is required to transmit 40KW power at 480 RPM. Required stiffness of shaft is 90N-m/Degree. Factor of safety based on  $S_{ys}$  is 1.5.

Using max shear stress theory of failure design the shaft with the objective of minimum weight by using optimum material from the list given in Table 1 above. Assume  $G = 70,000 \text{ N/mm}^2$  for all materials. [10]

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