Total No. of Questions : 12]

SEAT No. :

P2672

[Total No. of Pages : 5

[5154]-42
B.E. (Mechanical)
MECHANICAL SYSTEM DESIGN
(2008 Pattern) (Semester - II)

Time : 4 Hours] *[Max. Marks : 100*

Instructions to candidates:

1) ***Answer 3 questions from Section I and 3 questions from Section II.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Your answers will be valued as a whole.***
6) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
7) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) The piston rod of a hydraulic cylinder exerts an operating force of 10 kN. The friction due to piston packing and stuffing box is 10% of the operating force. The pressure in the cylinder is 10 MPa. The cylinder is made up of FG 200 and factor of safety is 5. Determine the internal diameter and thickness of the cylinder.
The flange thickness is 10 mm and CI cover plate of thickness 10 mm is fixed to the cylinder by means of 4, M10 bolts and a zinc gasket of 3 mm thickness. The bolts are made up of Fe400. Determine the factor of safety for bolts.

E_{steel} = 207 GPa

E_{CI} = 100 GPa

E_{zinc} = 90 GPa

Assume a preload of 20 kN in each bolt.

Std. Dia. of cylinder 20, 30, 40, 50, 60 mm

Std. Thickness 2, 4, 5, 6, 7, 8, 10 mm B. **[12]**

b) State and explain various catagories of welded joints used in unfired pressure vessels. Draw a neat sketch. **[6]**

OR

P.T.O.

Q2) a) A cylindrical pressure vessel shell of inside diameter 1500 mm is subjected to an internal pressure of 2 MPa. The shell as well as the heads are made of low alloy steel with sult = 450 MPa. Double welded butt joints which are spot radiographed are used to fabricate the vessel. Corrosion allowance is 3 mm. Determine the thickness of the cylindrical shell and thickness of head if the heads are **[12]**

i) Flat

ii) Plain formed

iii) Torispherical with crown radius of 1125 mm.

b) Derive Clavarino's equation for thick cylinder subjected to internal pressure. **[6]**

Q3) a) The cylinder of a 4 stroke diesel engine has the following specifications:
Brake power = 7.5 kW

Speed = 1400 RPM

IMEP = 0.35 MPa

Mechanical efficiency = 80%

Maximum gas pressure = 3.5 MPa

The cylinder liner and head are made of grey cast iron with Sut = 250 MPa and $\mu = 0.25$. The studs are made of plain carbon steel with Syt = 380 MPa. Factor of safety for all parts is 6.

Calculate:

i) Bore and length of cylinder liner

ii) Thickness of cylinder liner

iii) Thickness of cylinder head

iv) Size, number and pitch of stud. **[12]**

b) Explain the desirable properties of the materials used for cylinder, head and studs. **[4]**

OR

Q4) a) The following data is given for a four-stroke diesel engine: **[12]**

Cylinder bore = 250 mm

Length of stroke = 300 mm

Speed = 600 rpm

Indicated mean effective pressure = 0.6 MPa

Mechanical efficiency = 80%

Maximum gas pressure = 4 MPa

Fuel consumption = 0.25 kg/kW-hr.

Higher calorific value of fuel = 44000 kJ/kg

Assume that 5% of total heat developed in the cylinder is transmitted by the piston. The piston is made of gray C.I FG 200 (Sut = 200 N/mm^2 and K = 46.6 W/m°C) and the factor of safety is 5. The temperature difference between the center and the edge of the piston head is 220°C.

i) Determine the thickness of piston head by strength consideration and thermal consideration.

ii) State whether the ribs are required, if so calculate the number and thickness of ribs.

iii) State whether a cup is required in the top of piston head, if so calculate the radius of the cup.

b) Explain the desirable properties of the materials used for piston. **[4]**

Q5) a) Differentiate between optimum design problems with normal specifications and redundant specifications. **[4]**

b) A shaft is to be used to transmit a torque of 900 N-m. The required torsional stiffness (rigidity) of shaft is 90 N-m/degree while the factor of safety based on the yield strength is 1.5. Using the maximum shear stress theory, design the shaft with the objective of minimizing the weight. **[12]**

Material	Mass density(kg/m^3)	Modulus of rigidity(GPa)	Yield strength(MPa)
M1	8500	80	130
M2	3000	26.5	50
M3	4800	40	90

OR

Q6) a) Explain: **[4]**

i) Adequate design

ii) Optimum design

b) A tensile bar of length 200 mm is subjected to the constant tensile force of 5000 N. Design the bar with the objective of minimizing the material cost, out of the following materials: **[12]**

Material	Mass density (kg/m^3)	Material cost (Rs/kg)	Yield strength (N/mm^2)
Plain carbon steel	7500	16	130
Aluminum alloy	3000	32	50
Titanium alloy	4800	480	90

SECTION - II

Q7) a) Describe using a schematic a Man-Machine System and the factors influencing efficiency. **[6]**

b) Three rods with length of 40 mm each have to be assembled to form a total length of 120 ± 0.6 mm and each one has the same standard deviation as well as design and natural tolerances. Find the tolerances of each component. **[10]**

OR

Q8) a) Describe in detail the basic principles of design for manufacture and assembly that are employed in a well setup production line. **[6]**

b) A metal shaft of yield strength 180 MPa has a mean stress of 140 MPa. How many shafts will fail if the stresses and the yield strength are normally distributed with standard deviation of 20 MPa? Draw neat figures and use Area under the standard normal distribution curve from 0 to Z as,**[10]**

Z	1.0	1.2	1.4	1.6	1.8	2.0
Area	0.3413	0.3849	0.4192	0.4452	0.4641	0.4772

Z	2.2	2.4	2.6	2.8	3.0
Area	0.4861	0.4918	0.4953	0.4974	0.4987

Q9) a) Using a neat sketch explain what is a Gear Box and its purpose. **[5]**

b) Classify Gear Boxes and provide brief explanations of each. **[5]**

c) Sketch the Kinematic Diagram of a Gear Box and describe the concept of Structural Formulae. **[6]**

OR

Q10) Tabulate the eight speed steps of a gear box for a speed range of 100 rpm to 1800 rpm using geometric progression and then arrive at the optimum structure diagram. **[16]**

Q11) a) What are the guidelines in selecting Material Handling System? **[6]**

b) Discuss the advantages and disadvantages of Conveyors. **[6]**

c) Mineral of mass density 1200 kg/m^3 is transported by a horizontal 650 mm wide flat belt conveyor with 0.16 as the surcharge factor for the belt drive and belt speed 1.75 m/s. Determine the conveyor capacities. (Effective width b of material carried by belt safely is,b = 0.9B - 0.05 and B is belt width) **[6]**

OR

Q12) a) Discuss Belt Take-up Devices and their different types with neat sketches. **[5]**

b) Describe in detail types of pulleys used in conveyors. **[5]**

c) A conveyor carrying ore at 300,000 kg/hr has its 4 ply belt moving at 10 km/hr. The bulk density and the angle of surcharge of ore are 800 kg/m^3 and 15 respectively. Taking the material factor for plies (k1) as 2.0 and the belt tension and arc of contact factor (k2) as 63, Find: **[8]**

i) Belt width

ii) Drive pulley diameter and length.