Total No. of Questions : 12]

SEAT No. :

[Total No. of Pages : 7

P3139

B.E. (Semester - II)
MECHANICAL ENGINEERING
Mechanical System Design
(2008 Pattern)

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

Instructions to the candidates:

1) ***Answers of the two sections should be written in separate answer books.***
2) ***Answer three questions from each section.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right side indicate full marks.***
5) ***Use of calculator is allowed.***
6) ***Assume Suitable data, if necessary.***

SECTION - I

Q1) a) Derive Clavarino's equation for thick cylinder subjected to internal pressure. **[6]**

b) The following data refers to single acting hydraulic cylinder. **[12]**

Pressure of hydraulic fluid	= 10 MPa
Operating force available at the piston rod	= 10 KN
Friction due to piston ring and stuffing box	= 10% of operating force
Thickness of cylinder flange	= 10 mm
Thickness of cylinder head	= 8 mm
Cylinder and, cylinder head material	= FG200
Modulus of elasticity for FG200	= 100 GPa
Thickness of Zinc gasket	= 3 mm

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Modulus of elasticity for zinc	= 83 GPa
Number of bolts	= 4
Preload in each bolt	= 2.8 KN
Bolt material	= FeE400
Modulus of elasticity for FeE 400	= 207 GPa
Factor of safety for cylinder	= 5
Factor of safety for bolts	= 6
Standard diameter of cylinder	= 20, 30, 40, 50, 60 mm
Standard Thickness of cylinder	= 2, 4, 5, 6, 7, 8, 10 mm
Standard diameter of bolts	= 8, 10, 12, 14 mm

Determine :

i) Inner diameter of cylinder

ii) Thickness of cylinder

iii) Diameter of bolts

OR

Q2) a) State and explain various categories of welded joint used in unfired pressure vessel. Draw neat sketch. **[6]**

b) The cylindrical pressure vessel shell of inside diameter 1500 mm is subjected to an internal pressure of 2 MPa. The shell as well as head are made of low alloy steel with an ultimate tensile strength of 450 N/mm^2. The double welded butt joint which are spot radiographed are used to fabricate the vessel. The corrosion allowance is 3 mm. Determine the thickness of cylindrical shell and the thickness of head if the heads are : **[12]**

i) Flat

ii) Plain formed

iii) Torispherical with crown radius of 1125 mm

iv) Semi elliptical with ratio of major axis to minor axis as 2.

v) Hemispherical

vi) Conical with semi cone angle 30 °.

Q3) a) Design a cylinder, cylinder head and cylinder head studs for a four stroke C.I engine with the following data : **[16]**

Brake power	= 5 KW
Engine speed	= 1200 rpm
Indicated mean effective pressure	= 0.35 N/mm^2
Maximum gas pressure	= 3.5 N/mm^2
Mechanical efficiency	= 80 %
Compression ratio	= 12
Reboring factor C1	= 4.0 mm
Cylinder head thickness constant k_1	= 0.35

Take allowable tensile stresses as :

Name of part	**Cylinder liner**	**Cylinder head**	**Studs**
Material	Alloy cast iron	Alloy cast iron	Alloy steel 40 Ni 3
Allowable tensile stress N/mm^2	40	40	70

OR

Q4) a) What are the types of piston rings? State their functions. **[4]**

b) Determine the cross section of I section of connecting rod for single cylinder IC engine. Use the following data for engine : **[12]**

Piston diameter	= 100 mm
Mass of reciprocating parts	= 2.25 Kg
Length of connecting rod	= 300 mm
Stroke length	= 125 mm
Speed	= 1500 rpm
Maximum explosion pressure	= 3.5 N/mm^2
Factor of safety	= 7
Density of rod material	= 8000 Kg/m^3
Yield stress in compression	= 330 MPa

Assume width of section as 4 × t and depth as 5 × t where t is the web thickness of I section.

Q5) In light weight equipment a shaft is required to transmit 40 KW power at 425 rpm. The required stiffness of shaft is 90 N-m /degree. The factor of safety based on yield strength in shear is 1 .5.Using the maximum shear stress theory; design the shaft with the objective of minimizing the weight out of the following materials. **[16]**

Material	Mass density ρ, Kg/m^3	Material cost per unit weight c, Rs/N	Tensile yield strength Syt, N/mm^2	Modulus of rigidity G, N/mm^2
Alloy steel	7800	7.5	450	82×10^3
Aluminum alloy	2800	9	150	27×10^3
Titanium alloy	4500	150	800	41×10^3
Magnesium alloy	1800	10	100	17×10^3

What will be the change in design for minimum cost?

OR

Q6) a) Explain Johnson's method of Optimum design. **[4]**

b) The tensile bar of cross sectional area at least 85 mm^2 and length 200 mm is subjected to an constant load of 5000N. Design a bar for minimum cost, out of the following material. Assume factor of safety as 2. **[12]**

aterial	Mass density ρ, (Kg/m3)	Material cost c, (Rs/N)	Yield strength Syt, (MPa)
Steel	7500	16	130
Aluminum alloy	3000	32	50
Magnesium alloy	2100	32	20

SECTION - II

Q7) a) Explain the factor to be considered while designing the components for powder metallurgy. **[6]**

b) The recommended class for fit between the recess and the spigot of rigid coupling is 60H6-j5. **[10]**

The dimension of the two components is normally distributed and the specified tolerance is equal to the normal tolerance. Determine the probability of interference fit between the two components. The tolerance in micron is as follows :

Diameter (mm)	H_6		J_5	
	e_s	e_j	e_s	e_j
60	+19	0	+06	–07

The area under the standard normal distribution curve from zero to z are as follows.

z	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
Area	0.3413	0.3849	0.4192	0.4452	0.4641	0.4772	0.4861	0.4918	0.4953	0.4974	0.4987

OR

Q8) a) Explain the design recommendation for qualitative displays? **[5]**

b) Explain the basic principles of DFMA? **[5]**

c) A steel rod is subjected to axial stress within elastic limit.The strain in rod is normally distributed variable with a mean of 0.001 mm/mm and a standard deviation of 0.00007mm/mm. The modulus of elasticity is normally distributed with a mean of 2.07×105 N/mm^2. Determine the mean and standard deviation of the corresponding stress variable σ. Comment on the analysis. **[6]**

Q9) a) State the law of geometric progression used in machine tool gearbox design. Discuss the advantages& disadvantages. **[6]**

b) Draw the suitable speed diagram for a 14 speed machine tool gear box having six speeds for high range operations with ceramic tools. The spindle speed range is between 160 rpm and 4200rpm. The gear box is driven by 5KW, 1440 rpm. electric motor. **[10]**

OR

Q10) a) What do you understand by maximum loss of economic cutting speed? **[4]**

b) Multi speed sliding mesh gear box is to be designed for tapping spindle speeds varying between 20 rpm and 3170 rpm. The recommended geometric progression ratio is as per R5 series. The gear box is driven by 720 rpm three phase A.C. motor through belt drive. **[12]**

i) Draw the structure diagram.

ii) Select the optimum structure diagram.

iii) Draw the optimum speed diagram.

iv) Draw the kinematic diagram.

Q11) a) Explain in brief the system concept for material handling? **[6]**

b) The following data refers to horizontal belt conveyor for carrying bulk material **[12]**

Capacity of conveyor = 250 MT/hr

Belt speed = 1.5 m/s

Width of the belt = 1200 mm

Belt mass per unit length = 18.6 kg/m

Mass of each carrying run idler = 30.0 kg

Mass of each carrying run idler = 25.0 kg

Pitch of carrying run idler = 1.0 m

Pitch of carrying run idler = 2.0 m

Friction factor for idler = 0.02

Snub factor for snub pulley = 0.03

Snub factor for drive and tail pulley = 0.06

Drive and tail pulley diameter = 500 mm

Frictional resistance due to belt cleaner = (100 B) N Where B belt width, m Angle of lap on drive pulley = 200°

Coefficient of friction between belt and drive pulley = 0.4

Drive efficiency = 90%

Motor speed = 1440 rpm

Assume that the bulk material is carried over a length of 300 meters and neglecting resistance at loading station Determine :

i) The reduction ratio of gear box and

ii) The power required to drive the belt

OR

Q12) a) Draw & explain screw take up arrangement in belt conveyors? **[5]**

b) Explain the procedure to estimate the power requirement for belt conveyors? **[5]**

c) A triple ply belt conveyor is required to transport 4Tonn of iron ore per hour at a conveyor speed of 3 m/s. If the mass density of iron ore is 2.5 Tonn/m^3, suggest : **[8]**

i) The maximum suitable inclination for the conveyor which can be given.

ii) The diameter of the drive pulley.

iii) The gear box reduction ratio, if motor speed is 1440rpm.

Belt inclination 'α'	l6-20°	21-25°	26-30°	3 1-35°
Flowability 'K' factor	2.5×10^{-4}	2.35×10^{-4}	2.20×10^{-4}	2.05×10^{-4}

Material factor for plies for belt : $K_1 = 2.0$

Belt tension and arc of contact factor: $K_2 = 80$

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