Total No. of Questions : 10]

SEAT No. :

P3046

[Total No. of Pages : 5

[5670]-143

B.E. (Mechanical/Mechanical Sandwich)

MECHANICAL SYSTEM DESIGN

(2012 Pattern)

Time : 3 Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Figures to the right side indicate full marks.***
2) ***Use of electronic calculator is allowed.***
3) ***Assume suitable data if necessary.***

Q1) a) What are the various laws for stepped regulation of speeds in multi-speed gear boxes? State their relative advantages and limitations. **[6]**

b) Explain the following terms used in statistical analysis : **[4]**

i) Population
ii) Sample
iii) Variable
iv) Frequency distribution

OR

Q2) a) Draw Structural diagram for the following structural formulae. **[6]**

i) 2(1) 3(2)
ii) 2(3) 3(1)
iii) 3(1) 2(3)

b) Explain design based factor of safety and design based on reliability. **[4]**

Q3) a) Explain types of load handled by Material Handling system? **[4]**

b) Following data refers to a flat belt conveyor for transporting crushed rock : **[6]**

Mass density (ρ) = 2 tons/m^3,
Belt speed (v) = 1.75 m/s,

P.T.O.

Belt width (B) = 0.8m,
Flow ability factor = 2.35×10^{-4}.
Calculate capacity of conveyor in tons/hr

OR

Q4) A triple ply belt conveyor is required to transport 2 ton of iron ore per hour through a distance of 1000m and a height of 300m. The permissible belt speed is 90m/min. If the mass density of iron ore is 2.5 ton per cubic meter, determine : (i) the belt width; (ii) the diameter of drive pulley; and (iii) the reduction ratio of gear reducer, if electric motor speed is 1440 r.p.m. Use following data : **[10]**

Flowability factor 'k' :

Belt inclination, α	10° - 15°	16° - 20°	21° - 25°	26° - 30°	31° - 35°
Flow ability factor, k	2.65×10^{-4}	2.5×10^{-4}	2.35×10^{-4}	2.20×10^{-4}	2.05×10^{-4}

Standard belt widths 400, 450, 500, 600, 650, 750, 800, 900, 100, 1200, 1400, 1600, 1800, 2000 mm.

Material factor for plies for Capron belt : $K_1 = 2.0$;
Belt tension and arc of contact factor : $K_2 = 80$.

Q5) a) Derive Birnie's equation. Under what conditions it is used. **[8]**

b) A cylindrical pressure vessel shell of inside diameter 1500 mm is subjected to an internal pressure of 2 MPa. The shell as well as heads is made of low alloy steel with an ultimate tensile strength of 450 N/mm^2. The double welded butt joints which are spot radio graphed is used to fabricate the vessel. The corrosion allowance is 3 mm. FOS = 3.

Determine the thickness of the cylindrical shell and the thickness of the head if the head are :

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. **[10]**

OR

Q6) The following data refers to single acting hydraulic cylinder. **[18]**

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
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

Q7) a) What are the functions of Engine cylinder? What are dry and wet cylinder liners? **[6]**

b) The cylinder of a four stroke diesel engine has the following specifications: **[10]**

Brake power = 3kW

Speed = 800 rpm

Indicated mean effective pressure = 0.3 MPa

Mechanical efficiency = 80%

Take L/D = 1.5

Determine the bore and length of cylinder liner.

OR

Q8) a) The bore of a cylinder of the four stroke diesel engine is 120 mm. The maximum gas pressure inside the cylinder is limited to 4 MPa. The cylinder head is made of cast iron and the allowable tensile stress is 40 N/mm^2. Determine the thickness of the cylinder head. (Constant K = 0.162) **[6]**

The studs which are made of steel have allowable stress as 50 N/mm^2. Calculate

i) Number of studs

ii) Nominal diameter of studs

b) The following data is given for the cap and bolts of the big end of connecting rod : **[10]**

Engine Speed : 1800 rpm

Length of connecting rod = 350 mm

Length of stroke = 175 mm

Mass of reciprocating parts = 2.5 kg

Length of crank pin = 76 mm

Diameter of crank pin = 58 mm

Thickness of bearing bush = 3 mm

Permissible tensile stress for bolts = 60 N/mm^2

Permissible bending stress for cap = 80 N/mm^2

Calculate the nominal diameter of bolts and thickness of cap for the big end.

Q9) a) What are the principles of design of castings? **[6]**

b) A tensile bar of length 400 mm is subjected to constant tensile force of 4000N. If the factor of safety is 2, design the bar with the objective of minimizing the material cost, out of the following materials. **[10]**

Material	Mass Density (Kg/m^3)	Cost per unit mass c, (Rs./kg)	Yield strength (N/mm^2)
Mat 1	7800	28	400
Mat 2	7850	150	900
Mat 3	2800	140	150
Mat 4	4500	2200	800

OR

Q10) a) Write a short note on design of manufacturing and assembly. **[6]**

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 yield strength is 1.5. Using the maximum shear stress theory, design the shaft with the objective of minimizing the weight. **[10]**

Material	Mass Density, kg/m^3	Modulus of rigidity G (GPa)	Yield strength S_{yt} (MPa)	Material Cost c, (Rs/N)
M1	8500	80	130	16
M2	3000	26.5	50	32
M3	4800	40	90	480
M4	2100	16	20	32

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