Total No. of Questions : 12]

SEAT No. :

P3320

[Total No. of Pages : 6

[4959]-43

B.E. (Mechanical Engineering)

MECHANICAL SYSTEM DESIGN

(2008 Pattern) (Semester - II)

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

Instructions to the candidates:

1) ***Answer three questions from Section I and three 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) ***All questions carry equal marks.***
6) ***Your answers will be valued as a whole.***
7) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
8) ***Assume Suitable data if necessary.***

SECTION - I

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

b) A pressure vessel consists of a cylindrical shell with an inner diameter of 1500mm and thickness of 20mm. It is provided with a nozzle with an inner diameter of 250 mm and thickness of 15 mm. The yield strength of the material for the shell and nozzle is 200N/mm^2 and the design pressure is 2.5 MPa. The extension of the nozzle inside the vessel is 15mm. The corrosion allowance is 2mm, while the weld joint efficiency is 0.85. Neglecting the area of welds, determine whether or not a reinforcing pad is required for the opening. If so, determine the dimensions of pad made from a plate of 15mm thickness. **[12]**

OR

Q2) a) Explain the design of openings in pressure vessels by the area compensation method. **[6]**

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b) A horizontal pressure vessel consists of a cylindrical shell enclosed by hemispherical ends. The volumetric capacity of the vessel should be approximately $2m^3$ and the length should not exceed 3m. Assuming the thickness negligibly small compared with overall dimensions of the vessel, determine the internal diameter and the length of the cylindrical shell.

The pressure vessel is fabricated from steel plates with a yield strength of 225 N/mm^2. The weld joint efficiency factor is 0.85 and corrosion allowance 2mm the pressure vessel is subjected to an operating pressure of 2Mpa. Calculate the thickness of the cylindrical shell and the hemispherical end closures. **[12]**

Q3) a) What is desirable properties of I.C. engine piston material? What are the advantages and disadvantages of aluminium piston over cast Iron Piston. **[6]**

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

Engine speed = 1800 rpm, Length of connecting rod = 350mm

Length of stroke = 175mm, Mass of reciprocating parts = 2.5kg

Length of crank pin = 76mm, Diameter of crank pin = 58mm,

Thickness of bearing bush = 3mm,

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

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

Calculate the nominal diameter of bolts and thickness of cap for the big end. **[10]**

OR

Q4) a) Explain dry and wet liner with neat sketch. Discuss the stresses developed in the cylinder wall. **[6]**

b) Design a valve spring for the exhaust valve of a four - stroke engine using the following data:

Diameter of valve head = 75mm

Lift of valve = 25mm

Maximum suction pressure = 0.02MPa below atmosphere stiffness of spring = 10N/mm

spring index = 8

Permissible torsional shear stress for spring wire = 300N/mm^2

Modulus of rigidity = 84 × 10^{3}N/mm^2

Total gap between consecutive coils, when the spring is subjected to maximum force can be taken as 15% of the maximum compression. **[10]**

Q5) a) What is 'adequate design' and 'optimum design'? Explain with suitable examples. **[4]**

b) A cylindrical shell of the heat exchanger is required to accommodate a total of 100m length to standard diameter copper tubes. One meter square cross-sectional area inside the shell can accommodate 200 copper tubes. Design the heat exchanger shell with an objective of minimizing the cost of the heat exchanger, by using the following data:

i) Cost of the copper tubes = Rs. 20000

ii) Cost of the heat exchanger shell = Rs, 60000 $D^{2.5}L$

iii) Cost of floor space occupied by the heat exchanger = Rs. 10000 DL

Where , D = diameter of the heat exchanger shell, m.

L = Length of the heat exchanger shell, m. **[12]**

OR

Q6) a) A tensile bar of length 500mm is subjected to the constant tensile force of 3000N. If the factor of safety is 2, design the bar with the objective of minimizing the material cost, out of the following materials. **[12]**

Material	Mass Density 'ρ' kg/m^3	Material Cost per Unit Mass C, Rs/kg	Yield strength S_{yt} N/mm^2
Alloy Steel	7800	28	400
Aluminium alloy	7850	150	900
Titanium Alloy	2800	132	150
Plain Carbon Steel	4500	2200	800

b) Explain the Johnson's method of optimum design. **[4]**

SECTION - II

Q7) a) Explain the mechanical reliability in the modern engineering design? How it differs from the factor of safety? **[4]**

b) A batch of spindles, to be used in machine tool, are designed for a mean torque transmitting capacity of 15N-m. The spindles are subjected to mean load torque of 10N-m. The torque transmitting capacity as well as the load torque are normally distributed with a standard deviation of 2N-m and 2.5N-m respectively. Estimate the percentage of spindles likely to fail. The areas under the standard normal distribution curve from zero to Z are follows: **[12]**

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 . **[6]**

b) A mechanical component is subjected to a mean stress of 207 N/mm^2 with a standard deviation of 55.2 N/mm^2. The material has a yield strength of 276 N/mm^2 with a standard deviation of 41.4N/mm^2. **[10]**

Determine:

i) Probability of failure.

ii) the minimum factor of safety available &

iii) the average factor of safety available.

Q9) a) Draw the suitable speed ray 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 4200 rpm. The gearbox is driven by 5kW, 1440 rpm electric motor. **[12]**

b) What is the need of multispeed gearbox in a machine tool or automobile? **[6]**

OR

Q10)a) Explain and compare different laws of stepped speed Regulation. **[6]**

b) A machine tool requires 12 speeds in the range η_{max} = 1000 rpm to η_{min} = 180 rpm. List the most suitable speeds to be provided. **[6]**

c) What is structure diagram? Explain the procedure to construct a structure diagram for a multi-speed drive. **[6]**

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

b) With neat sketches, explain the following: **[6]**

i) Flat belt conveyors,

ii) Chain conveyors,

iii) Screw conveyors,

c) Explain the procedure to estimate the power requirement for belt conveyors. **[4]**

OR

Q12)a) An inclined belt conveyor is used for loading the mineral ore in a ship. The belt inclination is 20^{o} for which the flow ability factor 'k' is 2.5×10^{-4}. The belt width is 1000mm while belt speed is 2 m/s. If the specific weight of the mineral ore is 16000 N/m^3, determine the capacity of the conveyor. **[6]**

b) Write short notes on following: **[10]**

i) Power requirement of belt conveyors.

ii) Methods of feeding to flat belt conveyor.