Total No. of Questions : 10]

SEAT No. :

P2147

[Total No. of Pages : 6

[5254]-543

B.E. (Mechanical)

MECHANICAL SYSTEM DESIGN

(2012 Pattern)

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

Instructions to the candidates:

1) ***Answers Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8, Q9 or Q10.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of programmable calculator is not permitted.***
5) ***Assume suitable data if necessary.***

Q1) a) Draw the structure diagram and identify the optimum structural formula out of them. **[4]**

i) 2(1) 3(2)

ii) 2(3) 3(1)

iii) 3(2) 2(1)

b) The mean tensile strength of 250 nuts is 310 N/mm^2 and the standard deviation is 35 N/mm^2. Find **[6]**

i) how many nuts are expected to have strength less than 270 N/mm^2?

ii) how many nuts are expected to have strength between 270 and 410 N/mm^2?

OR

Q2) a) What is the need of multi speed gearbox in a machine tools or automobiles. **[4]**

b) Tension test is carried out on 120 specimens, of grade FG300. It is observed that the ultimate tensile strength is normally distributed with a mean of 300 MPa and a standard deviation of 25 MN/m^2. **[6]**

P.T.O.

i) How many specimens have ultimate tensile strength less than 275 MN/m^2?

ii) How many specimens have ultimate tensile strength between 275 and 350 MN/m^2.

Q3) a) With the help of sketches explain unloading methods in belt conveyor system. **[4]**

b) Design a horizontal belt conveyor used for conveying a coal in steel plant: **[6]**

i) Capacity of conveyor = 300×10^3 kg/hr

ii) Belt speed = 3 m/s

iii) Density of coal = 900 kg/m^3

iv) Surcharge factor for belt = 0.0725

v) No. of piles for belt = 4

vi) Material factor for plies = 2

vii) Belt tension & arc of contact factor for belt = 80

viii) Electric motor speed = 1440 rpm

ix) Centre dist. between snub pulley = 255 m

x) C.D. between drive & tail pulley = 260 m

xi) Pitch of carrying run idlers = 1m, pitch of return run idlers = 2.5m

Determine :

1) the standard belt width

2) dia of drive pulley

3) the reduction ratio of gear reducer

Standard belt width (mm) : 500, 600, 750, 800, 900, 1000, 1200, 1400, 1600.

OR

Q4) a) Explain the procedure to estimate the power requirement for belt conveyors. **[4]**

b) A horizontal belt conveyor is used for transporting the material having density 11772 N/m^3. The surcharge factor for belt is 0.2, while the belt width is 0.7 meter. If the belt speed is 1750 mm/sec determine the capacity of conveyor. **[6]**

Q5) a) What is autofrettage? Explain any one method of prestressing the cylinder. **[8]**

b) A pressure vessel consists of a cylindrical shell with an inner diameter of 1500 mm and thickness of 20mm. It is provided with a nozzle of inner diameter 250mm and thickness 15mm. The yield strength of the material for the shell and nozzle is 200 N/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. **[10]**

OR

Q6) a) Derive Birnie's equation. Explain under what conditions it is used. **[8]**

b) A pressure vessel subjected to a design pressure of 0.75 MPa consists of a cylindrical shell with 2m inside diameter and 10mm thickness. An opening of inner diameter 300mm and wall thickness 10mm is provided in the shell. The corrosion allowance is 2mm and the weld joint efficiency is 85%. The extension of the opening inside the shell is 15mm. The yield strength of the material used for the shell and opening is 210 N/mm^2. A reinforcing pad made of a 10mm thick plate is provided for the opening. Determine the inner and outer diameters of pad. **[10]**

z	0	1	2	3	4	5	6	7	8	9
0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998
3.5	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998	0.4998
3.6	0.4998	0.4998	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.7	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.8	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999	0.4999
3.9	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000	0.5000

Table No: 01, Areas below Normal Distribution Curve for 0 to Z .

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

b) Cylinder of Two stroke petrol engine is to be designed for following data: **[10]**

Brake power = 7 kW

IMEP = 0.5 MPa

Speed = 800 RPM

Efficiency = 80%

Design : Bore and stroke of cylinder liner, its thickness and thickness of cylinder head.

OR

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

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

Cylinder bore = 250mm

Piston pin length in bush = 0.45D

Maximum gas pressure = $4N/mm^2$

Bearing Pressure = $15N/mm^2$

ID OD ratio for piston pin = 0.6

Mean Dia of piston boss = 1.5 × OD of pin

Calculate OD, ID and mean diameters of piston pin

Q9) a) Differentiate between adequate and optimum design. Also explain different types of equations that are used in 'Johnson's method of optimum design'. **[6]**

b) A tensile bar of length 400mm is subjected to constant tensile force of 4000N. If the factor of safety is 2, design the bar diameter, using Johnson's method, with the objective of minimizing material cost by using optimum material from the list given in **Table 1**. **[10]**

Material	Density (ρ) kg/m^3	Cost (c) Rs./kg	Syt N/mm^2
Steel	7800	14	400
Aluminum alloy	2800	66	150
Titanium Alloy	4500	1100	800

Table 1

OR

Q10)a) Write a short note on design for machining **[6]**

b) In lightweight equipment, a shaft is required to transmit 40kW power at 425 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 2 below. **[10]**

Material	Desnity (ρ) kg/m^3	Modulus of Rigidity (G) N/mm^2	Syt N/mm^2
Chromium Steel	7800	82000	450
Al Alloy	2800	27000	150
Titanium Alloy	4500	41000	800

Table 2