BACHELOR OF TECHNOLOGY (C.B.C.S.) (2014 COURSE)
B.Tech.Sem - VIII MECHANICAL : WINTER- 2022
SUBJECT : OPTIMUM DESIGN

Day : Monday
Date : 28-11-2022

W-13466-2022

Time : 02:30 PM-06:30 PM
Max. Marks : 60

N.B.:

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Draw neat labelled diagrams **WHEREVER** necessary.
4) Assume suitable data if necessary.

Q.1 A 22 teeth straight bevel pinion rotating at 720 rpm transmits 10 KW power to a 40 teeth bevel gear. The module is 6 mm and the pressure angle is 20^0. The face width is 45 mm. If the shaft angle is 90^0. Determine the components of forces acting on meshing teeth. **(10)**

OR

Q.1 A triple start worm rotating at 1440 rpm transmits 6 KW power to a worm gear rotating at 72 rpm. The pitch circle diameter of worm is 60 mm and axial module is 6 mm. The tooth system is 20^0 stub involute, while the coefficient of friction between worm and worm gear tooth is 0.1. If the worm is left hand type, determine

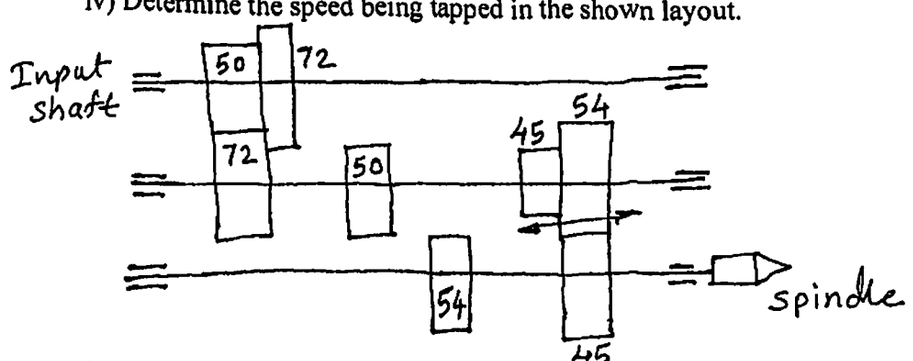
i) the components of tooth force acting on the worm and worm gear.
ii) the efficiency of worm gear pair.

Q.2 A multi speed gear box is to be designed for a machine tool having speeds varying from 120 rpm to 1900 rpm. The recommended series of speed is R5 using the standard spindle speeds. The gear box is connected to a motor driven by a pair of pulleys. Assuming the motor speed to be 1440 rpm, determine the ratio of pulley diameters required. Draw a suitable structure and speed diagram and find the number of teeth on each gear. **(10)**

OR

Q.2 Following figure shows the layout of machine tool gear with the number of teeth on different gear specified. If the input shaft is rotating at 100 rpm. **(10)**

i) Determine the speed available on the out-put shaft.
ii) Determine geometric progression ratio.
iii) Draw the structure diagram.
iv) Determine the speed being tapped in the shown layout.



Q.3 It is observed that sample of 500 pins produced on an automatic CNC machine that their diameters are normally distributed with a mean 20.5 and a standard deviation of 0.02 mm. If the rejection is limited to 20 pins determine the design tolerance. Assume the process is centered around the mean. **(10)**

1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	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

OR

Q.3 The diameter in a sample of 1000 bolts are normally distributed with 10.5 mm mean and 0.02 mm standard deviation. Determine the specified tolerance if the process is centered and only 950 bolts are accepted. Draw a neat figure and use area under the normal curve from 0 to Z. **(10)**

1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	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

Q.4 Following data refer to a vertical pressure vessel made of plain carbon steel having ultimate tensile strength of 425 MPa and yield strength of 250MPa. Gauge pressure inside the vessel :- 1 MPa inner diameter of shell:- 2m, Height of vessel :- 6m, Thickness of shell:-10mm, weight of each end cover:- 4 KN, weight of contents in the vessel:- 125 KN, wind pressure on vessel surface:– 1.25 KPa, torque due to offset piping:- 1.5 KNm. Find: **(10)**

i) Maximum resultant stress in the vessel

ii) Factor of safety available based on yield and ultimate strength.

Assuming the supports are located just above the lower head of the vessel.

OR

Q.4 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 S_{ut} = 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: **(10)**

i) Formed 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 30^0.

Q.5 Explain Johnson's method of optimum design in detail. **(10)**

OR

Q.5 A thin spherical pressure vessel is subjected on an internal pressure of 4 N/mm^2. The mass of the empty vessel should not exceed 125 kg. If the factor of safety is 3.0, design the pressure with the objective of maximizing the gas storage capacity, out fo the following material. $V = \pi / 6 d^3$.

Material	Density (ρ) kg/m^3	S_{yt} N/mm^2
M_1	7800	500
M_2	2800	250
M_3	8400	420

Q.6 Explain the basic principles of DFMA. **(10)**

OR

Q.6 Explain 3D printing process, its advantages and limitations. **(10)**

* * * *