

**B. TECH. (CBCS - 2014 COURSE) SEM - VIII (MECHANICAL
ENGG.) : SUMMER - 2018**
SUBJECT: OPTIMUM DESIGN

Day: **Thursday**
Date: **07/06/2018**

S-2018-4698

Time: **02.30 PM TO 06.30 PM**
Max. Marks: 60

N.B:

- 1) All questions are **COMPULSORY**.
- 2) Figures to the right indicate **FULL** marks.
- 3) Assume suitable data if necessary.
- 4) Use of non- programmable **CALCULATOR** is allowed.

Q.1 A pair of straight bevel gears, manufactured by cutting, consists of a 18 teeth pinion rotating at 1500 rpm meshing with a bevel gear rotating at 600 rpm. The axes of pinion and gear intersect at right angles. The module is 4mm, while the face width is 35mm. The tooth system is 20^0 full depths involute. The gear pair is made of plain carbon steel 55C₈ ($S_{ut} = 720 \text{ N/mm}^2$) and is heat treated to a surface hardness of 400 BHN. The service factor and factor of safety are 1.75 and 1.5 respectively. Assuming the suitable expression for velocity factor and considering the velocity factor accounts for the dynamic load. (Take - $y'_p = 0.3166$) **(10)**

Determine:

- i) the beam strength
- ii) the wear strength
- iii) the maximum static load that the gear pair can transmit; and
- iv) the rated power that the gear pair can transmit

OR

Derive an expression for minimum required face width of worm gear.

Q.2 A six speed gear box to be designed for machine tool drive spindle. The spindle speed range between 150 rpm and 1200 rpm. If the gear box is driven by 5kW, 1200 rpm electric motors through belt drive. **(10)**

- i) Draw the speed diagram
- ii) Draw the gearing diagram
- iii) Select the diameter of the pulleys for belt drive

The standard pulley diameters are: 80, 90, 100, 112, 125, 140, 160, 180, 200, 224, 250, 280, 290, 300, 310, 375, 400, 450, 500 mm.

OR

A multispeed gear box is to be designed for a machine tool having speeds varying from 100 rpm to 1000 rpm. The recommended series of speeds 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.

Q.3 A shaft and hole assembly of normal diameter 40 mm have the following dimensions: Hole diameter = $40^{+0.1}_{+0.0}$ mm shaft diameter = $40^{-0.1}_{-0.15}$ mm **(10)**
Assuming the shaft and hole diameters are normally distributed.

Determine:

- i) the percentage of assemblies having clearance less than 0.15 mm
- ii) The percentage of assemblies having clearance greater than 0.22 mm refer the following table for areas below normal distribution curve

Z	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4
Area	0.4332	0.4452	0.4554	0.4641	0.4713	0.4772	0.4821	0.4861	0.4893	0.4918

P.T.O.

OR

In a shaft and hole assembly of nominal diameter 28 mm, the total tolerance on shaft diameter is $0.001\sqrt[3]{d}$ mm, while the total tolerance on hole diameter is $0.002\sqrt[3]{d}$ mm. The shaft and hole diameters are normally distributed. The minimum shaft and hole diameters are equal. Determine the percentage of assemblies where interference is likely to occur.

- Q.4** A cylindrical shell of inner diameter 2.5 m and length 5 m is subjected to operating gauge pressure of 0.8 N/mm^2 . The shell and heads are made of plain carbon steel with yield strength of 250 MPa. Double welded butt joints which are spot radiographed are used to fabricate the shell. If corrosion allowance is 3mm determine (10)
- Thickness of the cylindrical shell
 - Thickness of torispherical head if crown radius is 2 m
 - Storage capacity of the pressure vessel

OR

Determine the inside diameter of shell and the crown radius of the torispherical heads if the thickness of the shell and the torispherical heads of a cylindrical pressure vessels are 12 mm and 16 mm respectively. The vessel operating at 2 MPa pressure is entirely made of 270 N/mm^2 yield strength material with weld joint efficiency 0.7 and corrosion allowance of 2 mm.

- Q.5** A shaft is required to transmit 900 N-m torque and the torsional stiffness of the shaft is 90 N-m/degree. Required factor of safety is 1.5. Design the shaft using maximum shear stress theory for minimum weight. Material properties are as follows. (10)

Material	Density Kg/m ³	Tensile strength MPa	Modulus of rigidity MPa
Alloy Steel	7800	450	82,000
Aluminum	2800	150	27,000
Magnesium	1800	100	17,000

OR

A tensile bar of length 400mm is subjected to constant tensile force of 4000 N. If the factor of safety is 2. Design the bar diameter with the objective of minimizing material cost using optimum material from the list given in table, What will be the cost of designed shaft?

Material	Density Kg/m ³	Cost ₹/Kg	S _{yt} N/mm ²	G N/mm ²
Steel	7800	14	400	82000
Al Alloy	2800	70	150	27000
Ti Alloy	4500	1100	800	41000

- Q.6** Explain different codes and standards used in product design process. (10)

OR

What is design of experiment? What are the benefits of design of experiments in product design and development process?

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