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# ME-802
## B.E. VIII Semester
Examination, December 2016
### Machine Design

*Time : Three Hours*

*Maximum Marks : 70*

*Note:* i) Answer five questions. In each question part A, B, C is compulsory and D part has internal choice.

ii) All parts of each question are to be attempted at one place.

iii) All questions carry equal marks, out of which part A and B (Max.50 words) carry 2 marks, part C (Max.100 words) carry 3 marks, part D (Max.400 words) carry 7 marks.

iv) Except numericals, Derivation, Design and Drawing etc.

v) Assume suitable data, if required.

vi) Use of Design Data Book is permitted.

1. a) Why are belt drives called flexible drive?

   b) What are the methods of chain tensioning?

   c) What are the advantages and disadvantages of ribbed V-belt?

   d) A V-belt is driven on a flat pulley and a V-pulley. The drive transmits 20 kW from a 250mm diameter V-pulley operating at 1800 rpm to a 900mm diameter flat pulley. The centre distance is 1m, the angle of groove 40° and $\mu = 0.2$. If density of belting is 1110 kg/m$^3$ and allowable stress is 2.1 MPa for belt material, what will be the number of belts required if C-size V-belts having 230mm$^2$ cross-sectional area are used.

OR

PTO

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A chain drive using bush roller chain transmits 5.6 kW of power. The driving shaft on an electric motor runs at 1440 rpm and velocity ratio is 5. The centre distance of the drive is restricted to 550±2%mm and allowable pressure on the pivot joint is not to exceed 10N/mm$^2$. The drive is required to operate continuously with periodic lubrication and driven machine is such that load can be regarded as fairly constant with jerk and impact. Design the chain drive by calculating leading dimensions, number of teeth on the sprocket and specify the breaking strength of the chain. Assume a factor of safety of 13.

2. a) What is a rimmed gear and what are its advantages?

   b) Discuss crossed helical gears.

   c) What is Tredgold's approximation about the formative number of teeth on bevel gear?

   d) It is required to design a pair of spur gears with 20° full depth involute teeth consisting of a 20 teeth pinion meshing with a 50 teeth gear. The pinion shaft is connected to a 22.5 kW, 1450 rpm electric motor. The starting torque of the motor is 150% of the rated torque. The material for the pinion is plain carbon steel Fe 410 ($S_{ut} = 410$ N/mm$^2$) while the gear is made of grey cast iron FG 200 ($S_{ut} = 200$ N/mm$^2$). The factor of safety is 1.5. Design the gear based on the Lewis equation and using velocity factor to account for the dynamic load.

OR

A pair of bevel gears, with 20° pressure angle, consists of a 20 teeth pinion meshing with a 30 teeth gear. The module is 4mm, while the face width is 20mm. The material for the pinion and gear is steel 50C4 ($S_{ut} = 750$ N/mm$^2$). The gear teeth are lapped and ground (Class - 3) and the surface

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hardness is 400 BHN. The pinion rotates at 500 rpm and receives 2.5 kW power from the electric motor. The starting torque of the motor is 150% of the rated torque. Determine the factor of safety against bending failure and against pitting failure.

3. a) Under what force, the big end bolts and caps are designed?

b) At what angle of the crank, the twisting moment is maximum in the crankshaft?

c) Why the area of the inlet valve port is made larger than the area of exhaust valve port?

d) A four stroke internal combustion engine has the following specifications :

| | |
|---|---|
| Brake power | = 7.5 kW |
| Speed | = 1000 rpm |
| Indicated mean effective pressure | = 0.35 N/mm$^2$ |
| Maximum gas pressure | = 3.5 N/mm$^2$ |
| Mechanical efficiency | = 80% |

Determine :

i) The dimensions of the cylinder, if the length of stroke is 1.4 times the bore of the cylinder.

ii) Wall thickness of the cylinder, if the hoop stress is 35 MPa.

iii) Thickness of the cylinder head and the size of studs when the permissible stresses for the cylinder head and stud materials are 45 MPa and 65 MPa respectively.

OR

Design a cast iron trunk type piston for a single acting four stroke engine developing 75 kW per cylinder when running at 600 rpm. The other available data is as follows :

| | |
|---|---|
| Maximum gas pressure | = 4.8 N/mm$^2$ |
| Indicated mean effective pressure | = 0.65 N/mm$^2$ |
| Mechanical efficiency | = 95% |
| Radius of crank | = 110mm |
| Fuel consumption | = 0.3kg/BP/hour |
| Calorific value of fuel (higher) | = 44×10$^3$kJ/kg |
| Difference of temperatures at the centre and edges of the piston head | = 200°C |
| Allowable stress for the material of the piston | = 33.5 MPa |
| Allowable stress for the material of the piston rings and gudgeon pin | = 80 MPa |
| Allowable bearing pressure on the piston barrel | = 0.4 N/mm$^2$ |
| Allowable bearing pressure on the gudgeon pin | = 17 N/mm$^2$ |

4. a) Why are two universal joints often used when there is angular misalignment between two shafts?

b) Distinguish between circumferential stress and longitudinal stress in a cylindrical shell, when subjected to an internal pressure.

c) Make out a systematic classification of pressure vessels and discuss the role of statutory regulations.

d) The shaft and the flange of a marine engine are to be designed for flange coupling, in which the flange is forged on the end of the shaft. The following particulars are to be considered in the design :

| | |
|---|---|
| Power of the engine | = 3 MW |
| Speed of the engine | = 100 rpm. |
| Permissible shear stress in bolts and shaft | = 60 MPa |
| Number of bolts used | = 8 |
| Pitch circle diameter of bolts | = 1.6×Diameter of shaft |

Find :

i) Diameter of Shaft

ii) Diameter of Bolts

iii) Thickness of Flange

iv) Diameter of Flange

### OR

The maximum force exerted by a small hydraulic press is 500 kN. The working pressure of the fluid is 20 N/mm². Determine the diameter of the plunger, operating the table. Also suggest the suitable thickness for the cast steel cylinder in which the plunger operates, if the permissible stress for cast steel is 100 MPa.

5. a) Define a saddle point and indicate its significance.

b) What is the significance of Lagrange multipliers?

c) Discuss Kuhn-Tucker Conditions.

d) Find the dimensions of an open rectangular box of volume V for which the amount of material required for manufacture (surface area) is a minimum.

### OR

A rectangular sheet of metal with sides a and b has four equal square portions (of side d) removed at the corners, and the sides are then turned up so as to form an open rectangular box. Find the depth of the box that maximizes the volume.

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