

BITS-PILANI, DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008

T E S T I
ME UC451MECHANICAL EQUIPMENT DESIGN

Date: 04-11-2007

Marks: 25

Time: 50 minutes

Weightage: 25%

Note: 1. Answer all questions

2. Marks are shown in the brackets against each question.

3. Assume the data suitably if necessary.

Question 1

Calculate the power that can be transmitted by a pair of spur gears with the data given below:

Number of teeth on pinion = 20

Number of teeth on gear = 80

Module = 4 mm

Face width = 60 mm

Allowable bending stress of the material = 200 MPa for pinion
= 160 MPa for gear

Speed of the pinion = 400 r.p.m

Service factor = 0.8

Lewis form factor = $0.154 - 0.912/T$

Velocity factor = $3 / (3 + v)$

[8M]

Question 2

A pair of bevel gears with 20° pressure angle consists of a 20 teeth pinion meshing with a 30 teeth gear. The module is 4 mm while the face width is 20 mm. Both the gear and pinion are made of steel for which the bending stress is 220 N/mm^2 . The pinion rotates at 500 r.p.m and receives power from electric motor. Find the dimensions of both the gear and pinion. Determine the beam strength and wear strength of the drive. Take material deformation factor as 2.56 N/mm^2 .

[6M]

Question 3

A pair of worm and worm wheel is designated as 3/60/10/6. The worm is transmitting 5 kW at 1440 r.p.m. Determine the tangential, axial and separating forces of both worm and wheel. The coefficient of friction and normal pressure angles are 0.1 and 20° respectively.

[7M]

Question 4

A radial load acting on a ball bearing is 5 kN and the expected life for the 90% of the bearing is 8000 hrs. Calculate the dynamic load carrying capacity of the bearing, when the shaft rotates at 1450 r.p.m.

[4M]

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COMPREHENSIVE EXAMINATION

ME UC 451 MECHANICAL EQUIPMENT DESIGN

Date: 06-01-2008

Marks: 40

Note: 1. Answer all questions.

2. Marks are shown in the brackets against each question.

3. Use the data sheet provided.

Time: 3 hrs.

Weightage: 40%

Question 1

A pair of straight teeth spur gears is to transmit 20 kW when the pinion rotates at 300 rpm. The velocity ratio is 1:3. The allowable static stresses for the pinion and gear materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its face width is 14 times the module. Determine the module, face width, and pitch circle diameters of both the pinion and gear from the stand point of strength only, taking into consideration of the effect of dynamic loading. Take service factor as unity. The tooth form factor y can be taken as

$$y = 0.154 - 0.912/(\text{No. of teeth}) \quad \text{and}$$

the velocity of factor C_v as

$$C_v = 3/(3 + v), \text{ where } v \text{ is in m/s.}$$

[10M]

Question 2

A pair of straight bevel gears, mounted on shaft which are intersecting at right angles, consists of a 24 teeth pinion meshing with a 32 teeth gear. The pinion shaft is connected to an electric motor developing 12.5 kW rated power at 1440 rpm. The starting torque of motor is 150% of rated torque. The pressure angle is 20° . Both the gears are made of case hardened steel ($\sigma_{ut} = 450$ MPa). Choose a factor of safety as 2. Estimate the module based on beam strength if pitch line velocity is 7.5 m/s. Find also the major dimensions of the gears.

[8M]

Question 3

A pair of worm and worm wheel is designated as 3/60/10/6. The worm is transmitting 5 kW power at 1440 rpm to the worm wheel. The coefficient of friction is 0.1 and the normal pressure angle is 20° . Determine the components of gear tooth force acting on the worm and worm wheel. [6M]

Question 4

A high pressure cylinder consists of a steel tube with inner and outer diameters of 20 mm and 40 mm respectively. It is jacketed by an outer steel tube with an outer diameter of 60 mm. The tubes are assembled by a shrinking process in such a way that the maximum principal stress induced in any tube is limited to 100 MPa. Calculate the shrinkage pressure and original dimensions of tubes. ($E = 207 \text{ GPa}$). [8M]

Question 5

A cast iron pipe used in hydraulic circuit is subjected to an internal pressure of 45 MPa. The inner and outer diameters of the pipe are 25 mm and 45 mm respectively. Plot the distribution of principal stresses across the pipe thickness. [8M]