

BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
ME UC451 MECHANICAL EQUIPMENT DESIGN
I SEMESTER 2008-2009

T E S T I (Closed Book)

Marks: 25

Duration: 50 Minutes

Date: 02-11-2008

- Answer all questions.
- Marks are shown in brackets against each question.

Question 1

A pair of 20° stub involute tooth spur gears of 8 mm module is designed with the following data:

Speed of pinion	= 300 rpm,
Velocity ratio	= 1:4
Static stress of cast iron gear and pinion	= 60 MPa
No of teeth on pinion	= 30
Face width	= 90 mm
Endurance strength	= 84 MPa
Deformation factor	= 60
Material combination factor for wear	= 1.4
Velocity Factor, C_v	= $3/(3 + v)$, v = pitch line velocity in m/s.
Tooth form factor for 20° stub teeth, y	= $0.175 - 0.841/T$, T = Number of teeth.

Check the design for the static, dynamic and wear loads.

[9M]

Question 2

A pair of straight bevel gears is mounted on shafts, which are intersecting at right angles. The number of teeth on pinion and gear are 25 and 50 respectively. developing 5 kW rated power. The pinion and gear are made of steel for which bending stress is 220 N/mm^2 . The form factor, module and face width are 0.34, 6 mm and 20 mm respectively. Determine the pitch angles of gear and pinion, cone distance and beam strength.

[4M]

Question 3

A pair of worm and wheel is designated as 3/60/10/6. The worm is transmitting 5 kW power at 1450 rpm to the worm wheel. Determine the diameters, tangential forces and axial forces on worm and wheel. The efficiency of the drive is 75%.

[4M]

Question 4

A motor shaft rotating at 1400 rpm has to transmit 18 Kw to a low speed shaft with reduction of 3:1. The teeth are $14 \frac{1}{2}^\circ$ involute of 6 mm module with 25 teeth on pinion. Both the gear and pinion are made of steel with a static stress of 200 MPa. The service factor is 0.8.

Velocity Factor, C_v = $3/(3 + v)$, v = pitch line velocity in m/s.
Tooth form factor for 20° stub teeth, y = $0.124 - 0.684/T$, T = Number of teeth. The weights of gear and pinion are 75 N and 40 N respectively. Find the resultant loads on gear and pinion. Design suitable diameters for the gear and pinion shafts if the shear stress of the shaft material is 40 MPa.

[8M]

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QUIZ II

Max. Marks: 5

Duration: 15 Min.

- **Answer all questions.**
 - **Marks are shown in brackets against each question.**
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Question 1

Find the bending load for a pair of bevel gears with module 30 mm and face width 19 mm respectively. Take bending stress, form factor, teeth on pinion and gear as 210N/mm^2 , 0.4, 30 and 50 respectively. [1M]

Question 2

Calculate pinion thrust of a bevel gear drive with number of teeth on pinion and gear as 40 and 60 respectively. The separating force on the drive is 2 kN. [1M]

Question 3

Find the tangential force on pinion of a pair of bevel gears if the pinion of 60 mm diameter transmits 6 kW at a speed of 1400 rpm. [2M]

Question 4

Find the gear thrust of a bevel gear unit, whose tangential force on pinion is 1.5 kN. The pitch angle of pinion and pressure angle are 34° and 20° respectively. [1M]

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Q U I Z III

Max. Marks: 10

Duration: 15 Min.

- **Answer all questions.**
 - **Marks are shown in brackets against each question.**
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Question 1

Find the thickness of an open cylinder with an internal pressure of 30 MPa. The allowable working stress is 100 MPa. It is subjected to an axial load of 1000 Kn. The cylinder is made of mild steel. [2M]

Question 2

A cast iron pipe of 110 mm internal diameter is subjected to internal pressure of 12 MPa. Determine thickness of the pipe by taking yield stress as 210 MPa and factor of safety as 3. [2M]

Question 3

A steel tank of 20 mm inner diameter is subjected to an internal pressure of 10 MPa. Find the outer diameter if the working stress is 56 MPa. [2M]

Question 4

Find the stress distribution for the thick cylinder of diameters 20mm and 60 mm is subjected to an internal pressure of 300 MPa. [4M]

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COMPREHENSIVE EXAMINATION

Max. Marks: 40

Duration: 3 hrs.
Date: 03-01-2009

- Answer all questions.
 - Marks are shown in brackets against each question.
 - Assume a suitable data, wherever necessary.
 - Use the data sheet supplied.
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Question 1

A bronze pinion rotating at 500 rpm drives a cast iron spur gear at a transmission ratio of 5:1. The allowable static stresses for the pinion and gear are 90 MPa and 110 MPa respectively. The pinion has 15 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 100 mm. Find the power that can be transmitted from the stand point of strength. Take the service factor as 1.

The tooth form factor can be taken as $y = 0.154 - \frac{0.912}{T}$ and the

velocity factor as $C_v = \frac{3}{3+V}$, where V is expressed in m/s. [8M]

Question 2

A pair of bevel gears consists of a 25-teeth meshing with a 50-teeth gear. The module and Face widths are 6 mm and 50 mm respectively. The pressure angle is 20°. The gear and pinion are made of steel for which the bending stress is 230 N/mm². The pinion rotates at 300 rpm and receives 5 Kw power. Calculate the pinion thrust and gear thrust if the service factor is 1.5. Find the beam strength

if the tooth form factor can be taken as $y = 0.154 - \frac{0.912}{T}$ and the

velocity factor as $C_v = \frac{6}{6+V}$, where V is expressed in m/s. [6M]

Question 3

A pair of worm gears is designated as 2/54/10/5. The worm rotates at 1000 rpm and the normal pressure angle is 20°. Find the dimensions of both the worm and wheel. Determine also the coefficient of friction and efficiency of the drive. [6M]

Question 4

A cast iron pipe in a hydraulic circuit is subjected to an internal pressure of 45 MPa. The inner diameter is 20 mm. Design the thickness using a suitable equation. Plot the distribution of principal stresses across the pipe thickness. The working stress is 200 MPa. [8M]

Question 5

A solid shaft of circular cross section of 130 mm diameter is subjected to a bending moment of 18 kNm. Determine the required torque to cause yielding based on 3 major theories of failure and examine which theory is most optimistic. [6M]

Question 6

A high pressure cylinder consists of an inner cylinder of inner diameters 200 and 300 mm respectively. It is jacketed by an outer cylinder of outside diameter 400 mm. The difference between the outer diameter of the inner cylinder and the inner diameter of the jacket before assembly is 0.25 mm. Calculate the shrinkage pressure. The modulus of elasticity is 207 GPa.. [6M]