BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2010-2011

COMPREHENSIVE EXAMINATION

ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 30-05-2011 **Time: 3 hrs.**
Marks: 40 **Weightage: 40%**

Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.
3. Use the data sheet provided.
4. Draw free hand sketches/drawings.
5.Assume logically the missing data, if any.

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 100 MPa and 120 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

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

the velocity of factor C_v as

$C_v = 3/(3 + v)$, where v is in m/s. **[8M]**

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 30 and 60 respectively. developing 6 kW rated power The pinion and gear are made of steel for which bending stress is 230 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. **[5M]**

Question 3

A motor shaft rotating at 1400 rpm has to transmit 15 Kw to a low speed shaft with reduction of 4:1. The teeth are $14\frac{1}{2}^{0}$ involute of 8 mm module with 30 teeth on pinion. Both the gear and pinion are made of steel with a static stress of 160 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 20^0 stub teeth, y = $0.124 - 0.684/T$, T = Number of teeth.

The weights of gear and pinion are 80 N and 50 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 45 MPa. **[8M]**

Question 4

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 20^0. Determine the components of gear tooth force acting on the worm and worm wheel. **[6M]**

Question 5

A thick cylinder made of cast iron is subjected to an internal pressure of 50 MPa. The inner and outer diameters of cylinder are 20 mm and 40 mm respectively. Draw the stress distribution diagrams of all principal stresses across the wall thickness. **[8M]**

Question 6

The piston rod of an hydraulic cylinder exerts an operating force of 10 kN. The friction is equivalent to 10% of the operating force. The pressure in the cylinder is 10 MPa. The cylinder is made of cast iron(σ_{ut} = 200 MPa) and factor of safety is 5. Determine the diameter and thickness of the cylinder. If it is made of plain carbon steel (σ_{ut} = 200 MPa and μ = 0.27), what will be its thickness? **[5M]**

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T E S T II (Open Book)

ME C 451 MECHANICAL EQUIPMENT DESIGN

Date: 15-05-2011 **Time: 50 minutes**
Marks: 20 **Weightage: 20%**

Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.
3. Text book and hand-written class notes are permitted.
4. Assume the missing data if any suitably.

Question 1
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 shrinkage pressure is 50 MPa. Draw free hand sketch. Calculate the deformation and original dimensions. Take E = 206 GPa. **[4M]**

Question 2
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. **[6M]**

Question 3
A steel tank for shipping gas is to have an inside diameter of 200 mm. The gas pressure and permissible stresses are 10 MPa and 55 MPa respectively. Design the tank using suitable equations. **[4M]**

Question 4
A high pressure pipe is subjected to an external pressure of 40MPa. The inner and outer diameters of the pipe are 40 mm and 60 mm respectively. Plot the distribution of principal stresses across the pipe thickness. **[6M]**

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T E S T 1

ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 27-03-2011 **Time: 50 minutes**
Marks: 25 **Weightage: 25%**

Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.
3. Use the data sheet provided.
4. Assume the missing data, if any logically.
5. Draw free hand sketches.

Question 1

A pair of straight teeth spur gears having 20^0 involute full depth is to transmit 12 kW at 300 rpm of the pinion. The speed ratio is 3:1. The allowable static stresses for gear of cast iron and pinion of steel are 105 MPa and 60 MPa respectively. Number of teeth on pinion is 16 and face width is 14 times the module. Design the spur gear drive.

The tooth form factor y is given by

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

the velocity of factor C_v as

$C_v = 4.5/(4.5 + v)$, where v is in m/s. **[8M]**

Question 2

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 $14\ \frac{1}{2}^0$ 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 20^0 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. **[7M]**

Question 3

A pair of straight bevel gears is mounted on perpendicular shafts, consists of a 30 teeth pinion meshing with a 48 teeth gear. The module is 4 mm. Calculate the pitch circle diameters and pitch angles of the pinion and gear and the cone distance. Draw the sketch of the gear drive, showing the diameters and pitch angles. **[5M]**

Question 4

A pair of worm and worm wheel is designated as 2/52/10/4. The worm is transmitting 10 kW at 720 r.p.m. Determine the pitch circle diameters and tangential forces on both the worm and wheel if the efficiency of drive is 80%. **[5M]**

Name: _____ **A**

ID NO: _____

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Q U I Z II

Max. Marks: 7 **Date: 18-04-2011**
Weightage: 7% **Duration: 20 Min.**

- **Answer all questions.**
- **Marks are shown in brackets against each question.**
- **Answers/solution should be given the space provided below the question.**

Question 1
Which of the following criteria is satisfied for a gun barrel?
A. Ratio of inner diameter to wall thickness is less than 15
B. Ratio of outer diameter to wall thickness is less than 15
C. Ratio of inner diameter to wall thickness is greater than 15
D. Ratio of outer diameter to wall thickness is greater than 15 **[1/2 M]**

ANSWER: _____

Question 2
For a high pressure pipe under internal pressure,
A. All the stresses are constant.
B. Radial and tangential stresses vary but longitudinal stress is constant
C. All the stresses vary over the wall thickness.
D. Longidinal and radial stresses are constant but tangential stress is constant. **[1/2 M]**

ANSWER: _____

Question 3
If tangential stress acting on a LPG tank is 150 MPa, its radial and longitudinal stresses are respectively
A. 0 and 300 MPa. C. 0 and 75 MPa
B. 300 MPa and 0. D. 75 MPa and 0. **[1/2 M]**

ANSWER: _____

Question 4

Which of the following equations is used for designing a high pressure MS pipe, subjected to an internal pressure?

A. Birnie's equation C. Lewis equation

B. Clavarino's equation D. Lame's equation **[1/2M]**

ANSWER: _____

Question 5

A boiler shell of internal diameter 250 mm is subjected to an internal pressure of 15 MPa.find its thickness if longitudinal stress acting on it is 70 MPa. **[2M]**

Question 6

Find the maximum tangential and radial stresses acting on a liquefied gas tank subjected to an internal pressure of 15 MPa. The outer diameter and thickness may be taken as 280 mm and 30 mm respectively. **[2M]**

Question7

Draw the free hand sketch of tangential and radial stress variation for a hydraulic cylinder subjected to an internal pressure. **[1M]**

Name:_____

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Q U I Z I

Max. Marks: 16 **Date: 28-02-2011**
Weightage: 8% **Duration: 20 Min.**

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

Question 1
Draw the free hand sketch of the tooth profile of spur gear showing all the load s acting on it. **[2M]**

Question2
Give the types of gears used according to the position of shafts. **[2M]**

Question 3
What is Lewis formula? Give its significance. **[2M]**

Question 4
Give possible remedies for wear and corrosion tooth failures. **[2M]**

Question 5
What are reasons for dynamic load on teeth? **[2M]**

Question 6
What is strength factor? Give its significance in the design of gears. **[2M]**

Question7
If the wear tooth load, static tooth load and incremental load are 50 KN, 25 kN and 6 kN respectively, check whether the design is safe or not? The gear is subjected to a normal load of 5 kN and pressure angle is 20^0. **[2M]**

Question8
Find the power transmitted for a gear drive, in which pinion is rotating at 600 rpm driving a spur gear at transmission ratio 4:1. The pinion has 16 teeth with a module of 8 mm. The tangential load is 6 kN. The service factor is 0.6. **[2M]**