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**BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2013-2014**

COMPREHENSIVE EXAMINATION (Closed Book)

ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 27-05-2014

Marks: 80

Time: 3 hrs

Weightage: 40%

Note: 1. Answer all questions.

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

3. Use the data sheet provided.

4. Assume the data missing, if any logically.

Question 1

A pair of straight teeth spur gears having 20° full depth involute is to transmit 16 kW at 600 rpm of the pinion. The speed ratio is 3:1. The allowable static stresses for gear and pinion of different materials are 120 MPa and 100 MPa respectively. Number of teeth on pinion is 35 and face width is 10 times the module. Find the module, face width and pitch circle diameters. The gears are carefully cut and used to carry light shock loads for 9 hrs/day. Check the design for static and wear loads. The endurance strength, deformation factor and load stress factor are 80 MPa, 50 N/mm and 1.4 N/mm^2 respectively. Draw free hand sketch showing the dimensions. **[15 M]**

Question 2

A motor shaft rotating at 1400 rpm has to transmit 20 kW to a low speed shaft with reduction of 4:1. The teeth are of $14\frac{1}{2}^\circ$ involute profile with 50 teeth on pinion. Both the gear and pinion are made of same materials with a static stresses of 220 MPa. The weights of gear and pinion are 60 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 of gear and pinion are 40 MPa and 50 MPa respectively. The gears are ordinary cut and used for a steady load, operating 8 hrs/day. The distance between centre of bearing and centre of gear is 140 mm. Assume face width is 12 times module. Draw the freehand sketch of both the gear and pinions, showing all the loads. **[15M]**

Question 3

(a) 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 40 and 50 respectively, developing 6 kW rated power. The pinion and gear are made of steel for which bending stress is 240 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. Find also the equivalent number of teeth on gear and pinion. Draw free hand sketch showing the dimensions **[5M]**

(b) A pair of worm and worm wheel is designated as 2/40/10/5. The worm is transmitting 5 kW power at 1200 rpm to the worm wheel. The coefficient of friction is 0.12 and the normal pressure angle is 20° . Determine the components of gear tooth force acting on the worm and worm wheel. Find all the dimensions including speeds and helix angle of worm and wheel. Draw free hand sketch showing the dimensions and forces. [5M]

Question 4

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. Draw the diagram to scale. [15M]

Question 5

(a) 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. [5M]

(b) A cast iron pipe of 100 mm internal diameter is subjected to an internal pressure of 14 MPa. Design suitable dimensions of the pipe. Take ultimate tensile stress is 220 MPa and factor of safety as 3. [5M]

Question 6

A high pressure pipe is subjected to an external pressure of 40 MPa. 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. Draw the diagram to scale. [15M]

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**T E ST II (Open Book)
ME C451MECHANICAL EQUIPMENT DESIGN**

Date: 21-04-2014

Time: 50 minutes

Marks: 40

Weightage: 20%

Note: 1. Answer all questions

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

3. Prescribed text book and hand-written class notes are only allowed.

4. Assume logically the missing data, if any.

Question 1

A pair of worm and wheel is designated as 2/60/10/5. The worm is transmitting 6kW power at 1500 rpm to the worm wheel. Determine the diameters, tangential forces and axial forces on worm and wheel. The efficiency of the drive is 80%. Draw the free hand sketch of worm gear drive showing dimensions and forces. **[6M]**

Question 2

A pair of straight bevel gears is mounted on perpendicular shafts, consists of a 40 teeth pinion meshing with a 50 teeth gear. The module is 4 mm. Calculate the pitch circle diameters, pitch angles of the pinion and gear, the cone distance and equivalent no of teeth on gear and pinions. Draw the sketch of the gear drive, showing the diameters and pitch angles. **[4M]**

Question 3

A thick cylindrical tube with 50 mm and 60 mm as inner and outer diameters respectively is subjected to an internal of 80 MPa. Draw the radial and tangential stress distribution diagram across the tube thickness proportionate to the data and scale. **[15M]**

Question 4

A thick cylindrical cast iron pipe used in hydraulic circuit is subjected to an external pressure of 40 MPa. The inner and outer diameters of the pipe are 30 mm and 40 mm respectively. Plot the distribution of both radial and tangential stresses across the pipe thickness proportionate to data and scale. **[15M]**

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SECOND SEMESTER 2013-2014**

T E S T 1(Closed Book)

ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 27-02-2014

Marks: 50

Time: 50 minutes

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.

Question 1

A gear drive is required to transmit a maximum power of 20 kW. The velocity ratio is 1:3 and speed of pinion is 300 rpm. The approximate centre distance between the shafts may be taken as 500 mm. The teeth have 20° full depth involute profiles. The gear and pinion are made of different materials with static stresses as 80 MPa and 100 MPa respectively. The endurance strength for may be taken as 80 MPa. The face width as 12 times the module. Find the module, face width and number of teeth on each gear. Check the design for dynamic and wear loads. The deformation factor and load stress factors may be taken as 90N/mm and 1.5 N/mm^2 respectively. The gears are ordinarily cut and used for medium shock load, operating 10 hrs/day. Draw the freehand sketch of gear drive, showing dimensions. **[15M]**

Question 2

A motor shaft rotating at 1400 rpm has to transmit 25kW to a low speed shaft with reduction of 4:1. The teeth are of $14\frac{1}{2}^\circ$ involute profile with 40 teeth on pinion. Both the gear and pinion are made of same materials with a static stresses of 200 MPa. The weights of gear and pinion are 70 N and 30 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 of gear and pinion are 30 MPa and 40 MPa respectively. The gears are ordinary cut and used for a steady load, operating 9 hrs/day. The distance between centre of bearing and centre of gear is 120 mm. Assume face width is 15 times module. Draw the freehand sketch of both the gear and pinions, showing all the loads. **[20M]**

Question 3

A pair of straight teeth spur gears having 20° full depth involute is to transmit 15 kW at 500 rpm of the pinion. The speed ratio is 2:1. The allowable static stresses for gear and pinion of different materials are 130 MPa and 90 MPa respectively. Number of teeth on pinion is 25 and face width is 14 times the module. Find the module, face width and pitch circle diameters. The gears are carefully cut and used to carry light shock loads for 10 hrs/day. **[15M]**

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ID NO: _____

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QUIZ II

**Max. Marks: 14
Weightage: 7%**

**Date: 15-05-2014
Duration: 20 Min.**

- Answer all questions.
 - Question no 1 to 6 carry 1 mark each and other two carry 4 marks each
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Question 1

How do you identify whether the pressure vessel is thin or thick?

Question 2

What design equation is used for designing a gun barrel made of cast steel?

Question 3

What are the values of maximum and minimum radial stress for a storage tank, subjected to an external pressure of 50 MPa?

Question 4

What is the relationship between the tangential and longitudinal stresses of a boiler vessel?

Question 5

What is the minimum principal stress of an LPG tank?

Question 6

What is the maximum shear stress of a thin walled tube whose tangential stress is 40 MPa?

Question 7

Draw the free hand sketch showing all the stresses for a gun barrel subjected to an internal pressure.

Question 8

Draw the free hand sketch showing all the stresses for a hydraulic cylinder subjected to an external pressure.

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QUIZ I

Max. Marks: 16

Weightage: 8%

Date: 23-03-2014

Duration: 20 Min.

- Answer all questions.
 - Question no 1 to 12 carry one mark each and the question no 13 and 14 carry 2 marks each.
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Question 1

Draw the free hand sketch of involute profile of spur teeth showing all the loads

Question 2

Find the cone distance of bevel gear drive if the pitch circle diameters of pinion and gear are 40 mm and 50 mm

Question 3

Draw the free hand sketch of bevel gear drive unit.

Question 4

What is wear tooth failure and give its remedy?

Question 5

What type of gears are used when the axis of shafts are neither parallel nor intersecting?

Question 6

Define strength factor for spur gear drive

Question 7

What is the principle on which worm works?

Question 8

What is the significance of Buckingham's equation?

Question 9

How do you calculate bending moment while designing gear shaft?

Question 10

If the material of gear and pinion is same, what is the basis of design?

Question 11

What is helix angle of worm?

Question 12

What is the relationship between normal load and radial load on a tooth?

Question 13

Find the pitch angle of pinion and gear in a bevel drive if no of teeth on gear and pinion are 25 and 15 respectively. Determine equivalent number of teeth on both.

Question 14

If the power transmitted by spur pinion is 20 kW, find the tangential load on a spur gear if the service factor is one and pinion is rotating at 500 rpm.