COMPREHENSIVE EXAMINATION

ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 27-12-2010   Time: 3 hrs.
Marks: 80   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 any missing data logically.

Question 1

A pair of straight teeth spur gears is to transmit 22 kW when the pinion rotates at 300 rpm. The velocity ratio is 1:4. 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 13 times the module. Determine the module, face width, and pitch circle diameters of 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

$$C_v = 3 / (3 + v), \text{ where v is in m/s.} \qquad \text{[12M]}$$

Question 2

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.   **[10M]**

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 20^0. Determine the components of gear tooth force acting on the worm and worm wheel.   **[10M]**

Question 4

A motor shaft rotating at 1400 rpm has to transmit 16 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 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 $\quad= 3/(3 + v)$, 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 70 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 40 MPa. **[12M]**

Question 5

A roller bearing subjected to a radial load of 2 kN is expected to have a satisfactory life of 10,000 hrs at 700 r.p.m with a reliability of 95%. Find the expected life of bearing in million revolutions and the dynamic load carrying capacity of the bearing so that it can be selected from a manufacturer's catalogue based on 90% reliability.

If there are 4 such bearings with a reliability of 95% in a system, what is the reliability of complete system? **[8M]**

Question 6

A high pressure cylinder consists of a steel tube with inner and outer diameters of 25 mm and 50 mm respectively. It is jacketed by an outer steel tube with an outer diameter of 70 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 110 MPa. Calculate the shrinkage pressure and original dimensions of tubes. (E = 200 GPa). **[8M]**

Question 7

An air receiver consists of a 500 mm diameter cylinder closed by hemispherical ends, is made of steel, whose ultimate strength is 340 MPa and the facor of safety is 3. Design the thickness of the cylinder wall and hemi spherical ends and give clearly the assumptions made if any in the design. **[8M]**

Question 8

A cast iron pipe in a hydraulic circuit is subjected to an external pressure of 55 MPa. The inner and outer diameters of pipe are 25 mm and 45mm respectively. Plot the distribution of principal stresses across the pipe thickness. **[12M]**

T E ST II (Open Book)
ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 28-11-2010   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 only
         allowed.
      4. Assume any missing data logically.

Question 1
A cast iron pipe in a hydraulic circuit is subjected to an internal pressure of 50 MPa. The inner and outer diameters of pipe are 20 mm and 40 mm respectively. Plot the distribution of principal stresses across the pipe thickness.   [6M]

Question 2
A high pressure cylinder with internal and external diameters 200 mm and 240 mm respectively is subjected to an external pressure of 20 MPa. Draw the stress variation diagrams of both the radial and tangential stresses.   [6M]

Question 3
The inner diameter of a cylindrical tank for liquefied gas is 300 mm. The gas pressure is limited to 17 MPa. The tank is made of plain carbon steel ($\sigma = 70$ N/mm^2 and $v = 0.3$) Calculate the cylinder wall thickness.   [5M]

Question 4
A tube with 60 mm and 85 mm as inner and outer diameters respectively is reinforced by shrinking a jacket of outer diameter 110 mm. The tubes are assembled by a shrinking process in such a way that maximum principal stress induced in any tube is limited to 100 MPa. Calculate the total deformation. (E = 207 GPa).   [3M]

T E S T I (Closed Book)

Marks: 25
Weightage: 25%

Duration: 50 Minutes
Date: 17-10-10

- Answer all questions.
- Marks are shown in brackets against each question.
- Assume any missing data suitably.

Question 1

A pair of 20^0 full-depth involute teeth spur gears is to transmit 30 kW power. For which the Data is given below:

Number of teeth on pinion	= 20
Face width	= 12, 5 times the module
Allowable bending stress of the material	= 100 MPa for pinion
	= 55 MPa for gear
Speed of the pinion	= 250 r.p.m
Lewis form factor	= 0.154 - o.912/T
Velocity factor	= 3/ (3 + v)

[8M]

Find module, face width, diameters of gear and pinion from the stand point of strength only taking velocity factor into consideration. Draw the free hand sketch of gear drive showing major dimensions.

Question 2

A pair of bevel gears is required to transmit 10 kW at 500 rpm from motor shaft to output shaft at 250 rpm. If the number of teeth on pinion is 24 and the shafts axes are perpendicular to each other, find module, face width, addendum, outside diameter and cone distance. The gears are capable of withstanding a static stress of 60 MPa.

Tooth form factor can be taken as $y = 0.154 - \dfrac{0.912}{T}$

T = Equivalent Number of teeth. and the

Velocity factor as $C_V = \dfrac{4.5}{4.5 \div V}$, where V is expressed in m/s.

Draw the free hand sketch of gear drive showing major dimensions. [6M]

Question 3

A double threaded worm drive has an axial pitch of 25 mm and pitch circle diameter of 70 mm. The torque on worm gear shaft is 1400 Nm, pitch circle diameter is 250 mm and Pressure angle is 25^0. Find tangential force, torque on worm, separating force, velocity Ratio and coefficient of friction is 0.04. **[6M]**

Question 4

A ball bearing is subjected to a radial load of 5 kN is expected to have a life of 8000 hrs at 1450 rpm with a reliability of 99%. Calculate the dynamic load capacity of bearing so that it can be selected from the manufacturer's catalogue with a reliability of 90%. **[5M]**

Name:_____

ID NO:_____

BITS, PILANI – DUBAI
ME C451 Mechanical Equipment Design
I SEMESTER 2010-2011
Q U I Z II

Date: 09-12-2010

Marks: 07   Duration: 20 Min.

- Answer all questions.
- Put √ mark in the brackets provided against the suitable answer.
- Marks are shown in brackets against each question.

S E C T I O N A

Question 1   Which of the following is related to thin cylinder?   [1/2M]

A   radial stress is constant   [   ]

B   tangential stress is less than longitudinal stress   [   ]

C   both radial and tangential stress vary   [   ]

D   none of the above   [   ]

Question 2   Which of the following is not considered as thick cylinder   [1/2M]

A   hydraulic cylinder   [   ]

B   gun barrel   [   ]

C   boiler shell   [   ]

D   high pressure pipe   [   ]

Question 3 Thin cylinder is considered as   [1/2M]

A   1-d stress state   [   ]

B   2-d stress state   [   ]

C   3-d stress state   [   ]

D   none of the above   [   ]

1

Question 4 Longitudinal stress for a gun barrel is

    A   constant   [   ]

    B   varies with respect to radius   [   ]

    C   varies with respect to pressure   [   ]

    D   none of the above   [   ]

Question 5 Which of the following theories of failure is related to Poisson's
               ratio ?   [1/2M]

    A   principal stress theory   [   ]

    B   principal strain theory   [   ]

    C   shear stress theory   [   ]

    D   none of the above.   [   ]

Question 6 Which of the following is true for shear stress theory   [1/2M]

    A   maximum shear stress is equal to half of yield point stress   [   ]

    B half of the difference of principal stresses is equal to yield
       point stress   [   ]

    C   maximum principal stress is equal to yield point stress.   [   ]

    D   none of the above.   [   ]

Question 7
Find the internal pressure of a boiler shell whose internal and external diameters 250 mm and 270 mm respectively. Take yield point stress as 150 MPa. Use suitable theory of failure. **[2M]**

Question 8
A high pressure cylinder with internal and external diameters 220 mm and 260 mm respectively is subjected to an internal pressure. Find its internal pressure using maximum principal stress theory if if the yield point stress is 200 MPa. **[2M]**

Q U I Z I

Max. Marks: 8

Weightage: 8%

Date: 08-11-10

Duration: 20 Min.

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

Question 1

What are the criteria of identifying whether cylinder is thin or thick?   [1M]

Question 2

Give some examples of thin cylinders.   [1M]

Question 3

A seamless steel pipe of 100 mm internal diameter is subjected to internal pressure of 15 MPa. Determine thickness of the pipe if the tangential stress is 50 MPa.   [2M]

Question 4

A high pressure cylinder consists of steel tube with inner and outer diameters of 20 mm and 45 mm respectively. Find the radial and tangential stresses. [2M]

Question 5

Find the radial and tangential stresses as a function of radius if the compound cylinder of diameters 20mm and 60 mm is subjected to an internal pressure of 300 MPa. [2M]