COMPREHENSIVE EXAMINATION

ME C451 MECHANICAL EQUIPMENT DESIGN

Date: 21-05-2009                                    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.

**Question 1**
A pair of straight teeth spur gears having $20^0$ involute full depth is to transmit 14 kW at 300 rpm of the pinion. The speed ratio is 4:1. The gear and pinion are made of cast iron and steel respectively.. Number of teeth on pinion is 16 and face width is 14 times the module.
The tooth form factor y is given by
y = 0.154 – 0.912/(No. of teeth) and the velocity of factor $C_v$ as
$C_v$ = 4.5/(4.5 + v), where v 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 25 teeth pinion meshing with a 30 teeth gear. The pinion shaft is connected to an electric motor developing 12 kW rated power at 1400 rpm. The pressure angle is $20^0$. Both the gears are made of case hardened steel. Choose a factor of safety as 3. Estimate the module based on beam strength if pitch line velocity is 7.5 m/s. Find also the major dimensions of the gears.                        [10M]

**Question 3**
A pair of worm and worm wheel is designated as 3/60/10/6. The worm is transmitting 6 kW power at 1500 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.                        [8M]

**Question 4**
A high pressure vessel consists of a steel tube with inner and outer diameters of 25 mm and 45 mm respectively. It is jacketed by an outer steel tube with an outer diameter of 65 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 120 MPa. Calculate the shrinkage pressure and original dimensions of tubes.(E = 208 GPa).                        [8M]

## Question 5

A cast iron pipe used in hydraulic circuit is subjected to an internal pressure of 50 MPa. The inner and outer diameters of the pipe are 30 mm and 50 mm respectively. Plot the distribution of principal stresses across the pipe thickness. **[8M]**

## Question 6

The stresses induced at a critical point in a machine component made of steel, for which yield stress is 400 MPa are normal stresses : 120 $N/mm^2$, 50 $N/mm^2$ and shear stress is 80 $N/mm^2$. Calculate factor of safety using maximum normal stress and maximum normal strain theories . **[8M]**

## Question 7

A ball 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 5 such bearings with a reliability of 95% in a system, what is the reliability of complete system? **[8M]**

**T E ST II (Open Book)**
**ME UC451MECHANICAL EQUIPMENT DESIGN**

Date: 12-04-2009                                                     Time: 50 minutes
Marks: 20                                                                  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/lecture notes are
     allowed.

## Question 1

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 35 respectively. The pressure angle is $20^0$. The pinion shaft is connected to an electric motor developing 6 Kw power at 1500 rpm. The bending stress is 200 MPa. The module and face width are 4 mm and 20 mm respectively. Take form fsctor as 0.345. Find the bending load and tangential load and also draw free hand sketch of gear drive,showing pitch circle diameters and pitch angles.                                     **[5M]**

## Question 2

A pair of worm gears is designated as 2/52/10/4. 12 kw power at 730 rpm is supplied to the worm shaft. Calculate the tangential and axial forces on both the worm and wheel. The coefficient of friction is 0.04 and the pressure angle is $20^0$. Draw the free hand sketch of the gear drive showing pitch diameters and centre distance.                                     **[5M]**

## Question 3

A pipe in a hydraulic system is subjected to an internal pressure of 40 Mpa. The inner and outer diameters are 25 mm and 45 mm respectively. Determine both the constant and variable stresses and also draw the stress distribution diagram.                                     **[6M]**

## Question 4

A ball bearing subjected to a radial load of 3 kN is expected to have a satisfactory life of 10,000 hrs at 720 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?                                     **[4M]**

T E ST I (Closed Book)
ME C451MECHANICAL EQUIPMENT DESIGN

Date: 01-02-2009                                                    Time: 50 minutes
Marks: 25                                                          Weightage: 25%
Note: 1. Answer all questions
      2. Marks are shown in the brackets against each question.

## Question 1

A spur gear drive is required to transmit a maximum power of 22.5 kW. The velocity ratio is 1:2 and speed of pinion is 200 r.p.m. The center distance between the shafts is 600 mm. The static stress and endurance strength for both the gear and pinion materials is 60 MPa and 84 MPa and face width is 10 times the module. Find the module, face width and number of teeth on each gear. Take module as 8 mm, the deformation and load stress factors are 80 and 1.4 respectively. Check the design for static and wear loads

| | | |
|---|---|---|
| Lewis form factor | = | 0.175 - 0.841/T |
| Velocity factor | = | 3/ (3 + v) |
| Service factor | = | 1.0 |

[10M]

## Question 2

A pinion of spur gear drive is to transmit 32 kW when it rotate at 600 rpm with a transmission ratio of 4:1. The allowable static stresses for the pinion and gear materials are 84 MPa and 105 MPa respectively. Find the module and diameters of pinion and gear. The face width is 10 times the module and pinion has 16 teeth.

| | | |
|---|---|---|
| Service factor | = | 1.0 |
| Lewis form factor | = | 0.175 - 0.841/T |
| Velocity factor | = | 3/ (3 + v) |

[10M]

## Question 3

Draw the free hand sketch of involute tooth profile of spur gear, showing the salient details and design the gear unit by finding tangential load with the data given below:

| | | |
|---|---|---|
| Power transmitted | = | 22 kW |
| No of teeth on gear | = | 80 |
| Transmission ratio | = | 4:1 |
| Speed of pinion | = | 400 rpm |
| Module | = | 4 mm |
| Lewis form factor | = | 0.154 - 0.912/T |
| Service factor | = | 1.0 |

[5M]

## Q U I Z II

**Max. Marks: 5**                                                     **Duration: 15 Min.**
                                                                              **Date:  23-03-09**

- **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 20 mm and face width 15 mm
respectively. Take bending stress, form factor, teeth on pinion and gear as 200 N/mm$^2$,
0.4, 20 and 40 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 3 kN.                  **[1M]**

**Question 3**

Find the tangential force on pinion of a pair of bevel gears if the pinion of 60 mm diameter transmits 5 kW at a speed of 1300 rpm. [1M]

**Question 4**

Find the gear thrust of a bevel gear unit, whose tangential force on pinion is 2 kN. The pitch angle of pinion and pressure angle are $34^0$ and $20^0$ respectively. [1M]

**Question 5**

Draw the free hand sketch of bevel gear unit showing pitch diameters and pitch angles.
[1M]

NAME:_____

ID NO:_____

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**ME C451 MECHANICAL EQUIPMENT DESIGN**
**II SEMESTER 2008-2009**

**Q U I Z I**

Max. Marks: 10                                    Duration: 15 Min.
Weightage: 5%                                     Date\; 23-02-2009
  • Answer all questions.
  • Marks are shown in brackets against each question.

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**Question 1**
List any 2 tooth failures and give remedies                    .                    [2M]

**Question 2**
What is the basis of Lewis equation? Give its significance.                    [2M]

**Question 3**
What is strength factor and give its importance in design.                    [2M]

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**Question 4**

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

**Question 5**

Find the power transmitted for a gear drive, in which pinion is rotating at 400 rpm driving a spur gear at transmission ratio 3:1. The pinion has 15 teeth with a module of 6 mm. The tangential load is 9 kN. The service factor is 0.8. [2M]