

**BITS PILANI, DUBAI CAMPUS**  
**DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI**  
**ME C451 MECHANICAL EQUIPMENT DESIGN**  
**II SEMESTER 2012-2013**

**COMPREHENSIVE EXAMINATION**

**Marks: 80**

**Duration: 3 hrs**

**Weightage: 40%**

**Date: 10-06-13**

- **Answer all questions.**
  - **Marks are shown in brackets against each question.**
  - **Assume any missing data suitably.**
  - **Draw free hand sketches for all questions.**
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**Question 1**

A pair of straight teeth spur gears is to transmit 40 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 140 MPa respectively. The pinion has 20 teeth and its face width is 15 times the module. The service factor is 0.8. 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 1.25. The tooth form factor  $y$  can be taken as

$$y = 0.154 - 0.912/T \text{ and}$$

the velocity of factor  $C_v$  as

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

The weights of gear and pinion are 95 N and 60 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 50 MPa. **[15M]**

**Question 2**

A pair of straight bevel gears is mounted on perpendicular shafts, consists of a 25 teeth pinion meshing with a 75 teeth gear. The module is 6 mm. Calculate the pitch circle diameters and pitch angles of the pinion and gear and the cone distance. Find also the tangential force, pinion and gear thrusts if this drive is transmitting 35 Kw at a pinion speed of 300 rpm. **[10M]**

**Question 3**

A pair of worm and wheel is designated as 2/60/112/6. The worm is transmitting 6kW power at 1200 rpm to the worm wheel. Determine the diameters, tangential forces and axial forces on worm and wheel. The efficiency of the drive is 75%. **[10M]**

**Question 4**

A high pressure cylinder consists of a steel tube with inner and outer diameters of 30 mm and 50 mm respectively. It is subjected to an internal pressure of 20 MPa. Draw the stress distribution diagram for the cylinder. [15 M]

**Question 5**

A thick cylindrical tube with 60 mm and 85 mm as inner and outer diameters respectively is subjected to an external pressure of 120 MPa. Draw the radial and tangential stress distribution diagram proportionate to the data. [15M]

**Question 6**

A cast iron steel pipe of 100 mm internal diameter is subjected to an internal pressure of 14 MPa. Design suitable dimensions of the of the pipe. Take ultimate tensile stress is 220 MPa and factor of safety as 3. [15 M]

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# BITS PBLONG, Dublin Corps

(1)

II Sem 20K - 13

Computer Exam

MISCUST Mech. Left Den

Answered scheme

Misc 80

Ans: 40%

Date: 10/6/13

(Q1)

Pure lead solder ——— 4M

Shank ends ——— 2M

middle 2 ends ——— 4M

Both leads ——— 2M

Turn ——— 2M

Pure or shank ——— 1M

15M

(Q2)

Pure lead solder ——— 4M

Turn ——— 2M

Pure ——— 4M

10M

(Q3)

Free body sketch

4 m

Reactions,

2 m

Forces

4 m

10 m

(2)

(Q4)

Calculate

10 m

Diagram

5 m

15 m

(Q5)

Calculate

10 m

Diagram

5 m

15 m

(Q6)

Free body sketch

2 m

Find down vis other

3 x 3 = 9 m

Order down

4 m

15 m

0

**BITS PILANI, DUBAI CAMPUS  
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI  
SECOND SEMESTER 2012-2013**

**T E S T 1(Closed book)**

**ME C451 MECHANICAL EQUIPMENT DESIGN**

**Date: 06-03-2013**

**Marks: 25**

**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.**

**5. Draw free hand sketches.**

**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 allowable static stresses for gear of cast iron and pinion of steel are 115 MPa and 65 MPa respectively. Number of teeth on pinion is 16 and face width is 15 times the module. Find the module, face width and pitch circle diameters of both the gear and pinion.

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.

**[10M]**

**Question 2**

A motor shaft connected to pinion rotating at 1200 rpm has to transmit 16 kW to a low speed shaft with reduction of 3:1. The teeth are  $20^0$  stub involute of 8 mm module with 20 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  $y = 0.124 - 0.684/T$ ,  $T$  = Number of teeth

Find the pitch circle diameters of gear and pinion, tangential load, normal load and radial load.

**[5M]**

**Question 3**

Calculate the power that can be transmitted safely by a pair of spur gears with the data given below: (Take Velocity factor =  $3/(3+v)$ )

Number of teeth on pinion = 40  
Number of teeth on gear = 120  
Module = 5 mm  
Face width = 70 mm

Allowable bending strength of the material  
= 210 MPa, for pinion  
= 150 MPa, for gear

Speed of the pinion = 500 rpm

Service factor = 0.8

Lewis form factor =  $0.154 - 0.912/T$

Check the design for dynamic and wear loads. The deformation factor and load stress factors may be taken as 85 and 1.5 respectively. [10M]

BITS PILANI, DURGAPUR CAMPUS

DIAR

II Sem 2012-13

ME C451 Mechanical Equipment Design

ANSWERS' scheme

TEST - 1

DATE: 6-03-13

Marks: 25  
Weightage: 25%

Q1

Free hand sketch	2 M
Sketch Ratchet	1 M
Tapered load	2 M
Module	3 M
Force work, Dealer	2 M
	<u>10 M</u>

Q2

Free hand sketch	1 M
Pitch of chain	1 M
TANGENTIAL LOAD	2 M
Normal & axial loads	1 M
	<u>(5 M)</u>

Q3

Free hand sketch	2 M
Sketch Ratchet	1 M
TANGENTIAL LOAD	2 M
DYNAMIC Load	2 M
bar load	2 M
check for stress	1 M
	<u>(10 M)</u>

Name: \_\_\_\_\_

A

ID NO: \_\_\_\_\_

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ME C451 MECHANICAL EQUIPMENT DESIGN  
II SEMESTER 2012-2013

QUIZ II

Max. Marks: 14

Weightage: 7%

Date: 28-03-2013

Duration: 20 Min.

- Answer all questions.
  - All questions carry equal marks
- 

**Question 1**

Define the pitch angle of a bevel gear

**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**

Draw the free hand sketch of worm gear unit.



**Question 5**

What type of gears are used when the axis of shafts are not in the same plane?

**Question 6**

Which is the driver in a worm gear unit?

**Question 7**

What is the principle on which worm works?

**Question 8**

How do you designate a worm gear unit?

**Question 9**

How do you find equivalent number of teeth for bevel gears?

**Question 10**

Define diametral factor and axial pitch in a worm gear drive.

**Question 11**

What is helix angle of worm?

**Question 12**

Find the central distance between worm and gear if the diametral factor, module and number of teeth on gear are 60, 6 mm and 20 respectively.

**Question 13**

Find the pitch angle of pinion in a bevel drive if no of teeth on gear and pinion are 30 and 20 respectively.

**Question 14**

If the power transmitted by worm gear is 5 kW, find the tangential force on gear of 20 mm diameter, rotating at 400 rpm.

# ANSWERS' scheme

Name: \_\_\_\_\_

**A**

ID NO: \_\_\_\_\_

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II SEMESTER 2012-2013**

## **QUIZ II**

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

**Date: 28-03-2013  
Duration: 20 Min.**

- Answer all questions.
  - All questions carry equal marks
- 

### **Question 1**

Define the pitch angle of a bevel gear

It is defined as angle that do  
make do teeth on gear to teeth on pinion

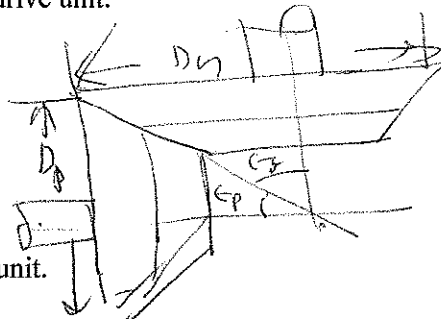
### **Question 2**

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

$$L = \sqrt{\left(\frac{40}{2}\right)^2 + \left(\frac{50}{2}\right)^2} = \sqrt{20^2 + 25^2} = \text{--- mm}$$

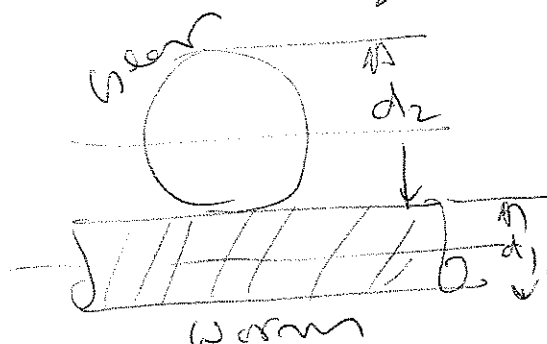
### **Question 3**

Draw the free hand sketch of bevel gear drive unit.



### **Question 4**

Draw the free hand sketch of worm gear unit.



**Question 5**

What type of gears are used when the axis of shafts are not in the same plane?

Worm Gears

**Question 6**

Which is the driver in a worm gear unit?

Worm

**Question 7**

What is the principle on which worm works?

Inclined plane

**Question 8**

How do you designate a worm gear unit?

$z_1/z_2 \quad r/m$

**Question 9**

How do you find equivalent number of teeth for bevel gears?

$$z_{eq} = z_g / \cos \alpha_g$$

**Question 10**

Define diametral factor and axial pitch in a worm gear drive.

$$q = \frac{d_1}{m}$$

**Question 11**

What is helix angle of worm?

$$\gamma = \tan^{-1} \frac{Z_1}{q}$$

**Question 12**

Find the central distance between worm and gear if the diametral factor, module and number of teeth on gear are 60, 6 mm and 20 respectively.

$$c = \frac{d_1 + d_2}{2} = \frac{mq + mZ}{2} = \frac{6(60 + 20)}{2} = 240 \text{ mm}$$

**Question 13**

Find the pitch angle of pinion in a bevel drive if no of teeth on gear and pinion are 30 and 20 respectively.

$$\epsilon_p = \tan^{-1} \frac{20}{30}$$

**Question 14**

If the power transmitted by worm gear is 5 kW, find the tangential force on gear of 20 mm diameter, rotating at 400 rpm.

$$P = 15 \times 10^3 = \frac{2\pi F_t d_2/2}{60} \Rightarrow F_t = \frac{15000 \times 60 \times 2}{2\pi \times 0.02}$$

Name: \_\_\_\_\_  
ID NO: \_\_\_\_\_

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II SEMESTER 2012-2013**

**Q U I Z I**

**Max. Marks: 8  
Weightage: 8%**

**Date: 28-02-2013  
Duration: 20 Min.**

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

**Question 1**

State the laws of gearing.

**[1]**

**Question 2**

What are the reasons for the dynamic load on tooth

**[1]**

**Question 3**

Mention any two types of tooth failure and their remedies

**[1]**

**Question 4**

What are the parameters on which wear load depends?

**[1]**

**Question 5**

What type of gears are used when the axis of shafts are intersecting?

[1/2]

**Question 6**

If static tooth load and dynamic tooth load are 10 Kn and 20 Kn, is the design safe? [1/2]

**Question 7**

What is the assumption made by Lewis equation in designing a gear?

[1/2]

**Question 8**

If the wear tooth load, static tooth load and incremental load are 50 KN, 20 kN and 5 kN respectively, check whether the design is safe or not? The gear is subjected to a tangential load of 4 Kn.

[1/2]

**Question 9**

Mention the parameters on which beam strength does depend?

[1/2]

**Question 10**

Define diametral pitch and circular pitch of a gear

[1/2]

**Question 11**

What is the significance of Lewis equation?

[1/2]

**Question 12**

Mention the reasons for the Barth formula in designing a gear

[1/2]



# ANSWERS' Scheme

Name: \_\_\_\_\_  
ID NO: \_\_\_\_\_

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ME C451 MECHANICAL EQUIPMENT DESIGN  
II SEMESTER 2012-2013

## QUIZ I

Max. Marks: 8  
Weightage: 8%

Date: 28-02-2013  
Duration: 20 Min.

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

### Question 1

State the laws of gearing.

[1]

- ① Corrobor pitches must be same
- ② Pitch line velocities must be equal.

### Question 2

What are the reasons for the dynamic load on tooth

[1]

- ① Irregularities in tooth profile
- ② Inaccuracies in tooth spacing
- ③ Deflection under tooth load

### Question 3

Mention any two types of tooth failure and their remedies

[1]

- ① Pitting failure  $\rightarrow W_S > W_D$
- ② Pitching failure  $\rightarrow W_W > W_D$

### Question 4

What are the parameters on which wear load depends?

[1]

ped. of pin, ratio factor, face width  
hardness factor

**Question 5**

What type of gears are used when the axis of shafts are intersecting?

[1/2]

Bevel gears

**Question 6**

If static tooth load and dynamic tooth load are 10 kN and 20 kN, is the design safe? [1/2]

$$W_S = 10 \text{ kN} ; W_D = 20 \text{ kN}$$

$\therefore W_S < W_D$ , design is not safe.

**Question 7**

What is the assumption made by Lewis equation in designing a gear?

[1/2]

each tooth is treated as CL.

**Question 8**

If the wear tooth load, static tooth load and incremental load are 50 kN, 20 kN and 5 kN respectively, check whether the design is safe or not? The gear is subjected to a tangential load of 4 kN.

[1/2]

$$W_W = 50 \text{ kN} \quad W_S = 20 \text{ kN} , W_I = 5 \text{ kN}$$

$$W_T = 4 \text{ kN}$$

$$W_D = 4 + 5 = 9 \text{ kN}$$

$\therefore W_S > W_D$   ~~$W_W > W_D$~~ , design is safe

**Question 9**

Mention the parameters on which beam strength does depend?

[1/2]

endurance limit, geometry, surface finish &  
stress factor

**Question 10**

Define diametral pitch and circular pitch of a gear

[1/2]

$$\begin{array}{l} \text{Diametral pitch } P_d = T/D \\ \text{Circular pitch } p_c = \pi m = \frac{\pi D}{T} \end{array} \left| \begin{array}{l} D = p_c D \\ T = \pi D / p_c \end{array} \right.$$

**Question 11**

What is the significance of Lewis equation?

[1/2]

Used to calculate  $W_T$ .

**Question 12**

Mention the reasons for the Barth formula in designing a gear

[1/2]

Dynamic effects & surface finish.