

BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
IV Year MECH
ME UC451 MECHANICAL EQUIPMENT DESIGN
II SEMESTER 2007-2008

Comprehensive Examination

Max. Marks: 40

Duration: 3 Hrs.

Date: 28-05-2008

- Answer all questions.
 - Marks are shown in brackets against each question.
- Draw suitable sketches, wherever necessary.
-

Question 1

A reciprocating compressor is to be connected to an electric motor with the use of spur gears. The distance between the shafts is to be 500 mm. The speed of electric motor is 900 rpm and that of compressor shaft is 200 rpm. The torque to be transmitted is 5 kNm. Taking the starting torque as 25% more than the normal torque, determine

- (a) the module and face width of gears using 20° stub teeth and
- (b) number of teeth and pitch circle diameter of each gear.

The allowable static stresses for cast steel gear attached to the compressor shaft is 140 MPa and for forged steel pinion, attached to the motor shaft is 245 MPa. Take velocity Factor, $C_v = 3/(3 + v)$, $v =$ pitch line velocity in m/s.

Tooth form factor for 20° stub teeth, $y = 0.175 - 0.841/T$, $T =$ Number of teeth and face Width, $b = 10$ times module in mm. **[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 21 and 26 respectively. The pressure angle is 20°. The pinion shaft is connected to an electric motor developing 5 kW rated power at 1440 rpm. The pinion and gear are made of steel for which ultimate tensile stress is 600 N/mm². The form factor, module and face width are 0.35, 4 mm and 20 mm respectively. Determine the beam strength and static load. **[6M]**

Question 3

A pair of worm and 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°. Determine the components of gear tooth force acting on worm and worm wheel. **[6M]**

Question 4

A ball bearing, subjected to a radial load of 5 kN and expected to have a life of 8000 hrs at 1450 rpm with a reliability of 99%. Calculate the dynamic load capacity of the bearing so that it can be selected from the manufacturer's catalogue based on a reliability of 90%. **[6M]**

Question 5

A high pressure cylinder consists of 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 shrinkage process in such a way that the maximum principal stress induced in any tube is limited to 100 N/mm^2 . Plot the distribution of stresses due to shrink fit in both the jacket and inner tube. [8M]

Question 6

A solid circular shaft of diameter 0.1 m is subjected to a bending moment of 15 kNm. Determine the required torque to cause yield based on the five major theories of failure.

$$\sigma_{yp} = 300 \text{ MPa}; \quad \nu = 0.3$$

[6M]

**BITS-PILANI, DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2007-2008**

T E S T II (OPEN BOOK)

ME UC 451 MECHANICAL EQUIPMENT DESIGN

Date: 11-05-2008

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 are only allowed.

Question 1

A high pressure vessel consists of a steel tube with inner and outer diameters of 22 mm and 42 mm respectively. It is jacketed by an outer steel tube with an outer diameter of 64 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 2

A cast iron pipe used in hydraulic circuit is subjected to an internal pressure of 46 MPa. The inner and outer diameters of the pipe are 27 mm and 47 mm respectively. Plot the distribution of principal stresses across the pipe thickness. **[8M]**

Question 3

The stresses induced at a critical point in a machine component made of steel, for which yield stress is 380 N/mm^2 are normal stresses : 100 N/mm^2 , 40 N/mm^2 and shear stress is 80 N/mm^2 . Calculate factor of safety using maximum normal stress and maximum shear stress theories of failure. **[4M]**

**BITS-PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2007-2008**

**T E S T I
ME UC451MECHANICAL EQUIPMENT DESIGN**

Date: 30-03-2008

Time: 50 minutes

Marks: 25

Weightage: 25%

Note: 1. Answer all questions

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

3. Assume the data suitably if necessary.

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 for both the gear and pinion materials is 60 MPa and face width is 10 times the module. Find the module, face width and number of teeth on each gear.

$$\text{Lewis form factor} = 0.154 - 0.912/T$$

$$\text{Velocity factor} = 3/(3 + v)$$

$$\text{Service factor} = 1.0$$

[9M]

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. **[5M]**

Question 3

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 reference diameters and tangential forces on both the worm and wheel if the efficiency of drive is 80%. **[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? **[5M]**