

**COMPREHENSIVE EXAMINATION**

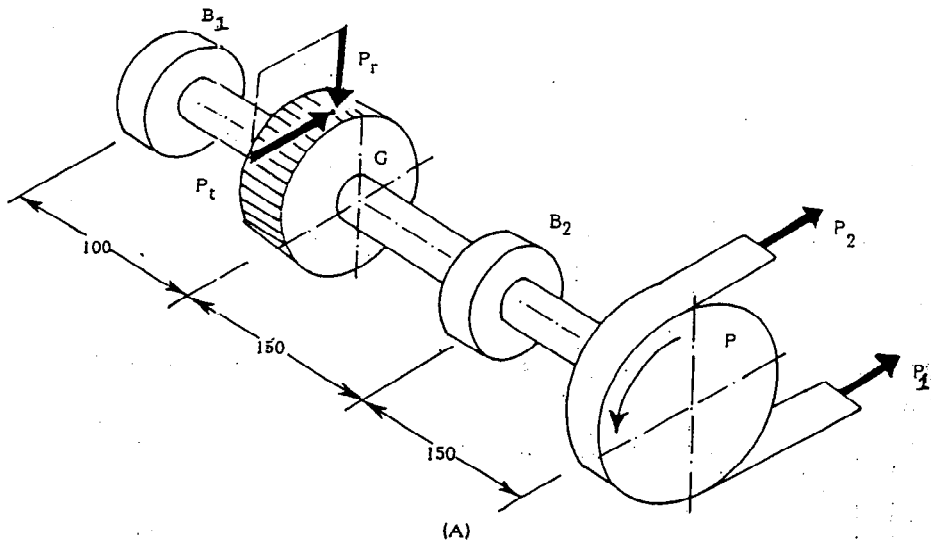
DATE: 25-12-06

DURATION: 3hrs MAXIMUM MARKS: 40 WEIGHTAGE: 40%

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1. a. Explain the reliability and uncertainty with respect to the design process 2
- b. A transmission shaft made of steel ( $S_{ut}=440 \text{ N/mm}^2$ ) is subjected to reversed torsional moment. The shaft diameter is 30 mm and the expected reliability is 95%. There is a step in the shaft at which the theoretical stress concentration factor is 1.8 while the notch sensitivity factor is 0.86. Determine the endurance limit for reversed torsional moment using the distortion energy theory. For the given data the surface finish factor, the size factor and the reliability factor may be taken as 0.82, 0.85 and 0.868 respectively. 4
2. A semi elliptic spring used for automobile suspension consists of two extra full length leaves and eight graduated –length leaves including the master leaf. The centre to centre distance between the two eyes is 1m. The maximum force acting on the spring is 10kN and the width of each leaf is 50 mm. The spring is initially preloaded in such a way that when the load is maximum the stresses induced in all the leaves are equal to  $350 \text{ N/mm}^2$ . The modulus of elasticity of the spring material is  $207000 \text{ N/mm}^2$ . Determine the thickness of the leaves and deflection of the spring at the maximum load. 5
3. A transmission shaft rotating at 720rpm and transmitting power from pulley P to spur gear G is shown in the figure1. The belt tensions and gear tooth forces are as follows.  
 $P_1=498 \text{ N}$  ,  $P_2=166 \text{ N}$        $P_t = 497 \text{ N}$        $P_r = 181 \text{ N}$
- The weight of the pulley is 100N. The diameter of the shaft at the bearings B1 and B2 is 10mm and 20mm respectively. The load factor is 2.5 and the expected life for 90% of the bearings is 8000hrs. Calculate the dynamic load capacity and select a suitable single row deep groove ball bearings at B1 and B2. The following bearings are available for 10mm and 20mm shaft dia.
- |                     |                     |
|---------------------|---------------------|
| For 10 mm dia       | For 20mm dia        |
| No 61800 - (C=1480) | No 6304 - (C=15900) |
| No 6000 - (C=4620)  | No 6404 - (C=30700) |

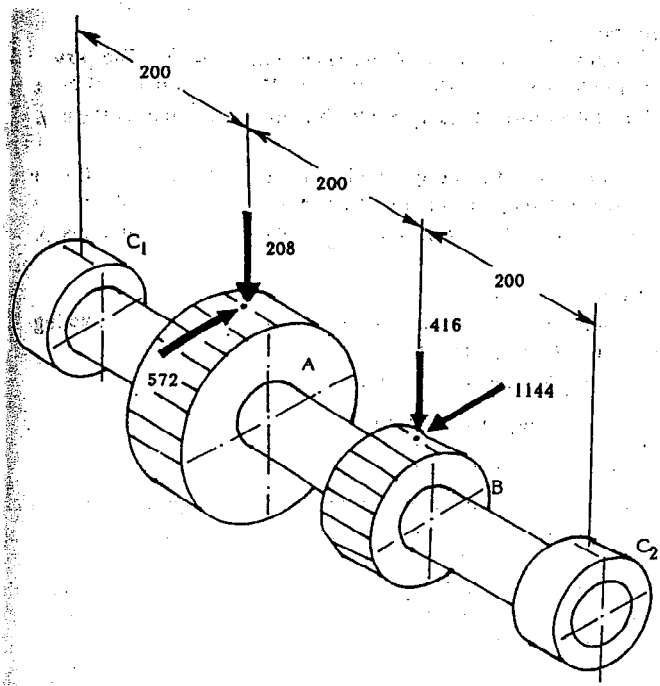
Figure 1



4. An intermediate shaft of a gearbox supporting two gears A and B and mounted between two bearings C1 and C2 is shown in the figure 2. The pitch circle diameters of gears A and B are 500 and 250mm respectively. The shaft is made of alloy steel with  $S_{ut} = 620 \text{ N/mm}^2$  and  $S_{yt} = 480 \text{ N/mm}^2$ . The factors  $K_b$  and  $K_t$  of the ASME code are 2 and 1.5 respectively. The gears are keyed to the shaft. Determine the shaft diameter using the ASME code. If the permissible angle of twist for the shaft is  $0.25^\circ$  per meter length and modulus of rigidity is  $79300 \text{ N/mm}^2$ . Determine the shaft diameter on the basis of torsional rigidity.

7

Figure2



5. A 70 mm diameter solid steel shaft, used as a torque transmitter is replaced with a 70 mm hollow shaft having 6 mm wall thickness. If both materials are subjected to same torque, what is the ratio of maximum shear stress induced in solid and hollow shafts?

2

6. A 10 x 50 mm cold drawn steel bar shown in Fig. Q6 is cantilevered to support a static load of 1350 N. The bar is secured to support using two bolts having a major diameter of 12 mm. Find the maximum load on each bolt.

3

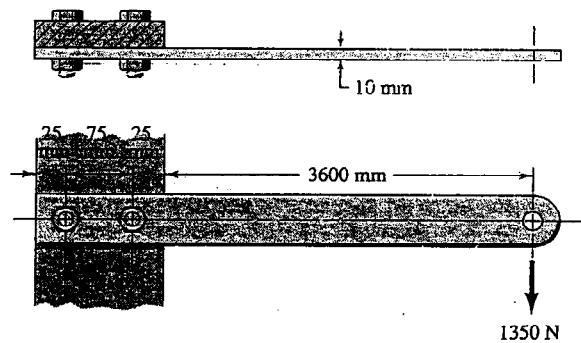


Fig. Q6

7. The gears shown in the Fig. Q7 have a module of 12 mm and a  $20^\circ$  pressure angle. The pinion rotates at 30 rev/s clockwise and transmits 150 kW through the idler pair to gear 5 on shaft c. The Lewis Form Factor (Y) for 18T pinion 2 is 0.309. Assume that the pinion face width is five times the circular pitch. Calculate the forces which act upon the pinion 2. Estimate the bending stress on the pinion 2 teeth.

3

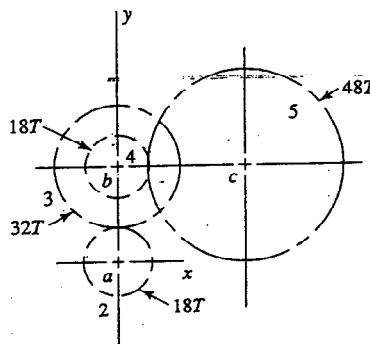


Fig. Q7

8. The brake shown in Fig. Q8 is 300 mm in diameter and is actuated by a mechanism that exerts the same force  $F$  on each shoe. The shoes are identical and have a face width of 40 mm. The lining is a molded asbestos having a coefficient of friction of 0.35 and pressure limitation of 1200 kPa. Estimate the braking torque applied by the right hand shoe.

3

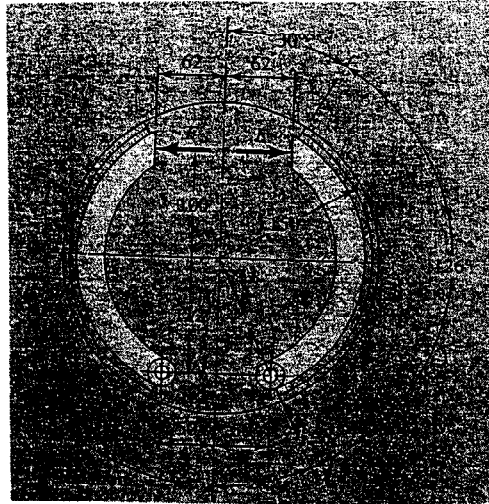


Fig. Q8

9. A plate clutch has a single pair of mating surfaces of 300 mm outer diameter by 225 mm inner diameter. The mean value of coefficient of friction is 0.25 and the actuating force is 5 kN. Find the maximum pressure and torque capacity using uniform-pressure model.

2

10. A flat belt of 200 mm width and 10 mm thickness is used to transmit 10 kW under light shock conditions as shown in Fig. Q10. The pulley rotational axes are parallel and in the horizontal plane. The shafts are 2440 mm apart. The 150 mm driving pulley rotates at 29.17 rev/s in such a way that loose side is on top. The driven pulley is 450 mm in diameter. The weight density of belt is  $9450 \text{ N/m}^3$ . Estimate the centrifugal tension.

2

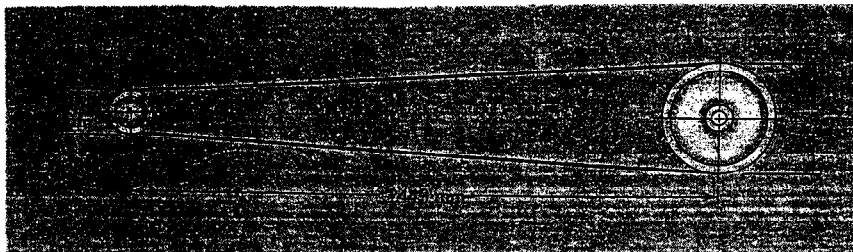


Fig. Q10

**B**

**BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI  
FIRST SEMESTER 2006-2007**

**ME UC312 DESIGN OF MACHINE ELEMENTS**

**QUIZ 2**

**DATE: 23-11-06**

**DURATION: 30 MINUTES    MAXIMUM MARKS: 10    WEIGHTAGE: 10%**

Name of the student: -----

I.D.: -----

**Answers**

(Write either a,b,c or d in the space provided. Change of answer and overwriting is not permitted, so be sure before entering your answer)

1	2	3	4	5	6	7	8	9	10

1. When the work cycle is divided in to number of elements and  $P_1, P_2, P_3$  etc are the loads and  $N_1, N_2, N_3$  are the speeds during these elements, the equivalent dynamic load in case of ball bearings subjected to cyclic loads and speeds is

a. 
$$\left[ \frac{N_1 P_1^3 + N_2 P_2^3 + \dots}{N_1 + N_2 + \dots} \right]^{1/2}$$

b. 
$$\left[ \frac{N_1^3 P_1 + N_2^3 P_2 + \dots}{N_1 + N_2 + \dots} \right]^{1/3}$$

c. 
$$\left[ \frac{N_1^3 P_1 + N_2^3 P_2 + \dots}{N_1 + N_2 + \dots} \right]^{1/2}$$

d. 
$$\left[ \frac{N_1 P_1^3 + N_2 P_2^3 + \dots}{N_1 + N_2 + \dots} \right]^{1/3}$$

2. A square thread power screw has a pitch of 4 mm with double threads. The given data include  $F=10$  kN per screw. The torque required to turn the screw against the load is 30 Nm. The overall efficiency in raising the load is

a. 0.545

b. 0.311

c. 0.424

d. 0.9

3. Steel members are clamped using M12 steel bolt. The bolt and member stiffnesses are computed as  $K_b=1$  MN/mm (for bolt) and  $K_m=1.5$  MN/mm (for members) respectively. The bolt is subjected to a preload ( $F_i$ ) of 100 kN. The bolted connection is subjected to an external tensile load ( $P$ ) of 30 kN. The resultant bolt load is

a. 112 kN

b. 88 kN

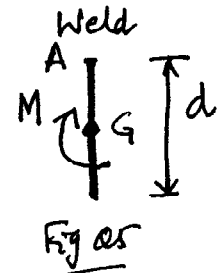
c. 118 kN

d. None of these

4. The shear reaction (V) and moment reaction (M) about the centroid of group of four bolts are  $V=12$  kN and  $M=2000$  Nm respectively. The distance from the centroid to the center of each bolt is 100 mm. The primary and secondary shear force per bolt is
- a. 5 kN and 5 kN      b. 3 kN and 5 kN      c. 3 kN and 3 kN      d. None of these

5. The secondary shear stress at the point A for the weld shown in Fig. Q5 is \_\_\_\_\_, where h is the weld size.

- a.  $M \times 0.5d / (0.707hd^3/12)$       b.  $M \times 0.5d / (0.707h^2d^2/12)$   
 c.  $M \times 0.5d / (0.707h^3d/12)$       d. None of these



6. The axial deflection of the helical coil spring is given by (with standard notations)

- a.  $\frac{8PD^3N}{Gd^4}$       b.  $\frac{8KPD}{\pi d^3}$       c.  $\frac{16PD^3N}{Gd^4}$       d.  $\frac{16KPD}{\pi d^3}$

7. In semi-elliptic multi leaf springs the bending stresses in full length leaves are ----- than those in graduated length leaves.

- a. 50 % less      b. 75% less      c. 75% more      d. 50%more

8. The initial gap between the extra full length leaf and graduated length leaf before assembly is called

- a. zip      b. nip      c. tip      d. hip

9. The type of bearing recommended for application in which misalignment between the axes of the shaft and housing is likely to exist.

- a. deep groove ball bearing      b. spherical roller bearings      c. thrust ball bearings  
 d. angular contact bearings

10. The expected life in million revolutions for a ball bearing with dynamic load capacity of 6000N and equivalent dynamic load of 3000N is

- a. 4      b. 16      c. 8      d. 14.13



BITS, PILANI-DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI  
FIRST SEMESTER 2006-2007

ME UC312 DESIGN OF MACHINE ELEMENTS

**QUIZ 1**

DATE: 12-10-06

DURATION: 30 MINUTES    MAXIMUM MARKS: 10    WEIGHTAGE: 10%

Name of the student: -----

I.D.: -----

**Answers**

(Write either a,b,c or d in the space provided. Change of answer and overwriting is not permitted, so be sure before entering your answer)

1	2	3	4	5	6	7	8	9	10

- Identify the one which is not a CAD Software package
  - Unigraphics
  - Pro Engineer
  - Aries
  - Excel spread sheet
- In the SAE published Unified Numbering System G10 means
  - Plain carbon steel
  - Nickel steel
  - Manganese steel
  - Chromium steel
- The carbon content of the Grey cast iron is
  - less than 0.3%
  - 0.4 to 0.8%
  - 0.9 to 1.5%
  - more than 1.7%
- A solid round shaft is supported by self aligning bearings at the ends. Mounted upon the shaft are a V-belt sheave and a gear. The maximum bending moment for this shaft is found to be 200 Nm. The diameter for this shaft is \_\_\_\_\_, if the bending stress is not to exceed 100 MPa.
  - 29.3 mm
  - 31.3 mm
  - 27.3 mm
  - None of the above

5. Assume a bar of length  $l$ , loaded by a force  $P$  acting along the centroidal axis. The specific Euler equation for the column having round cross section of diameter  $d$  is \_\_\_\_\_. The factor  $C$  is end-condition constant.

a.  $d = \left( \frac{64P_{cr}l^2}{\pi^3CE} \right)^{\frac{1}{4}}$     b.  $d = \left( \frac{16P_{cr}l^2}{\pi^3CE} \right)^{\frac{1}{4}}$     c.  $d = \left( \frac{32P_{cr}l^2}{\pi^3CE} \right)^{\frac{1}{4}}$     d. None of the above

6. The failure of six parts out of every thousand manufactured represents a reliability of  
 a. 99.4%                      b. 0.6%                      c. 94%                      d. 6%

7. Find out the incorrect statement

- a. For ductile materials maximum stress reached in the simple stress-strain diagram is greater than the stress at the fracture  
 b. In the engineering stress strain diagrams the actual stress values never decreases  
 c. The engineering stress is calculated based on the original cross sectional area of the specimen  
 d. Brittle materials do not exhibit definite plastic deformations.

8. For static loading conditions, the theory of failure used for the brittle materials is

- a. Maximum shear stress theory                      b. Maximum strain energy theory  
 c. Maximum normal stress theory                      d. Distortion energy theory

9. Identify the wrong expression ( $K_f$  = Fatigue stress concentration factor,  $K_t$  = Theoretical stress concentration factor,  $q$  = Notch sensitivity factor)

- a.  $K_t = 1 + q (K_f - 1)$                       b.  $K_f = 1 + q (K_t - 1)$   
 c.  $K_f = 1 + K_t (q - 1)$                       d.  $K_t = 1 + K_f (q - 1)$

10. In a typical fatigue loading condition the values of  $\sigma_{max} = 200$  and  $\sigma_{min} = 100$ , the values of mean stress and the stress amplitude ( $\sigma_{mean}, \sigma_a$ ) are given by

- a. 150, 100                      b. 150, 50                      c. 50, 150                      d. 100, 150