

BITS, PILANI-DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2008-2009
TEST-1

Component: Closed Book Test

Date: 05-10-08

Course Name: Design of Machine Elements

MAX MARKS: 25

Course No. : ME C312

WEIGHTAGE: 25%

Nature of Component: Closed Book

Duration: 50 Minutes

- NOTE:
- i) Write your ID Number on the top immediately on the receipt of this paper.
 - ii) Attempt all the questions.
 - iii) If any data is missing, assume suitable value.
 - iv) Use the tables & charts, enclosed herewith, wherever necessary.
 - v) No data table & charts are allowed in the examination hall.

Q.1

- (a) Define the Engineering Design and write the different design consideration. (Marks=2)
- (b) Explain the Miner's damage rule. (Marks=2)
- (c) Define the following terms related to screw fastenings:
 - (i) Endurance limit
 - (ii) Notch sensitivity(Marks:1+1= 2)

Q.2

- (a) A steel specimen shown in figure -1, used by SAE laboratory to performed standard tension test on UTM for evaluating several mechanical properties.

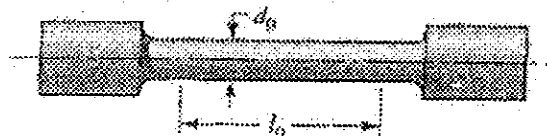


Figure-1

The dimensions of the specimen and observations made during the test are described below.

(Marks: 1.5X8=6)

- Diameter of the specimen $d_0 = 12.5$ mm
- Gauge length $l_0 = 62.5$ mm
- Load at upper yield point = 42.5 KN
- Load at lower yield point = 41.0 KN
- Maximum load = 72.5 KN
- Fracture load = 51.25 KN
- Gauge length at fracture = 80.5 mm
- Diameter of fracture section = 9.5 mm
- Strain at a load of 20 KN = 7.764×10^{-6} mm/mm.

Determine the numerical values of the following & explain them on stress strain diagram:

- (i) The yield strength
- (ii) The Ultimate Strength
- (iii) Modulus of toughness
- (iv) Modulus of resilience

(b) A solid circular shaft is subjected to bending moment of X KN-m & a torque of Y KN-m. Design the diameter of the shaft according to (Marks:6)

- Maximum Principal Stress theory.
- Maximum shear stress theory.
- Maximum strain Energy theory.

Take Value of X = Year of your date of birth -1947
 Value of Y = (Year of your date of birth -1947)/4
 FOS = 2.0
 μ = 0.25

- Q.3** A beam of circular section reduces in dia. from 100 mm to 90 mm over a transition radius of 5.0 mm shown in figure-1. The beam is subjected to a bending moment which fluctuates between M_{\min} 1 kN-m to $M_{\max} = 3$ kN-m. If beam is made in steel with following properties $S_u = 480$ MPa, $S'_e = 210$ MPa, show if beam is safe or not. Assume beam is ground & working temperature is 45 °C.

(Marks: 7)

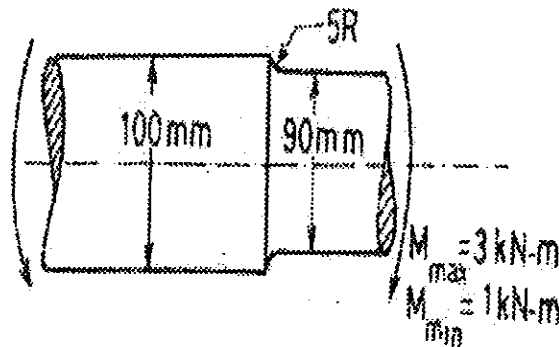


Figure-1

Assume following:

F or Surface Modification Factor	$a = 1.58$ & $b = 0.086$
Size Modification factor	$K_b = 0.85$
Temperature Modification factor	$K_d = 1$
Miscellaneous Effect Modification factor K_e	$= 1/K_f$

**BITS, PILANI-DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2008-2009**

OPEN BOOK TEST-2

Course Name: Design of Machine Elements
Course No. : ME C312
Duration : 50 Min.

Max Marks: 40
Weightage: 20%
Date: 16-11-2008

- NOTE:**
- Attempt all the questions.
 - Only Text Book & hand written class notes are allowed in the examination hall.
 - If any data is missing, assume the suitable value with proper justification.
 - Description of symbols & notations is necessary for formulae used.

Q.1

- (a) Describe the bolt of uniform strength with suitable sketch. **(Marks: 3)**
- (b) A single fillet shown in figure subjected by tensile force P through the centre of the throat. Develop the following relations:
Principal Stress $\sigma_1 = 3.414 P/hL$
Principal Stress $\sigma_2 = 0.586P/hL$
Maximum shear Stress $\tau_{max} = 1.414 P/hL$ **(Marks: 3+3+4=10)**

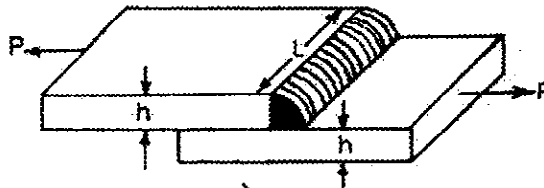


Figure-1

Q.2

- (a) Select the appropriate type of rolling contact bearing under the following condition of loading. Give the reason for your choice. **(Marks: 2+2)**
- Light Radial Load with high rotational speed.
 - Heavy axial and radial load with shock
- (b) A water cooled bearing having the following dimensions has operated at 600 rev/min under 9000N load with automobile oil for a number of years without any trouble. The viscosity of this oil at the oil temperature of 50 °C is 0.05 Kg/ms.
Journal diameter = 50 mm. **(Marks:5+5)**
Bearing Length = 80 mm.
Radial Clearance = 0.025 mm.
It is proposed to use bearings of this design in several new machines which are under design.
- What changes do you recommend if new machine operates at 300 rev/min?
 - What changes do you recommend if new machine operates under 18KN?

Q.3

- (a) What is the spring Surge? How we can avoid it? **(Marks:3)**
- (b) A close coiled helical spring is of 80 mm mean coil diameter. The spring extends by 37.75 mm when loaded axially by a weight of 500N. There is an angular rotation of 45° when this spring is subjected to an axial couple of magnitude 20 N.m. Determine the poisson's ratio for the material of the spring. **(Marks: 10)**

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BITS, PILANI-DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2008-2009
ME C 312 DESIGN OF MACHINE ELEMENTS (QUIZ-I)

MAX MARKS: 15
DURATION: 15 MINUTES

WEIGHTAGE: 5%
DATE: 24-09-2008

NAME OF STUDENT: _____ I.D: _____

NOTES: i) Change of answer & overwriting is not permitted.
 ii) If any one found in signal nodding or any form of cheating, his copy
 will be marked by # and then forwarded to discipline committee for further
 action.

Q.1. What is the Radius of Mohr's Circle for Biaxial system? (Marks: 2)

Ans:

Q.2 If hole of diameter 'd' is punched in a metal of thickness 't' then what force is required to punch a hole? (Marks: 2)

Ans:

Q.3. what are critical temperatures in Iron-Carbon Diagram? (Marks: 1)

Ans:

Q.4. What is the relation between E, G & K for homogenous, isotropic & elastic material?

Ans: (Marks: 2)

Q.5 Describe the state of stress at any point in the cross-section of a prismatic bar subjected to axial load P along X-axis, having cross-sectional area of the bar as A.

Ans: (Marks: 2)

Q.6 What is the neutral axis of a beam? (Marks: 1)

Ans:

Q.7 What is approximate value of modulus of elasticity for mild steel? (Marks: 1)

Ans:

Q.8 The original angle of 90 square changes to $90+\gamma$, what is the shearing strain is?

Ans:

(Marks: 2)

Q.9 What is the most important design consideration is?

Ans:

(Marks: 1)

Q.10 What are the Title & the Author of the text book for the course MEC 312? (Marks: 1)

Ans:

ESM

BITS, PILANI-DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2008-2009
ME C 312 DESIGN OF MACHINE ELEMENTS (QUIZ-II)

MAX MARKS: 10
DURATION: 15 MINUTES

WEIGHTAGE: 5%
DATE: 29-10-2008

NAME OF STUDENT: _____

I.D: _____

- NOTES:
- i) Change of answer & overwriting is not permitted.
 - ii) If any one found in signal nodding or any form of cheating, his copy will be marked by # and then forwarded to discipline committee for further action.
-
- iii) A Knuckle joint is subjected by tensile loading along the axis of the rods, Use the following notations for the description of joint,
- P = tensile force acting on rods (N)
 - D = diameter of each rod (mm).
 - D1 = enlarged diameter of each rod (mm).
 - d = diameter of knuckle pin (mm).
 - d0 = outside diameter of eye or fork (mm).
 - a = thickness of each eye of fork (mm).
 - b = thickness of eye end of rod-B (mm).
 - d1 = diameter of pin head (mm).
 - x = distance of the centre of fork radius R from the eye (mm).
-

Q.1. which type of load can not be transmitted by knuckle joint? (Marks: 0.5)

Ans:

Q.2. Propose the suitable material for the Pin? (Marks: 0.5)

Ans:

Q.3. Which part of the knuckle joint will be subjected by bending? (Marks: 0.5)

Ans:

Q.4. Which part of the knuckle joint will be subjected by tensile stresses? (Marks: 0.5)

Ans:

Q.5. If yield strength in crushing = n (yield strength in tension). What is the value of n ?
(Marks: 0.5)

Ans:

Q.6. Which two parts of steam engine are connected by knuckle joint ? (Marks: 0.5)

Ans:

Q.7. Write the strength equation for the tensile failure of Fork? (Marks: 1)

Ans:

Q.8. What is the equation for resisting area during the shear failure of the eye? (Marks: 1)

Ans:

Q.9. Give the equation for calculating the 'd' diameter of the pin using bending into consideration? (Marks: 1)

Ans:

Q.10. Draw the resisting area during the crushing failure of the pin in eye ? (Marks: 1)

Ans:

Q.11. Draw the free body diagram of the pin? (Marks: 1)

Ans:

ESM

BITS, PILANI-DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2008-2009
ME C 312 DESIGN OF MACHINE ELEMENTS (QUIZ-3)

MAX MARKS: 10 DURATION: 15 MINUTES

WEIGHTAGE: 5%

NAME OF STUDENT: _____

I.D: _____

NOTES: i) Change of answer & overwriting is not permitted.
ii) If any one found in signal nodding or any form of cheating, his copy will be marked by # and then forwarded to discipline committee for further action.

Q.1 What is counter shaft? (Marks: 1)

Ans:

Q.2 What is the most preferable method of shaft manufacturing? (Marks: 1)

Ans:

Q.3 What is the of D.O.F for any structure? (Marks: 1)

Ans:

Q.4 "Shafts are designed on the basis of rigidity". This statement is true or false? (Marks: 1)

Ans:

Q.5 A shaft is subjected is torsion only, Draw its shear stress variation along the radius. (Marks: 1)

Ans:

Q.6 What will be the D.O.F for a cylinder laying on a plane? (Marks: 1)

Ans:

Q.7 Two shaft A & B are of the same length & material. If the diameter of the shaft A is three times of shaft B, what will be the ratio torsional stiffness of shaft A & B.

(Marks: 4.)

**BITS PILANI-DUBAI, INTERNATIONAL ACADEMIC CITY, DUBAI
FIRST SEMESTER 2008-2009**

COMPREHENSIVE EXAMINATION

Course Name: Design of Machine Elements
Course No. : ME C312

Max Marks: 80
Weightage: 40%

Duration : 3 Hours

Date: 04-01-2009

- NOTE:**
- i) Write your ID Number on the top immediately on the receipt of this paper.
 - ii) Required values, tables & charts are given in the paper.
 - iii) Personal data table & charts are not allowed in the examination hall.
 - iv) If any data is missing, assume the suitable value with proper justification.
 - v) Description of symbols & notations is necessary for formulae used.
 - vi) *Attempt all the questions & maintain the order of questions in the answer script, as they appear in question paper.*

Q.1

- (a) Describe the phases of Design Process with a suitable flow process chart. (Marks:2)
- (b) In an I C engine cylinder head a hexagonal bolt is subjected to a direct load of 25 KN and shear load of 15 kN. The material of the bolt is C15 having 200 N/mm² yield strength. Take the f.o.s as 2, determine the size of the bolt, according to:
- i) Maximum Principal Stress theory.
 - ii) Maximum shear stress theory.
 - iii) Maximum strain Energy theory.

(Marks:2x3+2)

As a designer which theory of failure you will chose for bolt design & why?

Q.2

- (a) Describe the Greber's Parabola with its significance (Marks: 2)
- (b) In a material testing laboratory a test was performed for 1050 HR steel with the help of a rotating beam type fatigue testing machine. This steel specimen has mean ultimate tensile strength of 725 MPa & mean yield strength of 415 MPa. Determine:
- i) The rotating beam endurance limit.
 - ii) Endurance strength for a polished rotating-beam specimen corresponding to 10⁴ cycles to failure.
 - iii) The expected life under completely reversed stress of 380 MPa.

(Marks:2+3+3)

Q.3

- (a) What is the effect of Gasket on bolts? (Marks: 2)
- (b) An angle of size 200 mm x 150 mm x 10 mm is required to be welded to a steel plate by a fillet weld as shown in the figure-1. If the angle is subjected to a static load of 200 KN, determine the top and bottom weld lengths. The allowable shear strength for static loading may be taken as 75 N/mm². (Marks: 4+4)

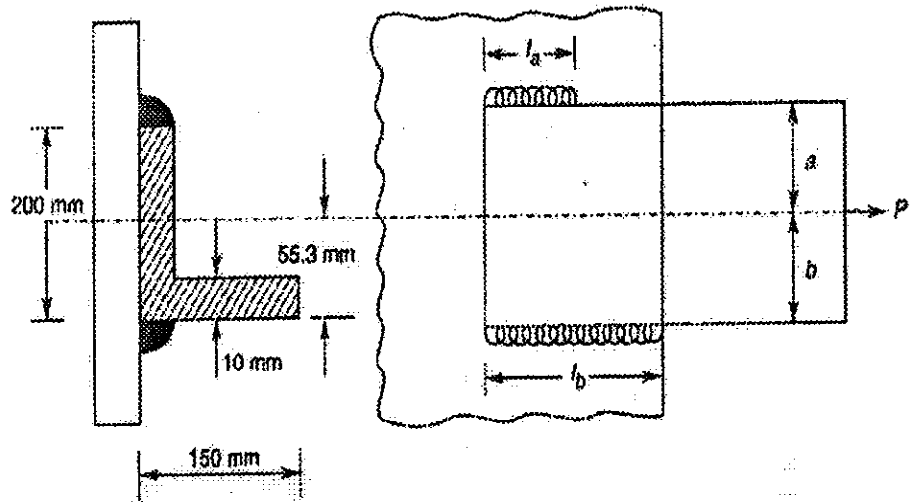


Figure-1

Q.4 A single plate clutch is to be designed for a vehicle. Both sides of the plate are to be effective. The clutch transmits 30 kW at a speed of 3000 r.p.m. and should cater for an over load of 20%. The intensity of pressure on the friction surface should not exceed 0.085 N/mm² and the surface speed at the mean radius should be limited to 2300 m /min. The outside diameter of the surfaces may be assumed as 1.3 times the inside diameter and the coefficient of friction for the surfaces may be taken as 0.3. If the axial thrust is to be provided by six springs of about 25 mm mean coil diameter, design the springs selecting wire from the standard wire gauge data.

SWG	4	5	6	7	8	9	10	11	12
Dia (mm)	5.893	5.385	4.877	4.470	4.064	3.658	3.251	2.946	2.642

Use the following:

Allowable Shear Stress for spring wire material = 420MPa.
 Modulus Of rigidity for spring wire material = 84 KN/mm²
 Active Number of coil in spring = 8
 Spring end condition is Square & ground

(Marks: 10)

what's K factor for spring index C

$$K = \frac{4C - 1}{4C - 4} + \frac{0.615}{C}$$

Q.5

(a) What are rolling contact bearing? Discuss their advantages over sliding contact bearings.

(Marks: 3)

(b) Derive Petroff's relation for power loss in a sliding contact bearing. Show that the effective coefficient of friction in the bearing is a function of $\mu N/P$, a non dimensional number. Using this relation discuss the stable & unstable lubrication.

(Marks: 7)

Q.6

- (a) Define the "coefficient of fluctuation of energy". (Marks: 2)
- (b) The layout of the leather belt drive transmitting 15 kw power is shown in Fig.-2. The centre distance between the pulleys is twice the diameter of the big pulley. The belt should operate at a velocity of 20 m/s approximately and the stresses in the belt should not exceed 2.25 N/mm². The density of leather is 0.95 gm/cc and the coefficient of friction is 0.35. The thickness of the belt is 5 mm. Calculate:
- i) The diameters of pulleys.
 - ii) The length and width of the belt.
 - iii) The belt tensions.
- (Marks:2+3+3)

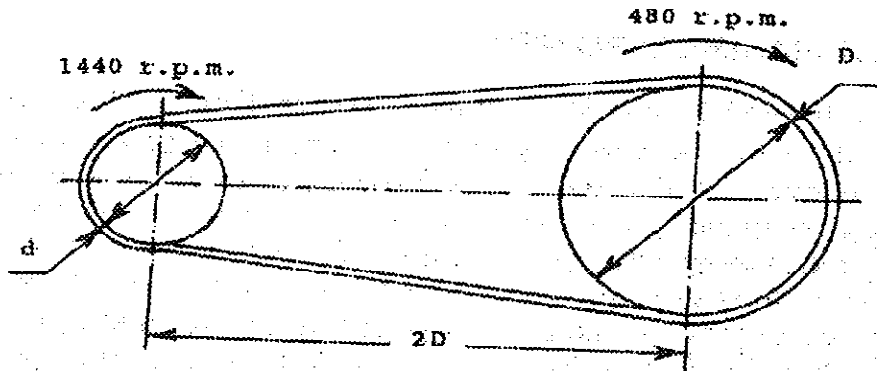


Figure-2

Q.7

- (a) What do you mean by beam strength of gear teeth? Derive the Lewis bending equation for helical gears. (Marks:5)
- (b) A pair of straight teeth spur gears is to transmit 20 kW when the pinion rotates at 300 r.p.m. The velocity ratio is 1: 3. The allowable stresses for the pinion and gear materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its face width is 14 times the module. Determine
- (i) Module (ii) Face width (iii) Pitch circle diameters of both the pinion and the gear.

Assume 20° involute full depth teeth & take the Lewis form factor as

$$Y = \left(0.154 - \frac{0.192}{Z} \right)$$

The velocity factor C_v & Service factor C_s can be taken as under

$$C_v = \frac{3}{3 + v}$$

$$C_s = 1$$

Face width can be taken as $b=14$ module & v is in m/sec

(Marks:2+1+2)

Q.8

- (a) Explain the following with reference to spur gears:
 i) Pressure Angle
 ii) Interference

(Marks:3)

- (b) The layout of an intermediate shaft of a gear box supporting two spur gears B and C is shown in Fig.3. The shaft is mounted on two bearing A and D. The pitch circle diameters of gears B and C are 900 and 600 mm respectively. The material of the shaft is steel C 580 ($S_{ut} = 770$ and 580 N/mm^2). The factors k_b and k_s of A.S.M.E. code are 1.5 and 2.0 respectively. Determine the shaft diameter using the A.S.M.E. code. Assume that the gears are keyed to the shaft. (Marks: 7)

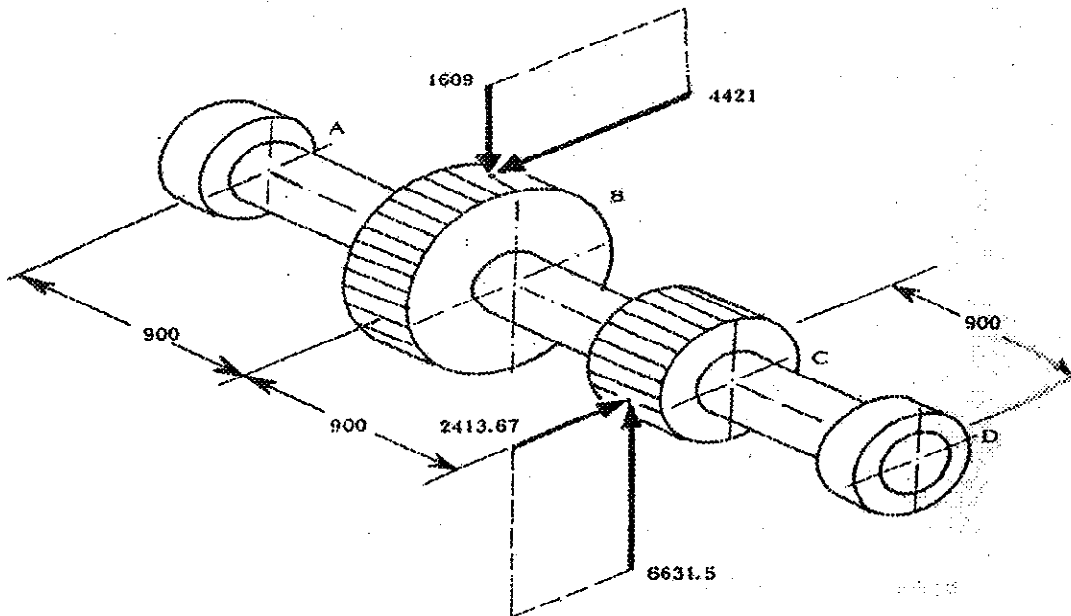


Figure-3

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