

BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
III Year I Semester: 2011 - 2012
Course: ME C312 Design of Machine Elements
Comprehensive Examination

Max.Marks: 40
Weightage: 80 %

Mechanical

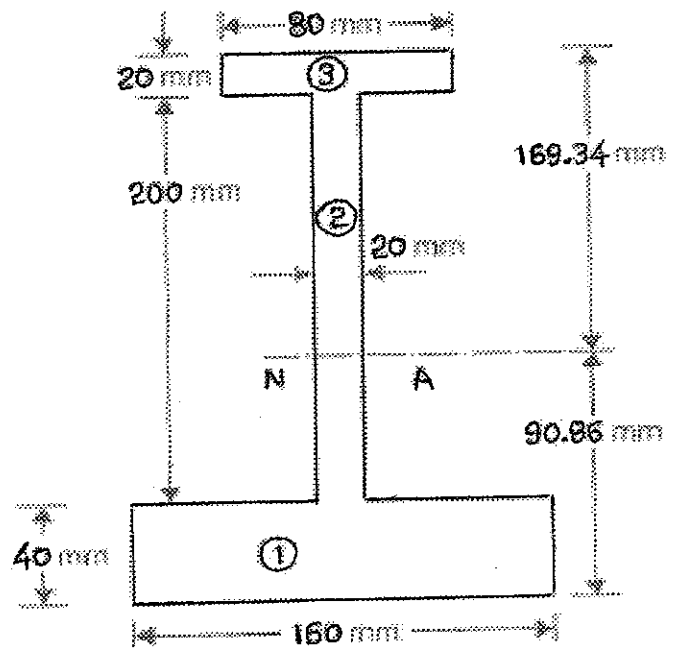
Date: 07-01-2012
Time: 3 hours

Note: **Notes::** (i) Answer all the questions (ii) Draw neat sketches wherever necessary
 (iii) Make suitable assumptions if required and clearly state them
 (iv) Charts and tables [Data Booklet will be permitted]

Q.1. A thin mild steel sheet is pulled in its own plane so that the stress components with respect to XY axes are as given below: Draw the Mohr's circle, find the principle stresses and directions, and show these on a stress element correctly aligned with respect to the xy coordinates. Draw another stress element to show τ_1 and τ_2 , find the corresponding normal stresses, and label the drawing completely.

$\sigma_x = 9 \text{ Mpa}$ $\sigma_y = -6 \text{ Mpa}$ $\tau_{xy} = 3 \text{ Mpa}$ c w [10 M]

Q.2. The cast-iron beam is subjected to bending has a cross section of I-Shape with unequal flanges as shown in Fig.1. If the maximum bending moment on the section is 21 MN mm, determine the maximum compressive stress on the top of the beam from the neutral axis.



[9 M]

Fig.1

- Q.3. The cold-drawn AISI 1040 steel bar shown in the figure 2 is subjected to a completely reversed axial load fluctuating between 28 kN in compression to 28kN in tension. Estimate the fatigue factor of safety based on achieving infinite life, and the yielding factor of safety. If infinite life is not predicted give justification and estimate the number of cycle to failure. [10M]

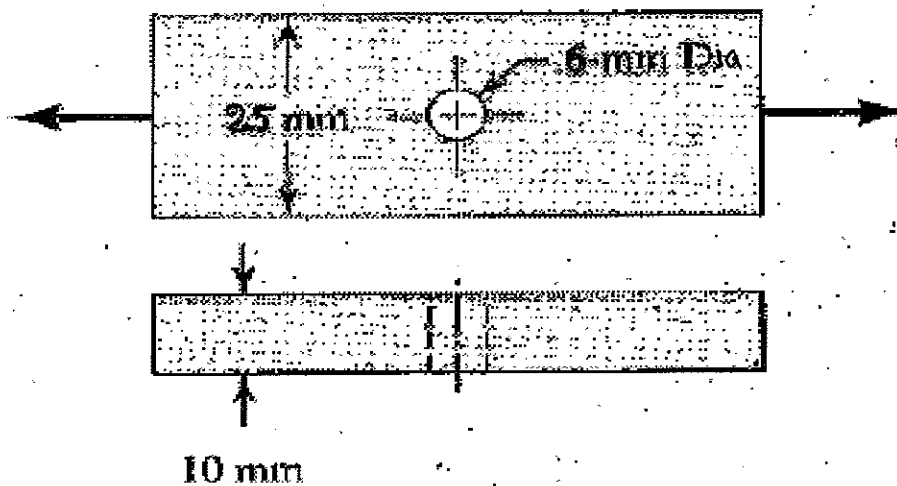


Fig.2

- Q.4. A shaft is loaded in bending and torsion such that $M_a = 70$ N-m, $T_a = 45$ N-m, $M_m = 55$ N-m and $T_m = 35$ N-m. For the shaft, $S_u = 700$ Mpa and $S_y = 560$ Mpa, and a fully corrected endurance limit of $S_e = 210$ Mpa is assumed. Let $K_f = 2.2$ and $k_{fs} = 1.8$, with design factor of 2.0. Determine the minimum acceptable diameter of the shaft using the (a) DE-Gerber criterion (b) DE-Elliptic criterion [8 M]
- Q.5. The figure 3 shows a cast-iron bearing block that is to be bolted to a steel ceiling joist and is to support a gravity load of 18 kN. Bolts used are M24 ISO 8.8 with coarse threads and with 4.6 mm thick steel washers under the bolt head and nut. The joist flanges are 20 mm in thickness, and the dimension A, shown in the figure is 20 mm.
- (a) Find the wrench torque required if the fasteners are lubricated during assembly and the joint is to be permanent.

- (b) Determine the factors of safety guarding against yielding, overload and joint separation. [10M]

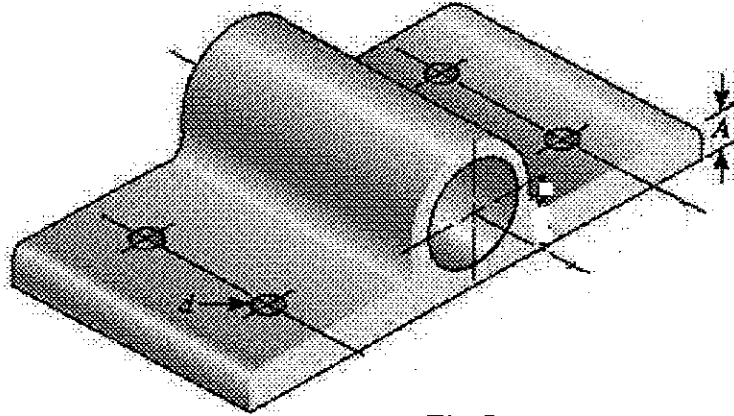


Fig.3

Take: Washers: $t = 4.6 \text{ mm}$, $d = 24 \text{ mm}$, $D = 36 \text{ mm}$, $E = 207 \text{ Gpa}$

Cast-Iron bearing block: $t = 20 \text{ mm}$, $d = 24 \text{ mm}$, $D = 41.31 \text{ mm}$, $E = 135 \text{ Gpa}$

Steel ceiling joist = $t = 20 \text{ mm}$, $d = 24 \text{ mm}$, $D = 41.31 \text{ mm}$, $E = 207 \text{ Gpa}$

Bolt: $l = 49.2 \text{ mm}$, $d = 24 \text{ mm}$

- Q.6. A steel bar of the thickness h , to be used as a beam, is welded to a vertical support by two fillet welds as shown in the figure 4. Take: $b = 50 \text{ mm}$, $c = 150 \text{ mm}$, $d = 30 \text{ mm}$, $h = 5 \text{ mm}$ Find the safe bending force F if the allowable shear stress in the welds $\tau_{\text{allow}} = 140 \text{ Mpa}$ [10M]

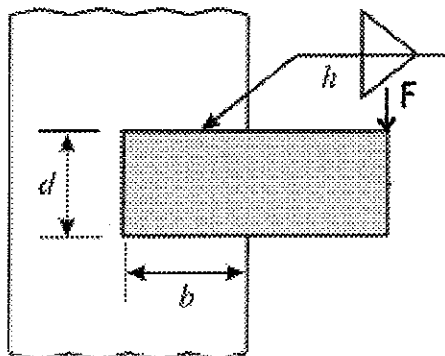


Fig.4

Q.7. A helical compression spring is to be made of oil-tempered wire of 4 mm diameter with a spring index of $C = 10$. The spring is to operate inside a hole, so buckling is not a problem and the **ends can be left plain**. The free length of the spring should be **80 mm**. A force of **50 N** should deflect the spring **15 mm**.

- (a) Determine the spring rate (b) Determine the minimum hole diameter for the spring to operate in
 (c) Determine the total number of coils needed (d) Determine the solid length
 (e) Determine a static factor of safety based on the yielding of the spring if it is compressed to its solid length. [10 M]

Q.8. In the reverted planetary train illustrated as shown in Fig.5, Find the speed and direction of rotation of the arm if gear 2 unable to rotate [stable] and gear 6 is driven at 12 rev/min in the clockwise direction. [8 M]

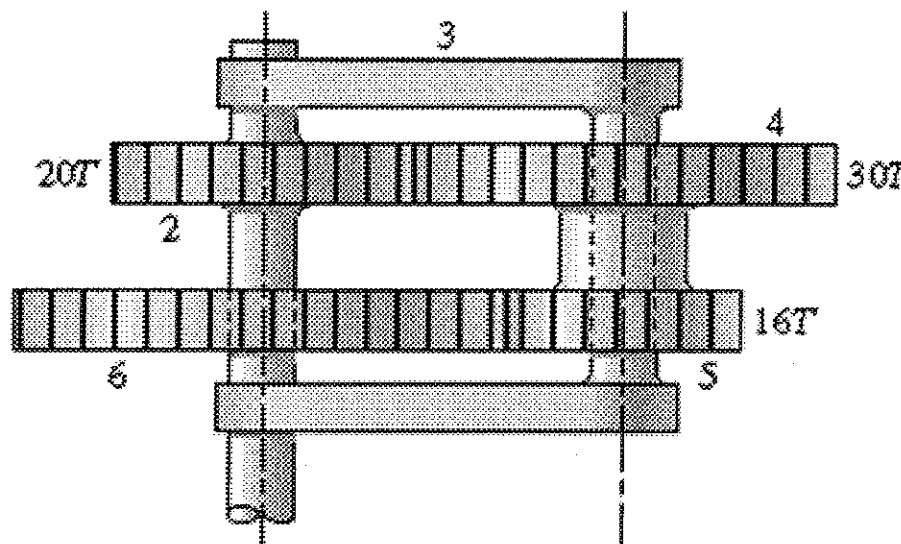


Fig.5

Q.9. Find the power transmitted by a belt running over a pulley of 600 mm diameter at 200 rpm. The coefficient of friction between the belt and pulley is 0.25, angle of contact 160° and the maximum tension in the belt is 2500N. [5 M]

BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

III Year I Semester 2011-2012 [Mechanical]

Test No. 2 (Open Book)

Course No. ME C 312 **Course Title:** Design of Machine Elements **Weightage:** 20%
Date: 04-12-2011 **Max.Marks:** 40 **Duration:** 50 min.

Notes: (i) Answer all the questions (ii) Draw neat sketches wherever necessary
(iii) Make suitable assumptions if required and clearly state them

- Q.1** The upside-down steel **A** frame shown in the figure is to be bolted to steel beams on the ceiling of a machine room using **ISO 8.8** bolts. This frame is to support the **40-kN** radial load as illustrated. The total bolt grip is **48 mm**, which includes the thickness of the steel beam, the **A** frame feet, and the steel washers used. The bolts are size **M20 X 2.5**. Take **E = 207 Gpa**, and coefficient of friction **f_c = 0.18**.
- (a) What tightening torque should be used if the connection is permanent and the fasteners are lubricated?
- (b) Determine the factors of safety guarding against yielding, over load and joint separation.
- [15 M]

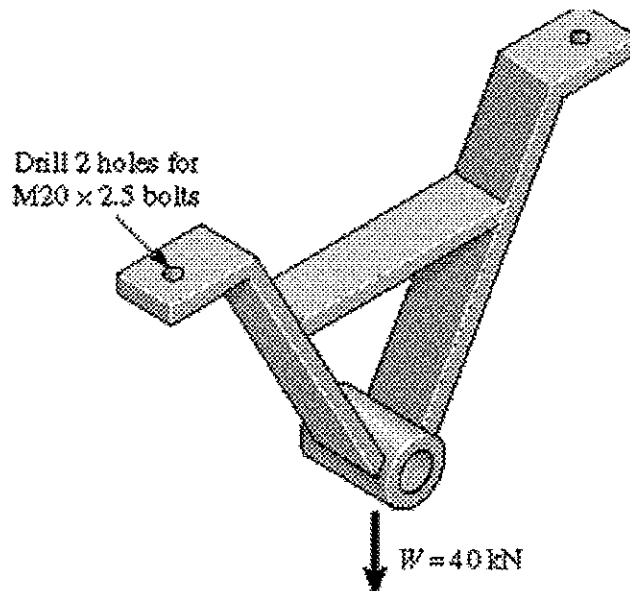


Fig.1

Q.2. A B159 phosphor-bronze, Squared and Ground-ended helical compression spring, has a wire size of **2.3 mm**, an outside coil diameter of **25.4mm**, solid free length of **95.3 mm**, total coils **13**. (a) Find the spring rate (b) Find the shear stress in the spring due to the force F_s . (c) Estimate if they are solid-safe. If not determine and what is the largest free length to which they can be wound using $n_s = 1.2$? [15 M]

Q.3 A safety valve of 60 mm diameter is to blow off at a pressure of 12 bar [1 bar = 10^5 N/mm²]. It is held on its seat by a close coiled helical spring. The maximum deflection of the valve is 45 mm and the maximum shear stress in the material of the wire is to be limited to 500 N/mm². Take spring index = 5, $K_w = 1.31$ and $G = 82\text{Gpa}$

Determine (a) wire diameter of the spring

(b) mean diameter of the spring

(c) active no of coils of the spring

[10 M]

BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

III Year I Semester 2011-2012 [Mechanical]

Test No.1 (Closed Book)

Course No. ME C 312 Course Title: Design of Machine Elements

Weightage: 25%

Date: 09-10-2011

Max.Marks: 25

Duration: 50 min.

- Notes: (i) Answer all the questions (ii) Draw neat sketches wherever necessary
(iii) Make suitable assumptions if required and clearly state them
(iv) Charts and tables are provided along with question papers

- Q.1. A component machined from a plate made of steel 45C8 ($S_{ut} = 630 \text{ N/mm}^2$) with shaft diameter is 30 mm is shown in Fig.1. It is subjected to a completely reversed axial force of 50 kN. The expected reliability is 90 % and the factor of safety is 2. Determine the plate thickness 't' for infinite life, if the notch sensitivity factor is 0.8. [5 M]

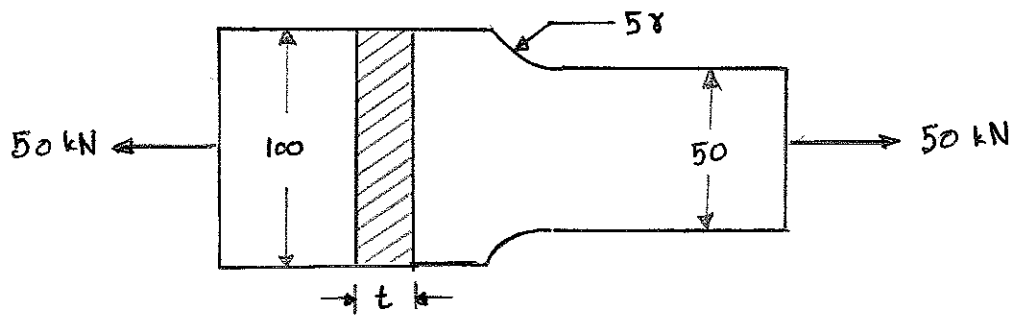


Fig.1

- Q.2. The cast-iron bracket subjected to bending has a cross section of I-Shape with unequal flanges as shown in Fig.2. If the compressive stress in top flange is not exceed 17.5 Mpa, what is the bending moment of the section can take? [10 M]

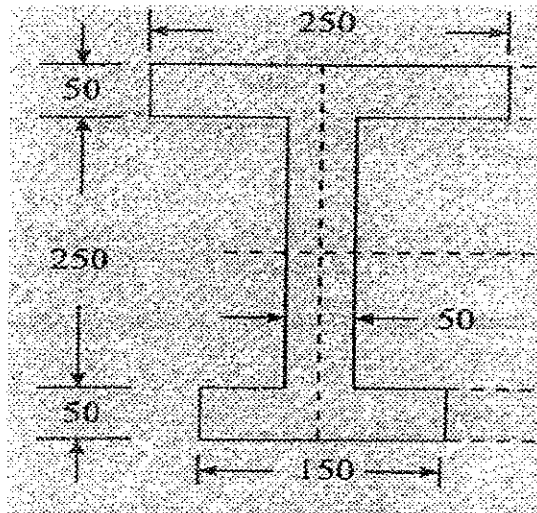
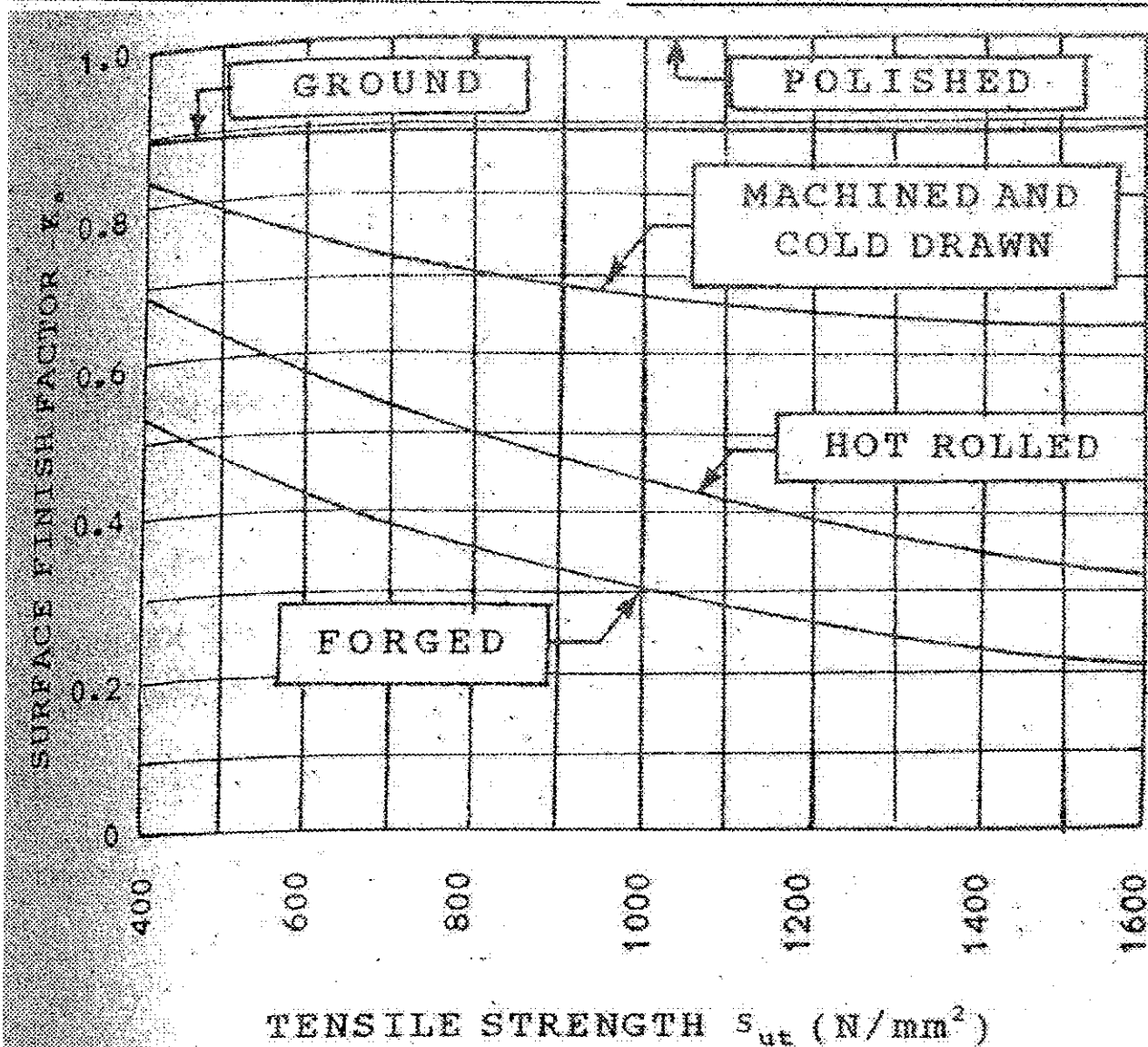


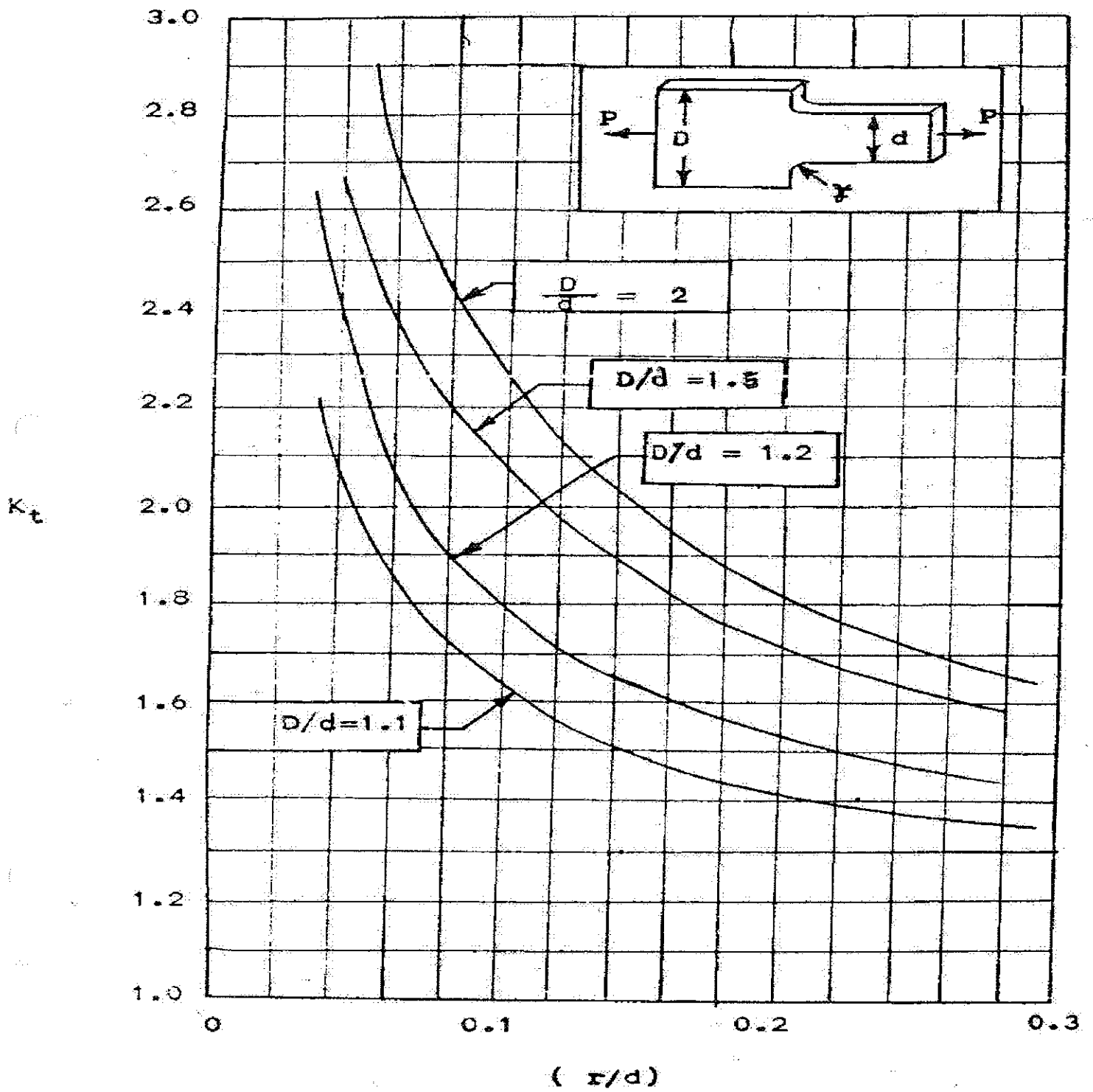
Fig 2

Q.3. A thin mild steel sheet is pulled in its own plane so that the stress components with respect to XY axes are as given below: Draw the Mohr's circle, find the principle stresses and directions, and show these on a stress element correctly aligned with respect to the xy coordinates. Draw another stress element to show τ_1 and τ_2 , find the corresponding normal stresses, and label the drawing completely. [10 M]

$$\begin{aligned}\sigma_x &= -10 \\ \sigma_y &= 18 \\ \tau_{xy} &= 9 \text{ c w}\end{aligned}$$

Reliability R (%)	K_r	Diameter (d) (mm)	K_d
50	1.000		
90	0.897	$d \leq 7.5$	1.00
95	0.868	$7.5 < d \leq 50$	0.85
99	0.814		
99.9	0.753	$d > 50$	0.75





BITS PILANI-DUBAI
Dubai International Academic City, Dubai
Ist Sem III yr-MECHANICAL 2011-12

Course No: ME C312

Subject: Design of Machine Elements

DATE: 23.11. 2011

Duration: 20 Min

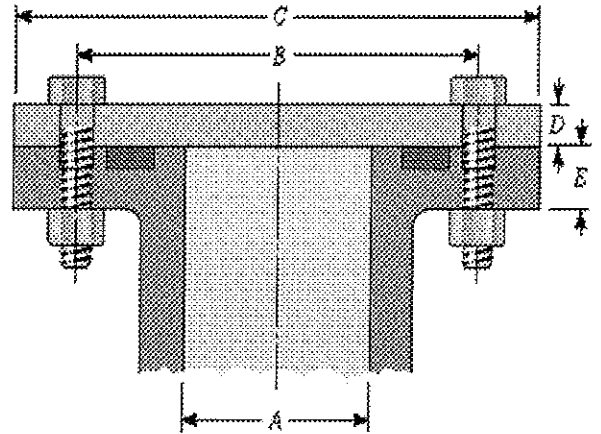
Max. Marks: 7

QUIZ-2

Weightage : 7 %

Name of the student: ----- I.D.: -----

1. For the given figure, Let $A=0.9$ m, $B=1$ m, $C=1.10$ m, $D=20$ mm, $E=25$ mm. The cylinder is made of ASTM No.35 cast iron and the head of low carbon steel. There are thirty-six [M10 X 1.5, ISO 10.9] bolts tightened to 75 percent of proof load. During use, the cylinder pressure fluctuates between 0 and 550 kPa. Find the factor of safety guarding against a fatigue failure of a bolt using the (a) Gerber criterion. Take spring rate of the member $k_m = 1057$ MN/m.



SOLUTION

BITS, PILANI-DUBAI
Dubai International Academic City, Dubai
Ist Sem III yr-MECHANICAL 2011-12

Course No: ME C312

Subject: Design of Machine Elements

DATE: 26. 10. 2011

Duration: 20 Min

Max. Marks: 8

QUIZ-1

Weightage : 8%

Name of the student: -----	I.D.: -----
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A transmission shaft having bending moment is 142.4 N-m and the steady torsion moment is 124.3N-m. The heat treated steel shaft has an ultimate strength of $S_{ut} = 735$ Mpa and a yield strength of $S_y = 574$ Mpa. Take: $K_t=1.68, K_{ts}= 1.42, q_{shear}=0.92, q= 0.85$, Factor of safety is 1.62 and endurance strength limit $S_e =205$ Mpa

- (i) Determine the shaft diameter using DE-Goodman criteria
- (ii) Find out the maximum stress by applying Von mises criteria.

SOLUTION