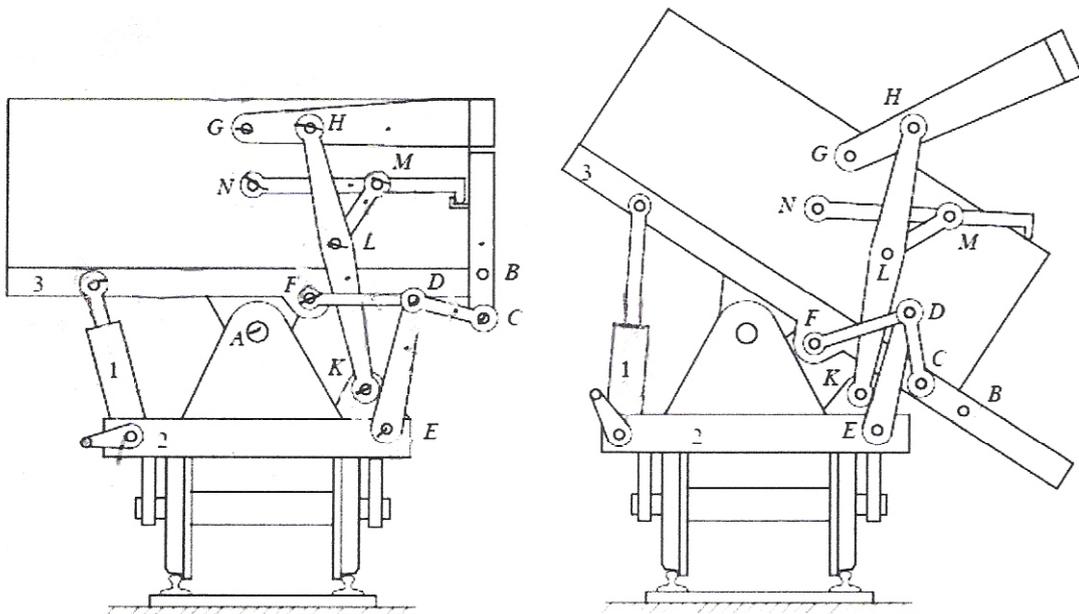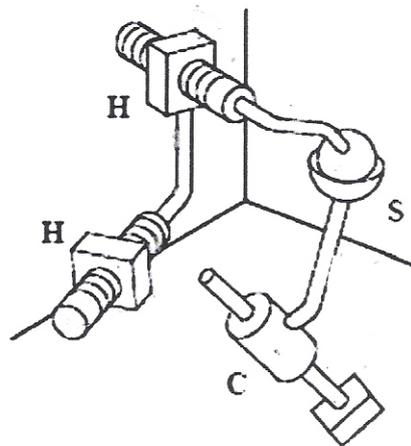1. Please explain the following terms:

   (a) Transmission angle
   (b) Degree of freedom
   (c) Instant center
   (d) Pressure angle
   (e) Cusp

2. Determine the mobility and number of idle degree of freedom for each of the mechanisms shown. Show the equations used to determine your answers.


(a)

3. A mechanism must be designed to move a computer terminal from under the desk
   to top level. The system will be guided by a linkage, and the use of a four-bar
   linkage will be tried first. As a first attempt at the design, do the following:

(a) Use C^* as a center point and find the corresponding circle point C in position 1.

(b) Use A as a circle point and find the corresponding center point A^*.

(c) Draw the linkage in position 1.

(d) Determine the type of linkage (crank rocker, double rocker, etc.) resulting.

(e) Evaluate the linkage to determine whether you would recommend that it be
manufactured
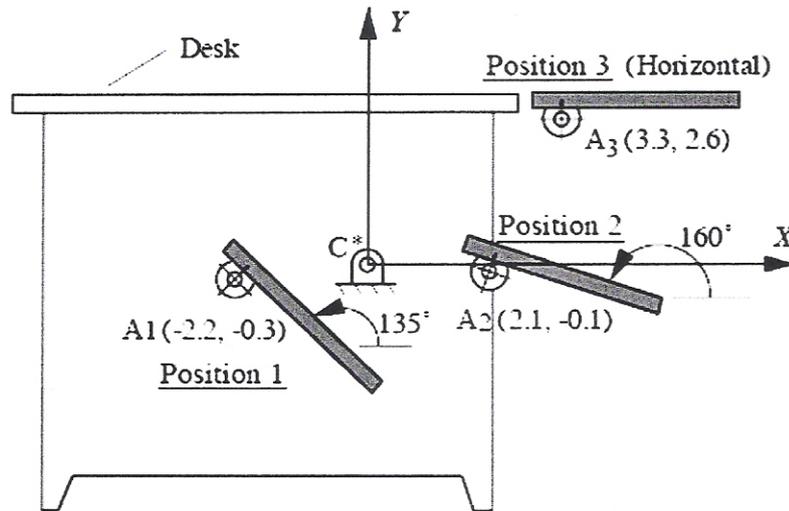
4. The door-closing linkage shown is to be analyzed as a slider-crank linkage. Link 2

   is the door, and links 3 and 4 are the two links of the door closer. Assume that
   the angular velocity of the door (link2) is a constant at 3.71 radians per second
   clockwise. Compute the angular velocity of link 4 if the dimensions are as
   follows: Coordinates of D (-2.5, -3.0) , $AB = 17.0$ inches
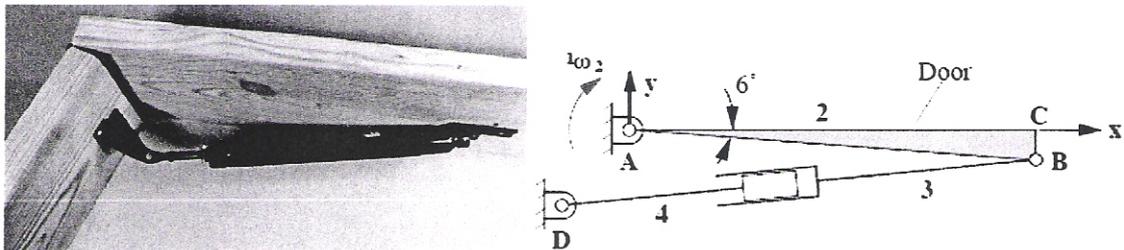
5. In the polishing machine shown in Fig 5

   (a) Determine the degrees of freedom for this linkage.

   (b) If we want to redesign the machine, please give all possible structural designs
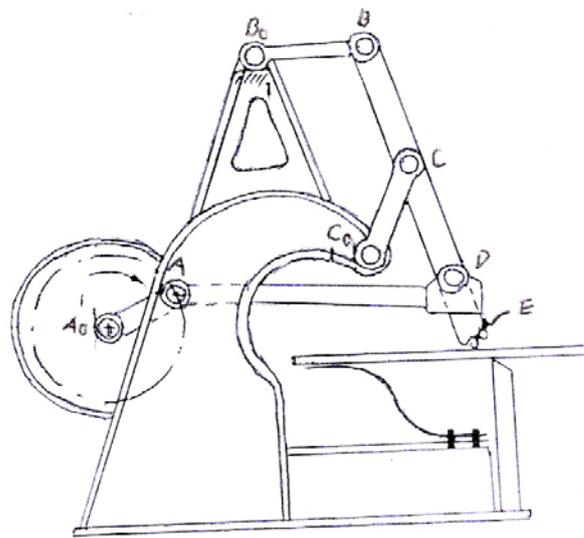   with the same link number for the polishing machine

Fig 5

國立虎尾科技大學　機械與機電工程研究所

98 學年度第 1 學期　博士班資格考　【機構設計】

1. Please explain the following terms. 30%
   (1) Centro
   (2) Simple curve
   (3) Regular simple curve
   (4) Singular point
   (5) Mechanisms

2. The surface $z = f(x, y)$ is said to have "Rulings" if through the point $p_0 = f(x_0, y_0, z_0)$ there is a straight line segment all of whose points are on the surface. This happens if through the point $(x_0, y_0, 0)$ in the $xy-$plane there is a line of points $(x_0 + h,\ y_0 + k,\ 0)$ such that along this line dz and Δz are equal. This happens if and only if

$$f(x_0 + h, y_0 + k) - f(x_0, y_0) = \left(\frac{\partial f}{\partial x}\right)_0 h + \left(\frac{\partial f}{\partial y}\right)_0 k \quad \text{when} \quad h = \Delta x = dx \ \text{ and } \ k = \Delta y = dy.$$ Show

that the surface $\dfrac{x^2}{a^2} + \dfrac{y^2}{a^2} - \dfrac{z^2}{c^2} = 1$ is ruled surface or not for $h = k$. 30%

3. A position vector $\vec{r}$ in coordinate systems is expressed as $\vec{r}(\alpha) = a\cos\alpha\,\vec{i} + a\sin\alpha\,\vec{j} + c\alpha\,\vec{k}$.
   Please determine (a) Unit tangent vector $\vec{t}(s)$ (b) Unit normal vector $\vec{n}(s)$ (c) Curvature κ
   (d) Unit binormal vector $\vec{b}(s)$. 40% (Hint: Where s is arc length, $ds^2 = d\vec{r} \cdot d\vec{r}$)

國立虎尾科技大學　機械與機電工程研究所

98 學年度第 2 學期　博士班資格考 【機構設計】

1. Determine the degrees of freedom of the mechanism shown in figure P-1. (30%)
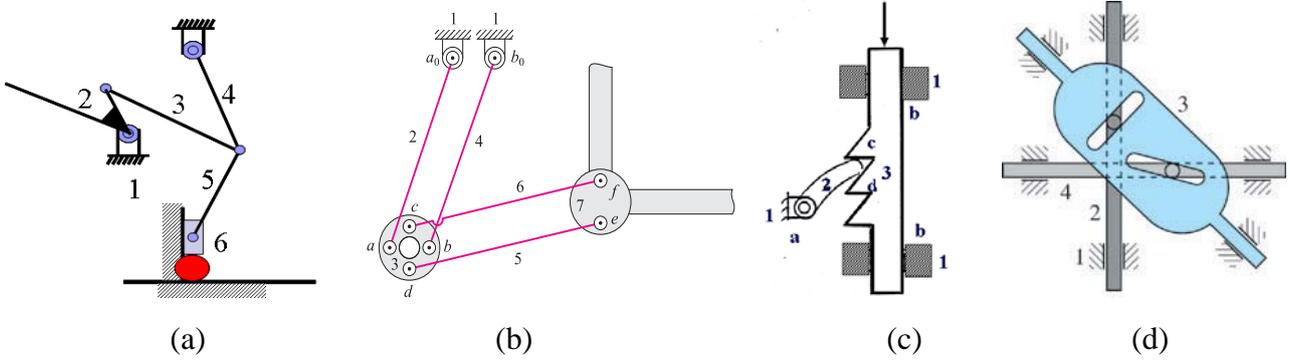

(a)　　　　　　　(b)　　　　　　　(c)　　　　　　(d)

Figure P-1

2. Synthesize a four-bar linkage to generate the three rigid-body position shown in figure P-2. (Note: A_1B_1=5cm, B_2A_3=2cm) (40%)
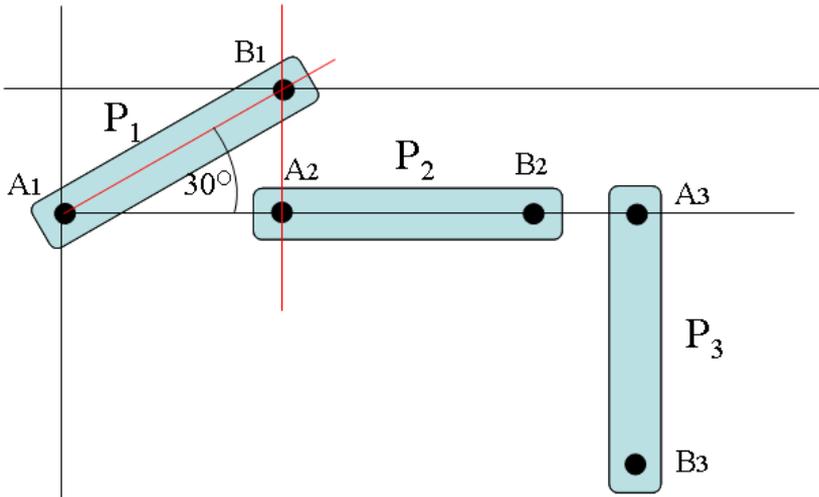

Figure P-2

3. For a mechanism shown in figure P-3, (a) find all instant centers, (b)use vector loop method, if r$_2$=20cm, a$_0$b$_0$=40cm, r$_4$=8cm, and $\theta_2 = 120^O, \omega_2 = 10 rad/s$, find ω_4 . (30%)

$$\vec{r_2} + \vec{r_3} = \vec{r_1} + \vec{r_4}$$
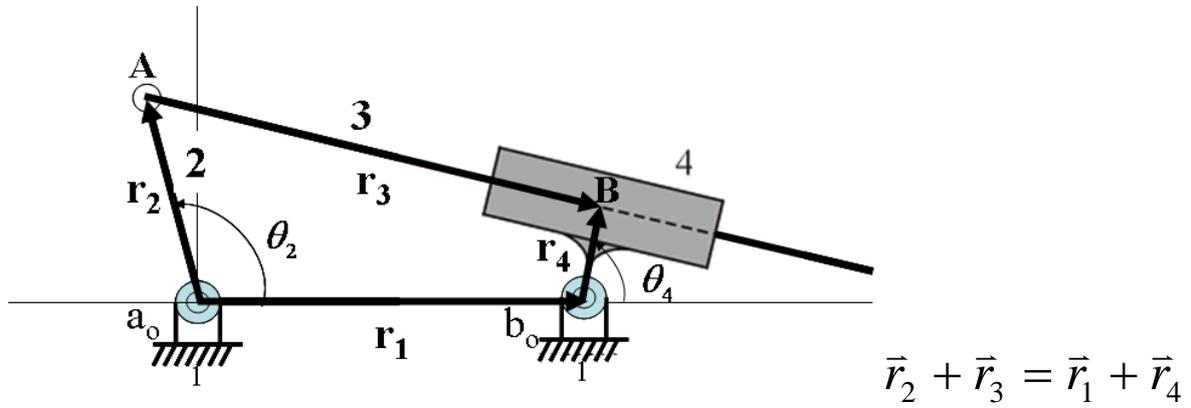
Figure P-3

*可使用計算機

1. Please explain the following terms: (25%)
   (a) cognate
   (b) kinematic inversion
   (c) structural error
   (d) circle-point curve
   (e) inflection circle

2. Find all possible non-isomorphic 6-bar planar kinematic chains with one degree of freedom and simple turning pairs only. (25%)

3.(a) Find the three-precision-point Chebyshev spacing for the function y = sin x, $0^{°} \leq x \leq 90^{°}$, where $\Delta \varphi = 60^{°}$ and $\Delta \phi = 90^{°}$.
   (b) Find φ_j, ψ_j (j=2, 3).
   (c) Find an acceptable four-bar function generator by the graphical method, with $\psi_0 = 60^{°}$, $A_0 B_0 = 1$ (the ground link), $B_0 B = 0.75$ (the output link).
   (25%)

4. As part of an automation process, a four-bar linkage must be designed to remove boxes from one conveyor belt and deposit them on an upper conveyor belt as shown in Fig.4 (three prescribed positions). Both fixed and moving pivots must be located between the upper and lower conveyor belts. Design an acceptable four-bar by the graphical method. (25%).
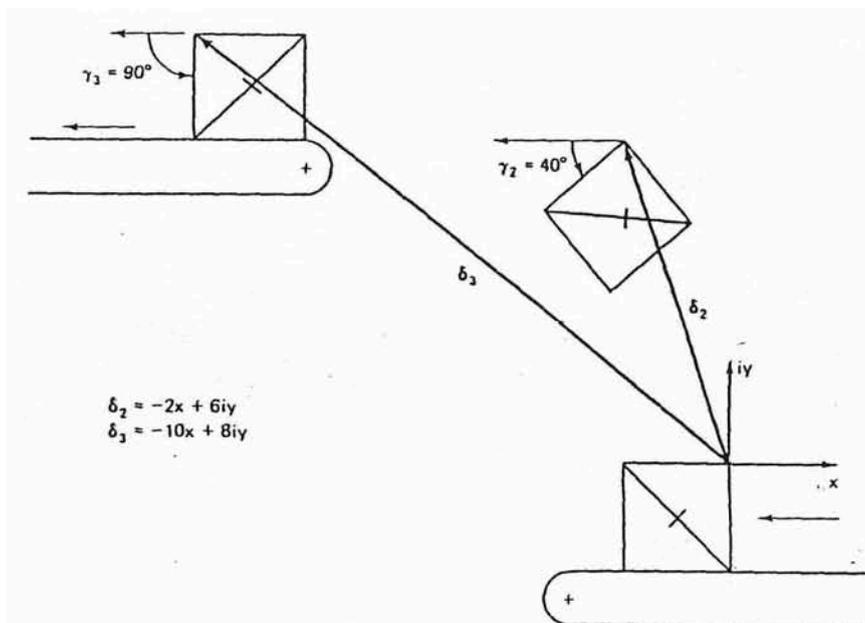

$$\delta_2 = -2x + 6iy$$
$$\delta_3 = -10x + 8iy$$

Fig. 4

班級：　　　　　　　　學號：　　　　　　　　姓名：
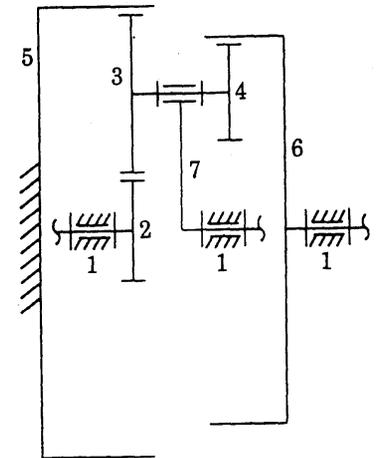
1. 請使用一個球與一個圓筒設計出一個五自由度的運動對，並說明其運動對特性(運動狀況)。20%
答：

2. 如圖所示之周轉輪系，若 $T_3 = 30$、$T_4 = 18$、$T_6 = 68$，若桿 2 輸入、桿 7 輸出、速比(Velocity ratio)為 0.25、$70 \leq T_5 \leq 80$，試設計齒輪 $2(T_2)$ 與齒輪 $5(T_5)$ 之齒數為若干？30%
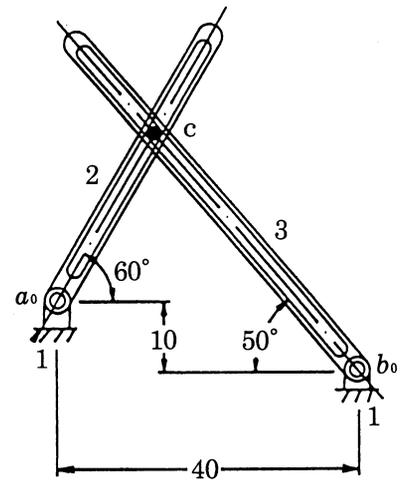答：

3. 試設計或舉出一種平面矛盾機構，請繪圖並依矛盾機構定義說明之。 20%

答：

4. 如圖所示，利用向量迴路法解此機構 C 點之位置與速度，**但方程式的非線性項要最低**。 30%

答：

注意事項：
（1）本試題共有 4 題，合計一百分。
（2）請依序作答於答案卷上並註明題號。
（3）可使用計算機；close book。

1. (a) What is the "coupling"? (b) Show any four types of couplings in text or graph. (20%)

2. A shaft with mounted belt drives has tensile forces applied as shown in Fig.1 and frictionless journal bearings at locations A and B. Please show (a) moment diagram in x-z plane; (b) moment diagram in x-y plane; (c) torque diagram. (30%)
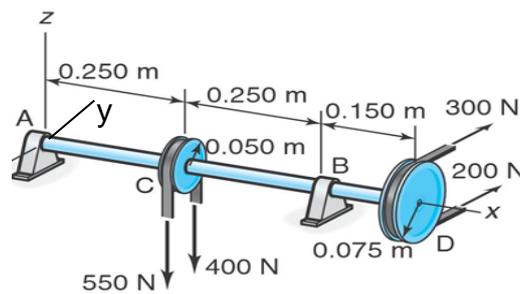

Fig. 1

3. Please briefly introduce (a) Maximum-Shear-Stress Theory; (b) Distortion-Energy Theory. (30%)

4. A planetary gear train shown in Fig. 2 is used as part of a transmission for a forklift truck. The sun gear (太陽齒輪) is driven by the engine at 3000 rpm, the ring gear (環齒輪) is bolted to the machine frame, and the arm (行星臂) is connected to the track drive system. The sun has 16 teeth, the ring has 84 teeth, and there are three planets (行星齒輪), each with 34 teeth. Please show the angular velocities of the arm and planet. (20%)
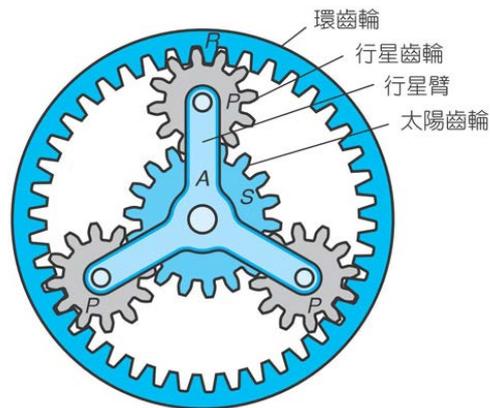

Fig. 2

注意事項：
（1）本試題共有 4 題，每題 25 分，合計一百分。
（2）請依序作答於答案卷上並註明題號。
（3）可使用計算機， close book，may use calculator，

1. The link shown in following figure is subjected to a completely reversing load of 90,000 N. Find the maximum value of stress at each hole.
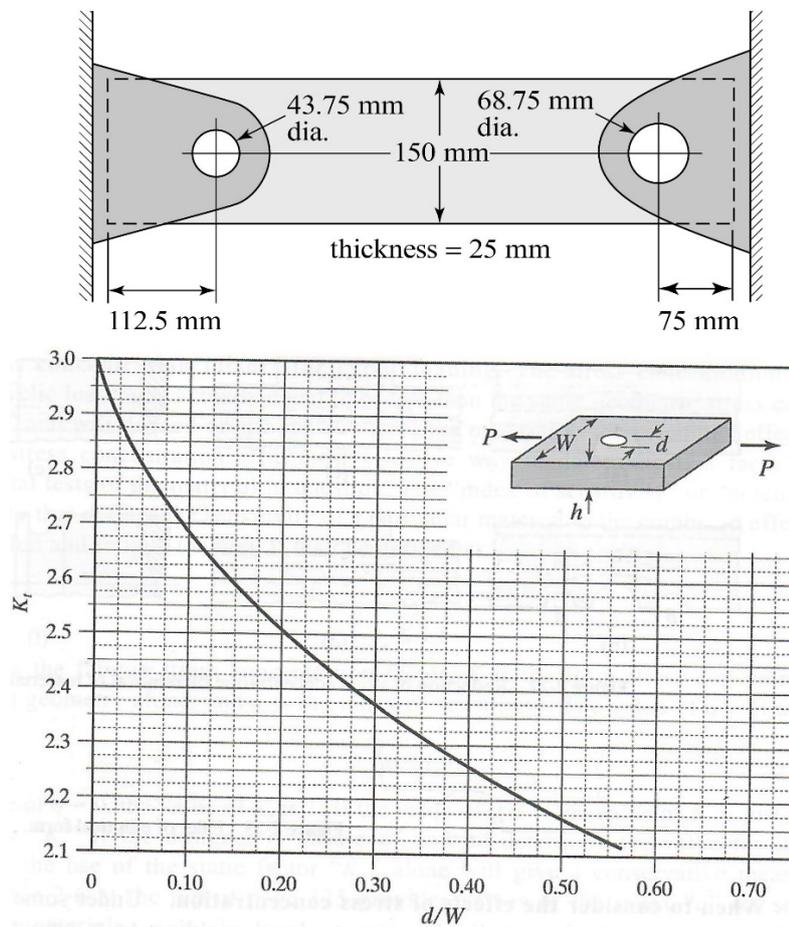

43.75 mm dia. 68.75 mm dia.
150 mm
thickness = 25 mm
112.5 mm   75 mm

Figure 2-20 Stress concentration factor for a flat bar with a transverse hole in axial tension. (Spreadsheet Module 2-17.)
(Curves from Peterson, R. E. "Design Factors for Stress Concentration, Parts 1 to 5," *Machine Design,* February–July, 1951.)

2. The shaft of following figure does not rotate, and is simply supported at A and B. The element at C is on the top surface; the element at D is at the elevation of the shaft axis.
   (a)   Draw a view of the element at C with sides parallel and perpendicular to the shaft axis; show arrows representing stresses, together with numerical values.
   (b)   Draw a view for the element at C, properly oriented with respect to the shaft axis, which has the maximum shearing stress. Show arrows and numerical values for all stresses acting.
   (c) Work part (b) for the element at D.
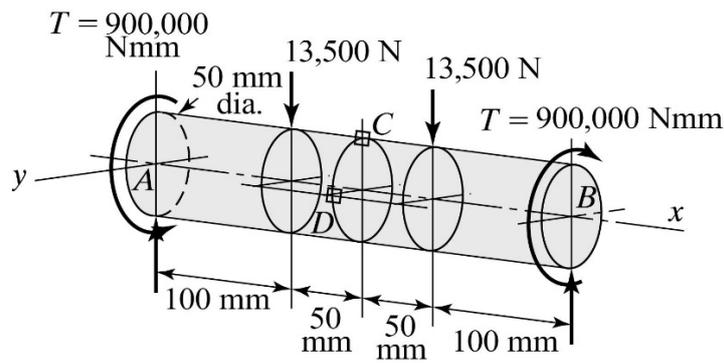

3. Find the value of force P for the brake in following figure $_{\max} = 0.7$ MPa. $\mu = 0.25$.
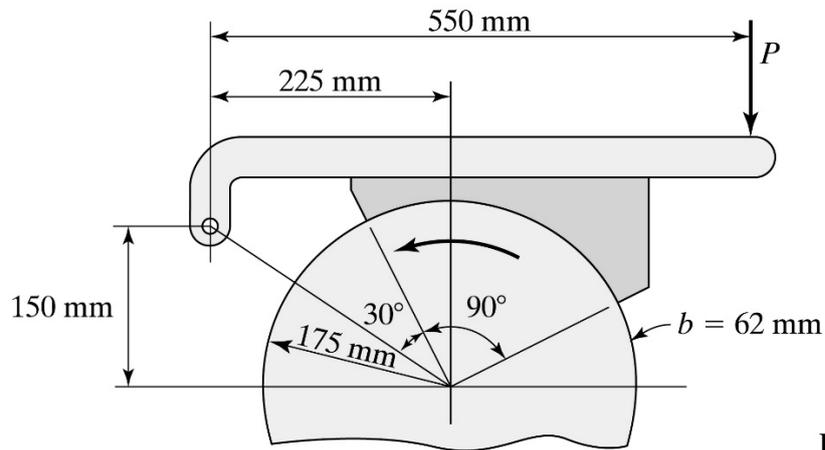
4. (a) Find the reactions, and draw and dimension the bending moment diagram for the shaft of following figure. All bearings are on immovable supports at the same elevation. Include the effect of the dead load of the shaft. For the shaft, $E = 206{,}900$ MPa; $\gamma = 7.682 \times 10^{-5}$ N/mm^3.

(b) Find the values of the reactions if the bearing at C is 1.25 mm lower than the others. Include the effect of the dead load of the shaft.

(c) Let the center support consist of a 60 mm. I-beam, 0.1824 N per mm ($I = 218{,}000$ mm^4), 1 m long, simply supported, with bearing C at its center. Find the reactions for the shaft, and draw and dimension the bending moment diagram. Neglect effects of the dead loads.

(d) What must the moment of inertia be for a beam supporting the bearing at C if the value of the bending moments, as caused by the 2000 N loads at points B, C, and D, are to be numerically equal? What will be the deflection of point C? Neglect effects of the dead loads.
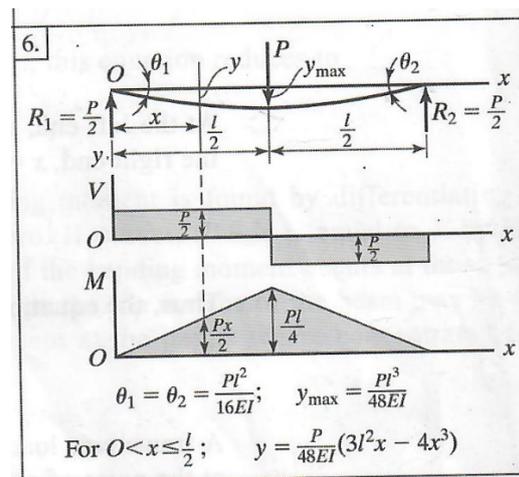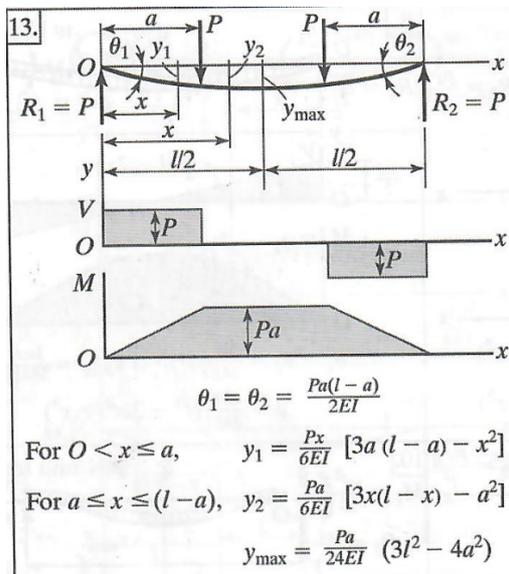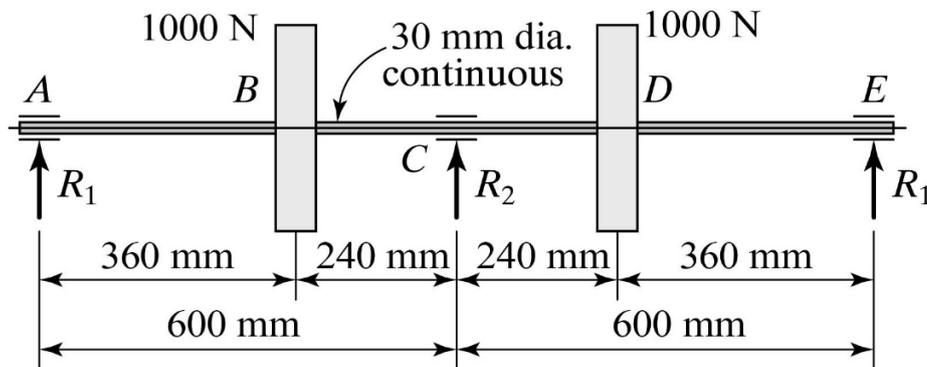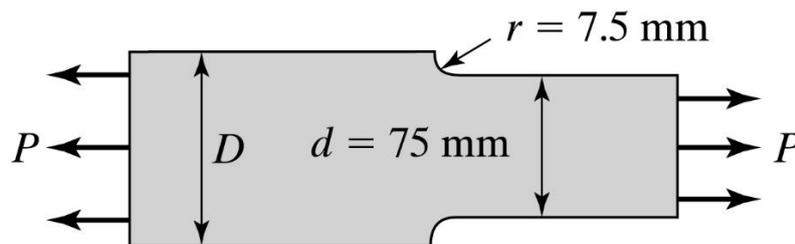
系別：動力機械工程系機械與機電工程博士班　　　　　　　Page　1　/　1

科目：機械設計

注意事項：
（1）本試題共有 4 題，每題 25 分，合計一百分。
（2）請依序作答於答案卷上並註明題號。
（3）可使用計算機，　close book，may use calculator，

1. The plate shown in following figure is 13 mm thick. Load P varies from 90,000 N to 45,000 N. If the material has σ_{yp} = 290 MPa; σ_e = 165 MPa, and q = 0.5 determine if the part will fail by the Soderberg equation if the factor of safety based on yield point is 2

Stress Concentration Caused by Sudden Change in Form
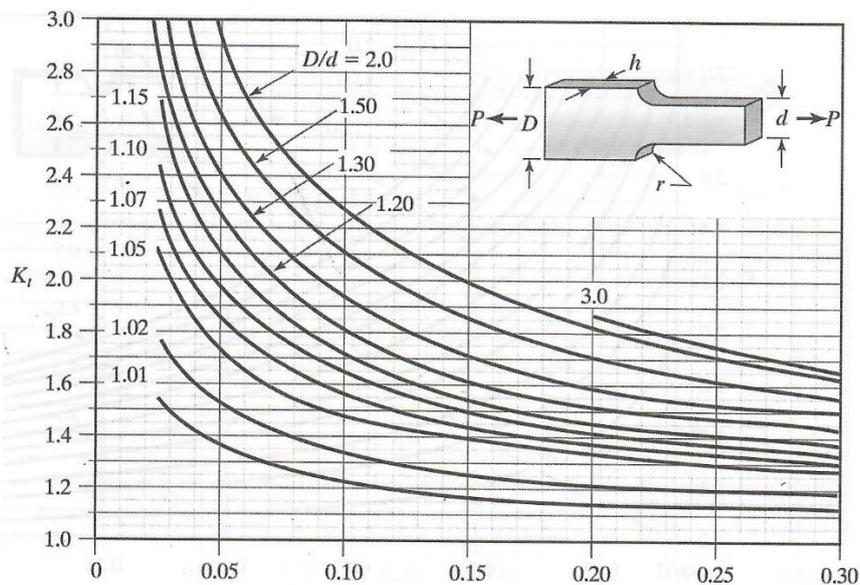
2. The shaft shown in following figure carries the steady loads shown and does not rotate. (a) For the element at point A, draw a cube that shows the state of stress and use Mohr's circle to compute the principal normal stresses for this location. (b) For the element at point B, draw a cube that shows the state of stress and use Mohr's circle to compute the principal normal stresses for this location. Be sure to include the effect of transverse shear at this point.

$T = 800,000$ Nmm
50 mm dia.
$P = 9,000$ N
$T = 800,000$ Nmm
B
A
140 mm
70 mm
70 mm
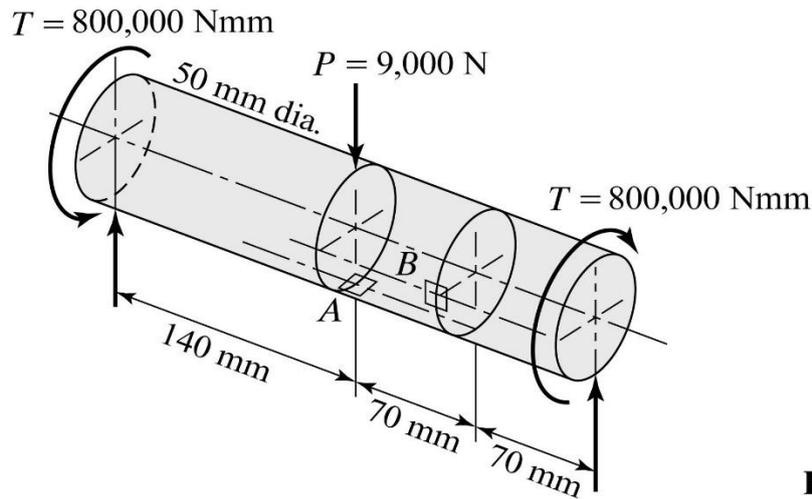
Fi

3. The shaft shown in following figure is simply supported at A and B and is keyed against rotation at A. (a) Draw a view of the element on the top surface of the shaft at B with sides parallel to the x and y axes. Show arrows and numerical values for all stresses acting. (b) Draw the element at B properly oriented to give the maximum shearing stresses. Show arrows and numerical values for all stresses.

500 mm
A
50 mm dia
400 mm
B
y
C
x
250 mm
5000 N
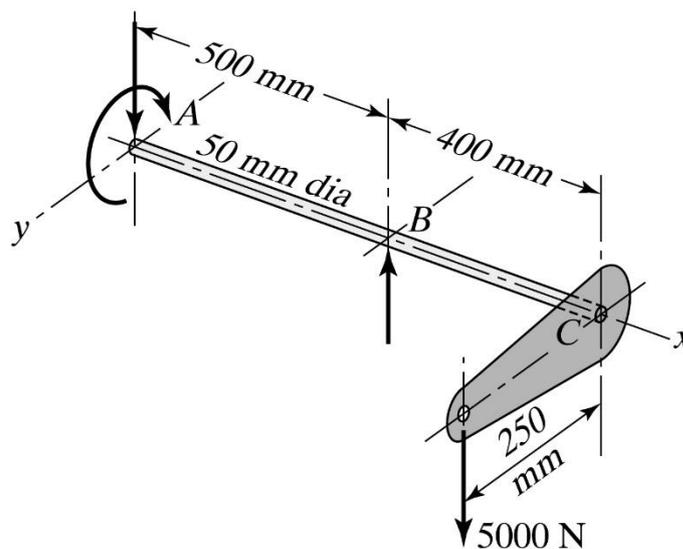
4. For the planetary gear train shown in following figure, $N_1 = 70$, $N_2 = 30$, $N_3 = 60$, and $N_4 = 40$ teeth. If the arm is rotating at 100 rpm in a counterclockwise direction as viewed from the left, what will be the speed and direction of the rotation of the output shaft connected to gear 4?