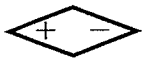
國立臺灣海洋大學 101 學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目：機電整合 (電路學、電子學、控制工程導論、動力學、流體力學五科選一科作答)

系所名稱：系統工程暨造船學系碩士班不分組　　＊可使用計算器

1.答案以橫式由左至右書寫。2.請依題號順序作答。

科目：電路學

The symbol  represents dependent voltage source.

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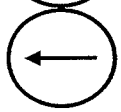
The symbol  represents independent current source.

$j=\sqrt{-1}$

$14+j17=22.02\angle 50.53$　　$14-j17=22.02\angle -50.53$

$-14+j17=22.02\angle 129.47$　　$-14-j17=22.02\angle -129.47$

$15.2+j18.6=24.02\angle 50.74$　　$15.2-j18.6=24.02\angle -50.74$

$-15.2+j18.6=24.02\angle 129.26$　　$-15.2-j18.6=24.02\angle -129.26$

1. The variable resistor (R_o) in the circuit in Fig.1 is adjusted for maximum power transfer to R_o. (25 points)

(a) Find the Thévenin equivalent and Norton Equivalent with respect to the terminals ***a*** and ***b***, and draw them.

(b) Find the value of R_o.

(c) Find the maximum power that can be delivered to R_o.

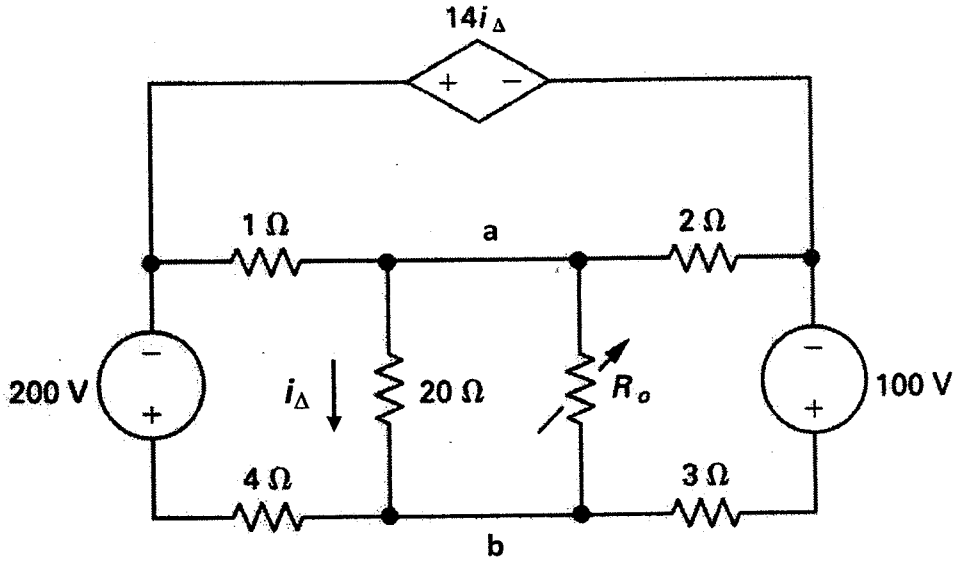


Fig. 1

2. Find v_o and i_o in the circuit shown in Fig. 2, assuming the op amps (operational amplifier) are ideal. (25 points)

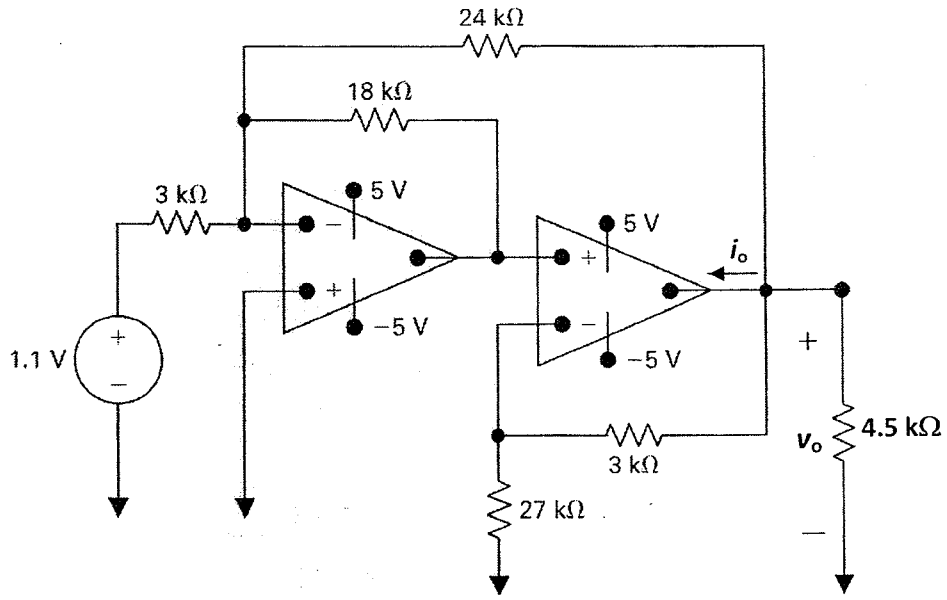


Fig. 2

3. Switches 1 and 2 in the circuit in Fig. 3 are synchronized. When switch 1 is opened, switch 2 closes, and vice versa. Switch 1 has been open a long time before closing at $t = 0$. Find $i_L(t)$ for $t \geq 0$. (25 points)

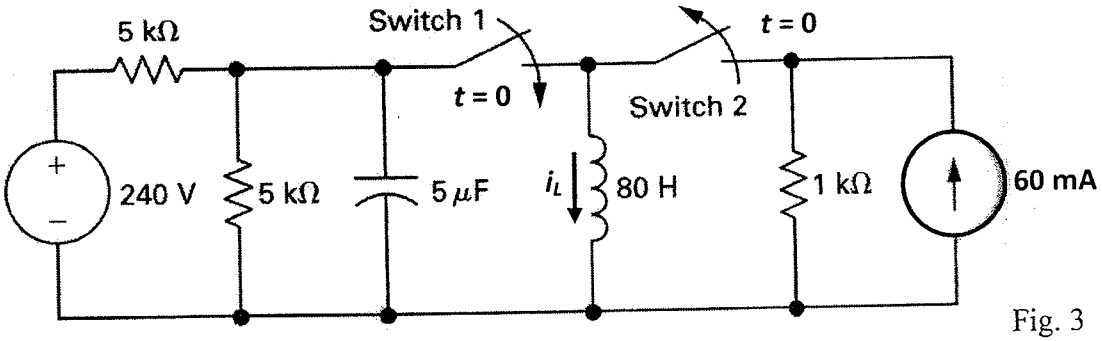


Fig. 3

4. (a) Transfer the circuit shown in Fig. 4 to the frequency domain and draw it.
(b) Find the steady-state expression for the branch current i_a and i_b by phasor calculation.(25 points)

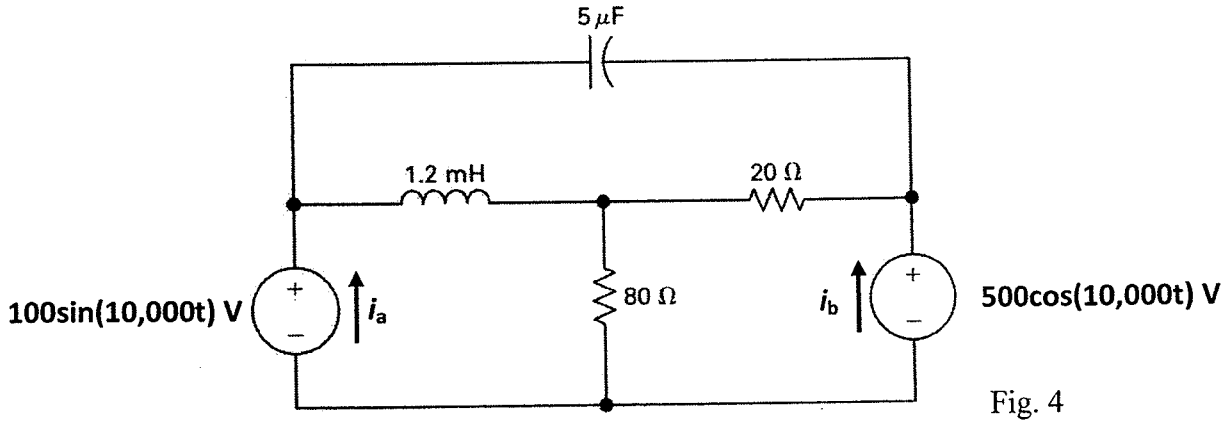


Fig. 4

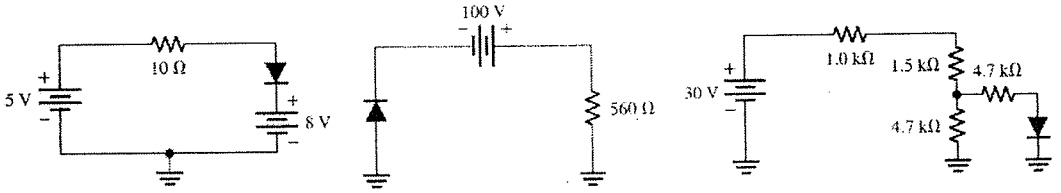
科目：電子學

1. 如圖 1 (a)~(c)。(共 16 分)

(1) 假設其中的二極體是屬於實際模型(the practical diode model)，請寫出每個矽二極體的偏壓大小？(3 分)

(2) 假設其中的二極體是屬於理想二極體(the ideal diode model)，請計算出每個二極體兩端的電壓？(3 分)

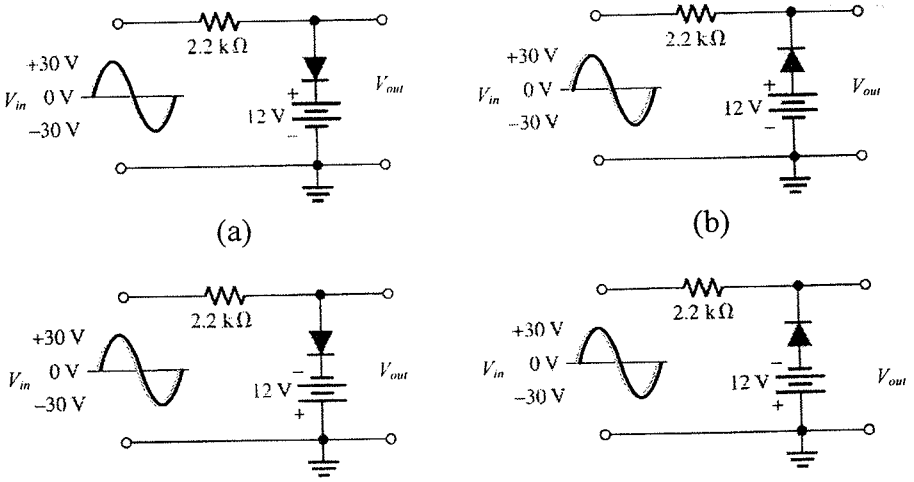
(3) 利用完整二極體模型(the complete diode model)，計算出每個二極體兩端的電壓，其中順向動態阻抗 $r_d' = 10\Omega$ ，內部逆向組抗 $r_R' = 100\ \text{M}\Omega$ ？(3,3,4 分)



(a) (b) (c)

圖 1

2. 如圖 2(a)~(d)中，若輸入電壓是峰對峰值為+30 V~ −30 V 的正弦波，試求每個二極體的峰值順向電流是多少？(共 12 分)



(a) (b) (c) (d)

圖 2

3. (1)齊納阻抗如何影響齊納二極體兩端的電壓降?(3 分)

(2)在齊納二極體(Zener Diode)調整電路中，怎樣的負載電阻值能產生最大的齊納電流？(3 分)

(3)順向偏壓的齊納二極體(Zener Diode)電壓降是多少？(3 分)

4. 試求圖 3 電路的下列數值：(共 24 分)

(1)電晶體 Q1 與 Q2 的直流端電壓(6 分)

(2)總 β_{ac} (4 分)

(3)每個電晶體的交流射集電阻(r'_e)值(6 分)

(4)總輸入阻抗(4 分)

(5)總電流增益 A_i (4 分)

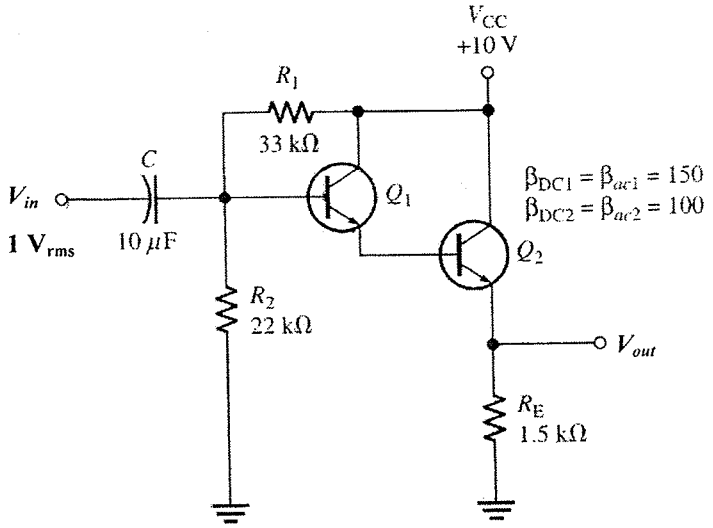


圖 3

5. 如圖 4 試求中放大器的電晶體基極電壓、共振頻率以及輸出信號的峰對峰值。(共 15 分)

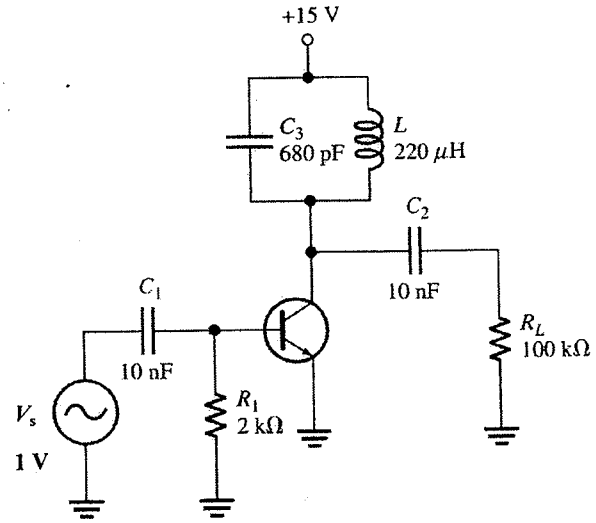


圖 4

6. 如圖 5 (a)~(c)中的運算放大器電路，其中 Z_{in}、Z_{out}、以及 A_{ol} 指的是運算放大器的輸入阻抗、輸出阻抗以及開路增益(open-loop voltage gain)。試求每個電路的輸入阻抗和輸出阻抗。(共 24 分)

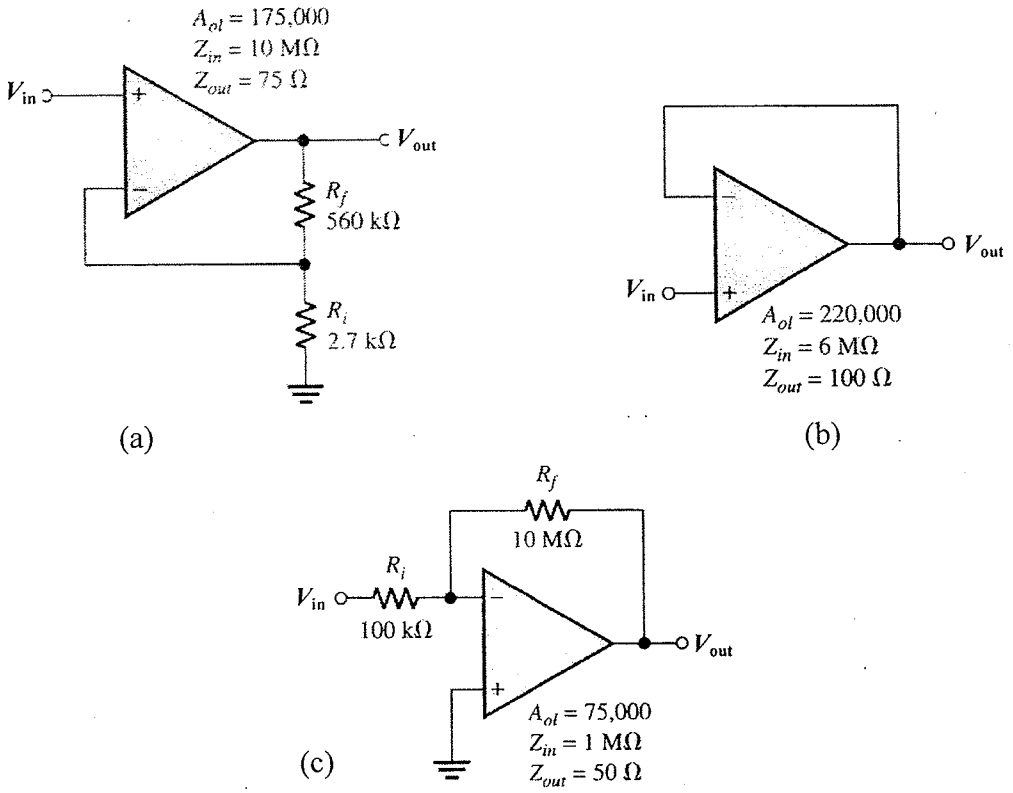


圖 5

科目：控制工程導論

1. (a) Reduce the block diagram shown in Fig. 1 (a) to unity feedback form, and find the transfer function of $\frac{Y}{X}$. (10%)

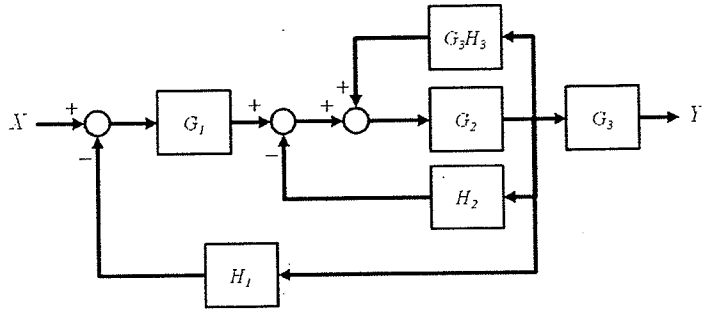


Fig. 1 (a)

(b) Draw the equivalent signal flow graph for the block diagram of the system as shown in Fig. 1 (b), and find the transfer function of $\frac{Y_1}{Y_2}$. (10%)

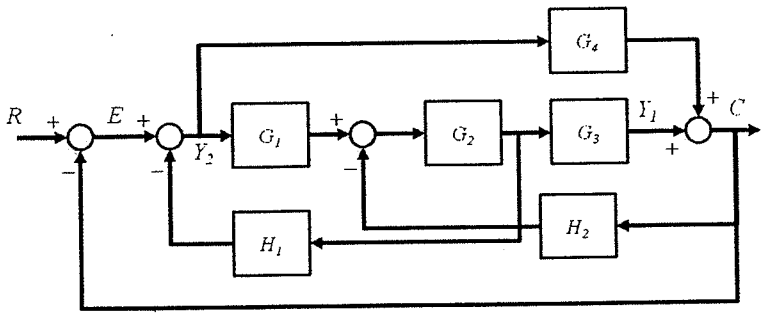


Fig. 1 (b)

2. The block diagram of a control system is shown in Fig. 2.

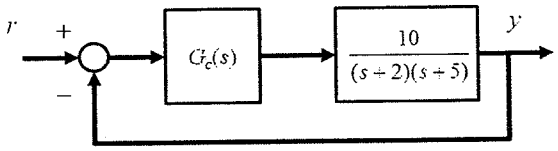


Fig. 2

(a) Let $G_c(s) = K$, as simple gain adjustment. Find the value of K such that the damping ratio of the closed-loop system is 0.707. (10%)

(b) With K in (a), find the steady state error, when input is a unit step. (10%)

(c) Enhance the system type [Hint: $G_c(s) = \frac{K}{s}$] to eliminate the steady state error, find the range of K. (10%)

3. (a) The Bode plot of magnitude for a control system is shown in Fig. 3. Assume the system has minimum phase transfer function. Determine the transfer function of the control system. (10%)

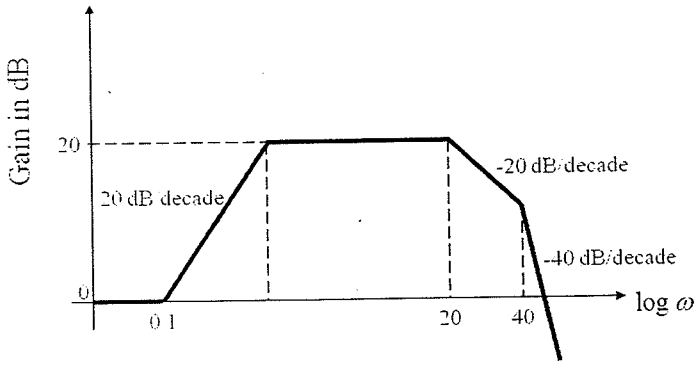


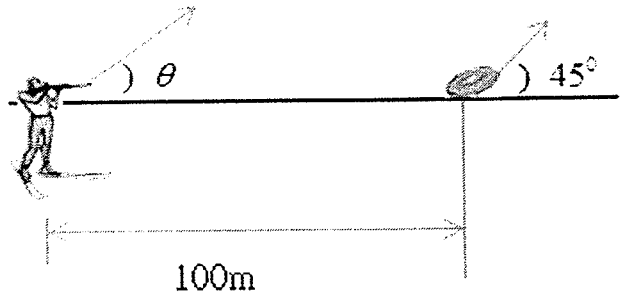
Fig. 3

(b) Find the gain margin associated with the transfer function $G(s)=\dfrac{7}{s(s+2)(s+5)}$. (10%)

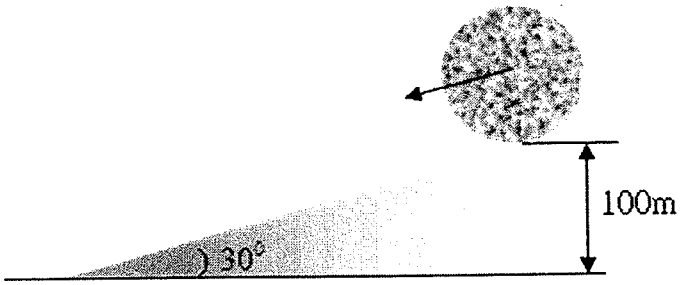
4. The characteristic equation of a control system is $s^3+s+K(s^2+b)=0$, $0\le K\le\infty$, Sketch the root locus for (a) $b=\dfrac{1}{5}$ (15%); (b) $b=\dfrac{1}{25}$ (15%); and specify the angles and intersection of the asymptotes, departure and arrival angles, breakaway (break-in) points, and system stability (calculation of the values of gain K).

科目：動力學

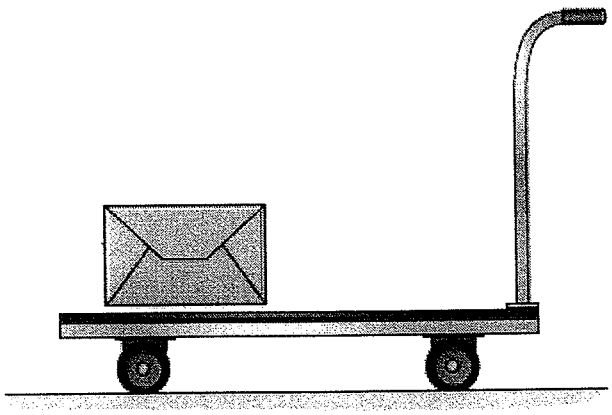
1. 飛靶練習時，射擊者站立於飛靶發射器"後"100*m* 處。飛靶以速度 10*m/s*，仰角 45 度向"前"發射，假射射擊者在飛靶發射同時開槍如圖，求射擊仰角與飛靶被擊中的位置。子彈速度為 340*m/s*。 (25%)



2. 一圓形落石(500*kg*，半徑 1*m*)從高度 100*m*、坡度 30 度的斜坡上向下滾動如圖。坡面與巨石之間之摩擦係數為 0.3。求石頭滾到斜坡底時之直線速度(m/s)與轉動速度(*rad/s*)。(25%)

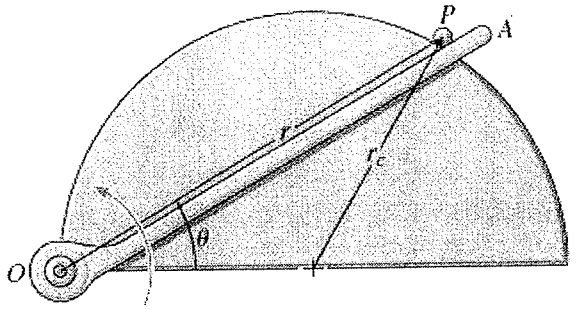


3. 一輛 30*kg* 的拖車上放有重 20*kg* 之貨物 *A* 如圖，貨物與拖車板之間的靜摩擦與動摩擦係數分別為 $\mu_s = 0.3$ 與 $\mu_k = 0.25$。現在以 250*N* 的力量拖動拖車。證明貨物會在拖車上滑動，並求出貨物在拖車上滑動 1.0*m* 所需要的時間。(貨物與車皆由靜止開始)(25%)



4. 一個 0.2kg 的鋼球如圖，在半圓板上方，由固定於 O 點之槓桿 OA 推動，圖中之 P 與 O 兩點之距離可用 $r = 2r_c \cos\theta$ 表示。當 $\theta = 30°$ 時，槓桿之轉角速度與角加速度分別為 $\dot{\theta} = 0.5 rad/s$ ， $\ddot{\theta} = 0.8 rad/s^2$。求槓桿施加在鋼球上的力之大小與方向。令 $r_c = 0.2m$。(25%)

提示：$\boldsymbol{a} = (\ddot{r} - r\dot{\theta}^2)\hat{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\hat{e}_\theta$



cos45° = 0.7071　sin45° = 0.7071　cos30° = 0.8660　sin30° = 0.5
cos60° = 0.5　sin60° = 0.8660
sin(0.62°)=0.0108　cos(0.62°)=0.9999
sin(1.19°)=0.0208　cos(1.19°)=0.9998
sin(1.76°)=0.0308　cos(1.76°)=0.9995
π = 3.14

科目：流體力學

g=9.81 m/s^2, $\rho_{H_2O}=1000$ kg/m^3, $\pi=3.14$

1. A finite plate is moved over a second plate on a layer of liquid as shown figure 1. For small gap width, d, we assume a linear velocity distribution in the liquid. The liquid viscosity is 0.65 centipoise and its specific gravity is 0.88(SG=0.88).

   Determine: (20%)

   (a) The kinematic viscosity of the liquid, in m^2/s.

   (b) The shear stress on the upper plate, in Pa.

   (c) The shear stress on the lower plate, in Pa.

   (d) Draw the figure to show the direction of each shear stress calculated in (b) and (c).

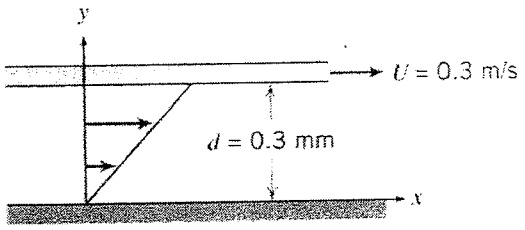


Figure 1

2. Water flows through pipes A and B shown as figure 2. Lubricating oil is in the upper portion of the inverted U. Mercury is in the bottom of the manometer bends. Determine the pressure difference, $p_A - p_B$, in units of kPa. (SG_{Hg}=13.6, SG_{oil}=0.88) (20%)

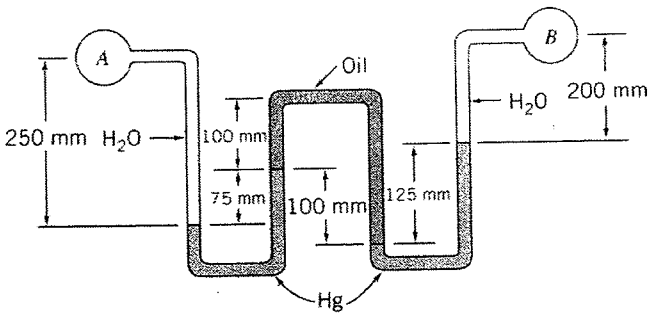


Figure 2

3. Water from a stationary nozzle is ejected on a moving vane with turning angle $\theta = 120°$ shown as figure 3. The vane moves away from the nozzle with constant speed, U = 10 m/s, and receives a jet that leaves the nozzle with speed V= 30 m/s. The nozzle has an exit area of 0.004 m^2. Find the force that must be applied to maintain the vane speed constant. ($\cos 120° = -0.5$, $\sin 120° = 0.8660$) (20%)

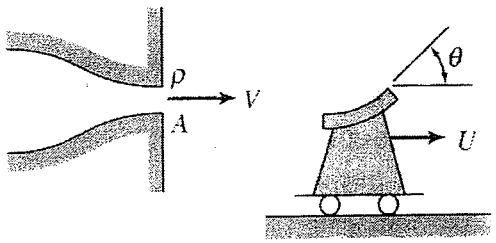


Figure 3

4. Air flows into the narrow gap, of height h, between closely spaced parallel plates through a porous surface as shown in figure 4. Use a control volume, with outer surface located at position x, to show that uniform velocity in the x direction is $u=v_0x/h$. Find an expression for the velocity component in the y direction. Evaluate the acceleration of a fluid particle in the gap. (20%)

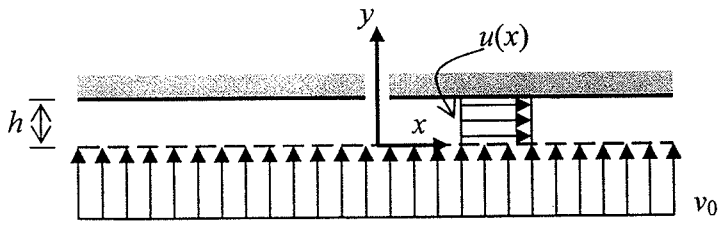


Figure 4

5. Water flow under a sluice gate on a horizontal bed at the inlet to a flume, shown as figure 5. Upstream from the gate, the water depth is 0.45 m and the speed is negligible. At the vena contracta downstream from the gate, the flow streamlines are straight and the depth is 50 mm. Determine the flow speed downstream from the gate and the discharge in cubic meter per second per meter of width. (20%)

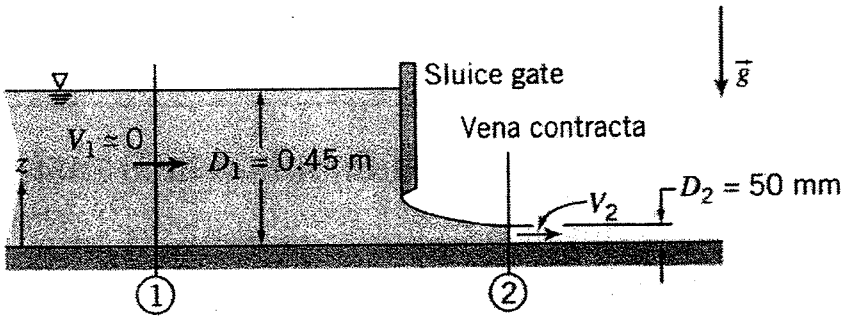


Figure 5