Part A. Figure 1 shows a single transistor amplifier circuit.

Solve or discuss the following problem using this figure.

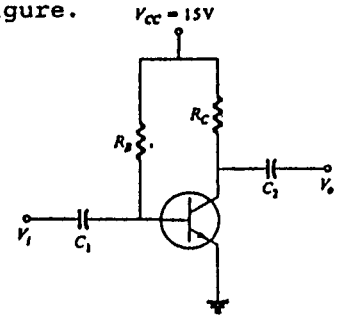
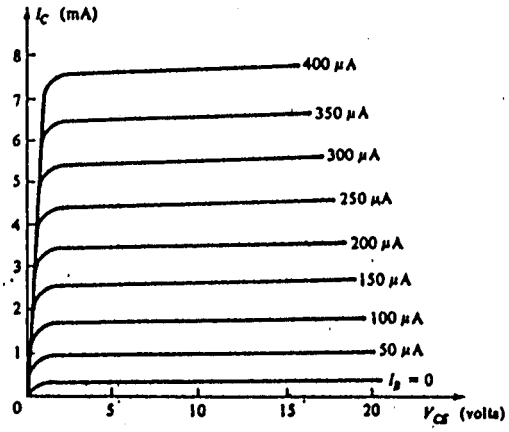


Figure 1.



1. Describe and discuss the design process and consideration to determine a load line and operating point (Q-point) for this transistor.
   Following your idea, calculate R_B and R_C to meet the requirement. (10%)

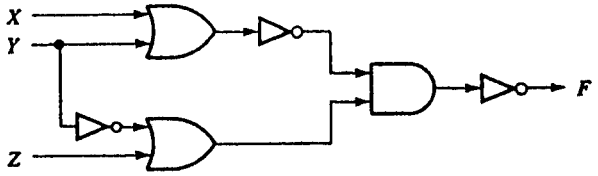
2. Use an appropriate small signal equivalent model to convert Figure 1 into a.c. equivalent circuit, by assuming a voltage signal V_s in series with a resistance R_s is applied to V_i, and a load resistance R_L is applied to V_o. (10%)

3. Following Problem 2, formulate the relation equation of voltage gain $A_V = V_o / V_s$. (10%)

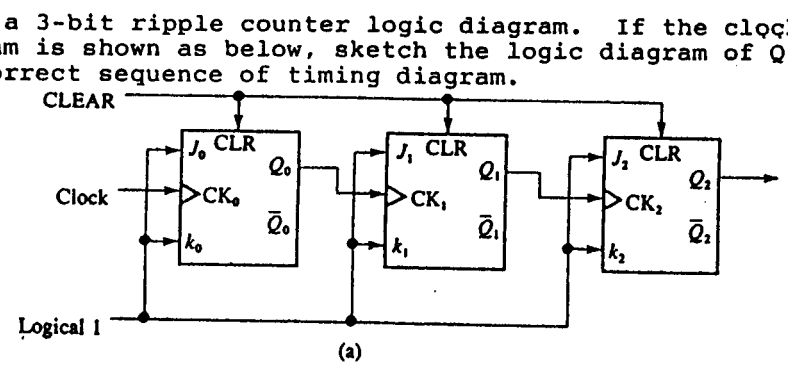
4. In Figure 1, what is the purpose to apply the capacitors, C_1 and C_2 ?
   Following Problem 2, formulate the equation to calculate C_1 and C_2.. (10%)

Part B.

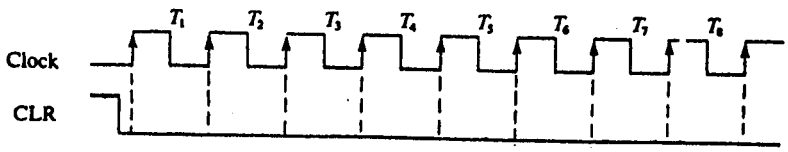
5. Derive the Boolean expression of Figure 2. Find the possible combination of inputs X, Y, Z to get output F logic 1. Assume positive logic is applied. (10%)



6. Figure 3 is a 3-bit ripple counter logic diagram. If the clock and clear diagram is shown as below, sketch the logic diagram of Q_1 and Q_2 following correct sequence of timing diagram. (10%)



(a)



Part C

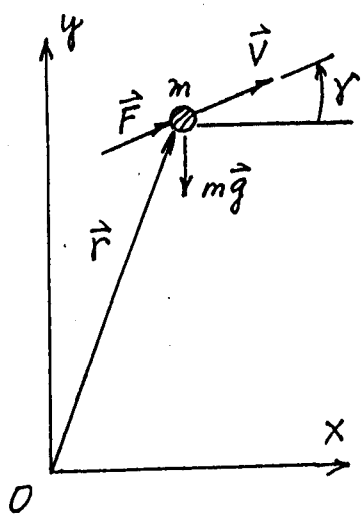
〔第七題〕 在右圖中，考慮一質點，其質量爲m，受到力F與重力mg之作用。力F總是沿著速度V之方向，重力 係沿著負y軸之方向，xy爲慣性軸，V與x軸之夾角爲γ。利用(1)位置向量之微分爲速度，(2)加速度爲單位質量所受之總力，

1. 導出運動方程式，並以一階微分方程式表示之，此即，將運動方程式寫成

$$\dot{x} = f(x, u)$$

之形式，式中，$x = \lfloor x(t)\ y(t)\ V(t)\ \gamma(t) \rfloor^T$爲描述此質點運動所需最少之變數，亦稱爲狀態變數(state variables)，$u = \lfloor m\ g\ F(t) \rfloor^T$，其中$g$爲重力加速度，在此係假設爲常數。 (15%)

2. 用數質分析法解此方程式與利用計算機模擬(simulate)此質點運動有何關連性？ (5%)



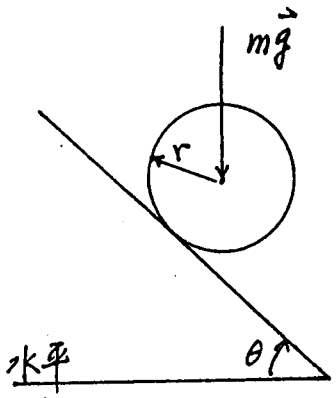
图：第七題

〔第八題〕 在右圖中，考慮一半徑爲r，質量爲m之均勻實心圓盤，置於與水平夾角爲θ之斜坡上，重力加速度爲g，

1. 若圓盤與斜坡均爲光滑無摩擦之表面，求圓盤之角加速度與其中心點之加速度。 (7%)

2. 若圓盤爲純滾動，求圓盤之角加速度與其中心點之加速度。 (7%)

3. 若圓盤於一平面($\theta = 0$)之上純滾動，接觸處之摩擦力係與圓盤運動之方向同向或反向？圓盤應加速或減速？試以作用於圓盤之力，與其對於圓盤中心點所產生之力矩說明之。 (6%)



图：第八題