110 學年度四技二專第一次聯合模擬考試
電機與電子群　專業科目(一)　詳解

110-1-03-4、110-1-04-4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	D	B	C	D	D	C	D	C	A	D	B	C	A	C	B	C	C	A	D	B	C	A	B	C
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	B	D	B	D	A	C	B	C	B	A	B	C	D	A	A	B	C	D	B	A	A	D	A	B

第一部分：基本電學

1. $\eta\% = \frac{P_o}{P_i} \times 100\% = \frac{5 \times 746}{100 \times 40} = 93.25\%$

2. (1) 拉長前 $R = \frac{1}{5}\,\Omega$

   (2) 拉長後電阻變爲 $(\frac{1}{5}) \times 2^4 = \frac{16}{5}\,\Omega$

   (3) 拉長後的電導 $G = \frac{5}{16}\,S$

3. (1) 棕綠紅金爲 $1500\,\Omega \pm 5\%$ ；範圍爲 1425 Ω~1575 Ω

   (2) 紫綠棕銀爲 $750\,\Omega \pm 10\%$ ；範圍爲 675 Ω~825 Ω

   (3) $I_{max} = \frac{21\,V}{1425\,\Omega + 675\,\Omega} = 10\,mA$

4. (1) $V_2 = 15\,V - 10\,V = 5\,V$

   (2) $I = \frac{5\,V}{50\,\Omega} = 0.1\,A = 100\,mA$

   (3) R_1 所消耗的功率爲

   $P = V_1 \times I = 10\,V \times 100\,mA = 1\,W$

5. (1) 並聯電路的電壓相同， $R_2 = \frac{12\,V}{4\,mA} = 3\,k\Omega$

   (2) $R_1 = 2R_2 = 3R_3$

   因此可以得到 $R_1 = 6\,k\Omega$ ， $R_3 = 2\,k\Omega$

   (3) $I_3 = \frac{12\,V}{2\,k\Omega} = 6\,mA$

6. (1) $8\,\Omega/10\,W \Rightarrow V^2 = 80$

   $1\,\Omega/15\,W \Rightarrow V^2 = 15$

   $1\,\Omega/12\,W \Rightarrow V^2 = 12$

   (2) 選擇電壓爲最小者，因此

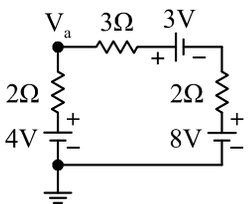
   $P = \frac{V^2}{R} = \frac{12}{8 // 1 // 1} = 25.5\,W$

8. (1) $I = \frac{V_b - V_c}{1\,\Omega} = \frac{-26\,V - (-30\,V)}{1\,\Omega} = \frac{4\,V}{1\,\Omega} = 4\,A$

   (2) $\frac{40\,V}{4\,A} = 10\,\Omega$

   因此電阻 $R = 10\,\Omega - 1\,\Omega - 4\,\Omega = 5\,\Omega$

9. (1) 電路化簡如下



   (2) $I = \frac{8+3-4}{2+3+2} = 1\,A$ (逆時針)； $V_a = 4 + 2 \times 1 = 6\,V$

10. $\frac{V-60}{5} + \frac{V-0}{10} + \frac{V-56}{2} = 0 \Rightarrow V = 50\,V$

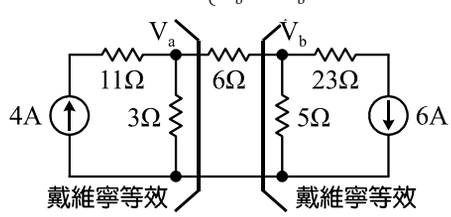
    $\therefore I_{10\,\Omega} = \frac{50-0}{10} = 5\,A$ (向下)

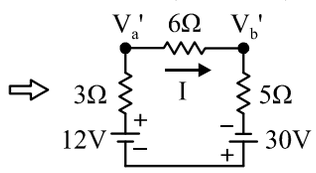
11. $\frac{E_T - 5I_T}{5+2} = 3 \Rightarrow E_T - 5I_T = 21$

12. (1) 取雙戴維寧等效電路

    (2) $I = \frac{30+12}{3+6+5} = 3\,A$

    (3) 端點等效電壓 $\begin{cases} V_a' = V_a = 12 - 3 \times 3 = 3\,V \\ V_b' = V_b = -30 + 3 \times 5 = -15\,V \end{cases}$





13. (1) 戴維寧等效電壓 $E_{th} = \frac{\frac{24}{6} + 3}{\frac{1}{6} + \frac{1}{6}} = 21\,V$

    (2) 戴維寧等效電阻 $R_{th} = 6\,\Omega // 6\,\Omega = 3\,\Omega$ ，該電阻相當於諾頓等效電阻 R_N

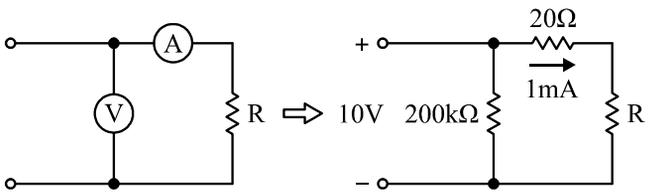
    (3) 諾頓等效電流 $I_N = \frac{E_{th}}{R_{th}} = \frac{21}{3} = 7\,A$

第二部分：基本電學實習

20. (1) 測量值 $R_M = \frac{10}{1\,mA} = 10\,k\Omega$

(2) 將電路化簡如下，實際值

$R_T = \frac{10}{1\,mA} - 20 = 9.98\,k\Omega$



(3) 誤差百分比 $\varepsilon\% = \frac{\text{測量值} - \text{實際值}}{\text{實際值}} \times 100\%$

$= \frac{10 - 9.98}{9.98} \times 100\% \approx 0.2\%$

(4) 待測電阻的測量值

$R_T \geq \sqrt{R_V \times R_A} \Rightarrow 10\,k\Omega \geq \sqrt{200\,k\Omega \times 20\,\Omega}$

所以宜採用高電阻之測量方法，因此伏特表與安培計之接線不必更換

22. (1) 開關 S 打開時，電壓表指示 3 V，此電壓爲電源電壓 3 V

(2) 開關 S 閉合時，電壓表指示 2 V

$\frac{3}{R+10} = \frac{2}{10} \Rightarrow R = 5\,\Omega$

23. $R_X \times R_B = R_Y \times R_A$

$\Rightarrow R_X \times 100\,k\Omega = 100\,k\Omega \times 20\,k\Omega \Rightarrow R_X = 20\,k\Omega$

24. 此題運用重疊定理，(a)圖與(c)圖的電流重疊的結果爲(b)圖，所以(c)圖爲 3 A

第三部分：電子學

29. (1) 平均值： $V_{av} = \frac{10\,V \times 4\,ms - 10 \times 1\,ms}{5\,ms} = 6\,V$

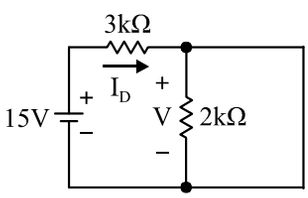
(2) 工作週期(duty cycle)

$= \frac{T_W}{T} \times 100\% = \frac{4\,ms}{5\,ms} \times 100\% = 80\%$ ，屬於寬幅波

30. $r_d = \frac{\eta V_T}{I_D} = \frac{26\,mV}{6.5\,mA} = 4\,\Omega$

31. 二極體順向偏壓時視爲短路，因此

(1) $I_D = \frac{15\,V}{3\,k\Omega} = 5\,mA$　(2) $V = 0$ 伏特



34. $\beta \times I_B \geq I_{C(sat)} \Rightarrow \beta \times \frac{V_i - V_{BE(t)}}{R_B} \geq \frac{V_{CC} - V_{LED(ON)} - V_{CE(sat)}}{R_C}$

$\Rightarrow 100 \times \frac{3\,V - 0.6\,V}{50\,k\Omega} \geq \frac{12 - 1.6 - 0.2}{R_C} \Rightarrow R_C \geq 2.125\,k\Omega$

故集極電阻 R_C 的最小值爲 2.125 kΩ

35. (1) 輸入迴路：利用克西荷夫電壓定律(KVL)，可得輸入迴路 $V_{EE} = V_{BE} + I_E \times R_E$

$I_E = \frac{V_{EE} - V_{BE}}{R_E} = \frac{10.7 - 0.7}{2.5\,k\Omega} = 4\,mA$

(2) 集極飽和電流

$I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)} + V_{BE}}{R_C} \approx \frac{V_{CC}}{R_C} = \frac{18\,V}{2\,k\Omega} = 9\,mA$

(3) 集極電流 $I_C = \alpha \times I_E = 0.95 \times 4\,mA = 3.8\,mA$

(4) $I_C < I_{C(sat)}$，故電晶體工作於主動區

(5) $V_{CB} = V_{CC} - I_C \times R_C = 18\,V - 3.8\,mA \times 2\,k\Omega = 10.4\,V$

36. $\beta = \frac{I_C}{I_B} = \frac{(\frac{12\,V - 6\,V}{2\,k\Omega})}{\frac{12\,V - 0.7\,V}{390\,k\Omega}} \approx 104$

37. (1) $\beta = g_m \times r_\pi = 50\,mS \times 3.98\,k\Omega = 199$

(2) $r_\pi = (1+\beta) \times r_e \Rightarrow 3980 = (1+199) \times r_e \Rightarrow r_e = 19.9\,\Omega$

38. (A) $Z_i = R_S + Z_i' = R_S + [R_B \,//\, (r_\pi + (1+\beta) \times R_E)]$

$= 1\,k\Omega + [450\,k\Omega \,//\, (1\,k\Omega + (1+99) \times 300)]$

$= 1\,k\Omega + [450\,k\Omega \,//\, 31\,k\Omega] \approx 30\,k\Omega$

(B) $Z_o = Z_o' \,//\, R_L = \infty \,//\, R_C \,//\, R_L = R_C \,//\, R_L$

$= 1.8\,k\Omega \,//\, 1.2\,k\Omega = 0.72\,k\Omega$

(C) $A_{VS} = \frac{v_o}{v_S} = \frac{v_o}{v_i} \times \frac{v_i}{v_S}$

$= -\beta \times \frac{R_C \,//\, R_L}{r_\pi + (1+\beta) \times R_E} \times \frac{i_i \times Z_i'}{i_i \times (R_S + Z_i')}$

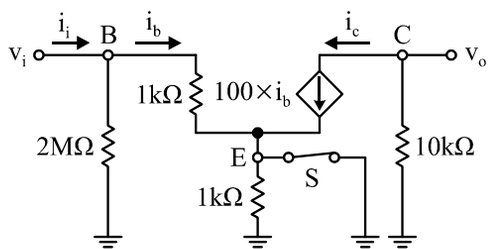
$= -99 \times \frac{1.8\,k\Omega \,//\, 1.2\,k\Omega}{31\,k\Omega} \times \frac{(31\,k\Omega \,//\, 450\,k\Omega)}{1\,k\Omega + (31\,k\Omega \,//\, 450\,k\Omega)}$

≈ -2.2

(D) $A_{is} = -\beta \times \frac{R_B}{R_B + [r_\pi + (1+\beta) \times R_E]} \times \frac{R_C}{R_C + R_L}$

$= -99 \times \frac{450\,k\Omega}{450\,k\Omega + 31\,k\Omega} \times \frac{1.8\,k\Omega}{1.8\,k\Omega + 1.2\,k\Omega} \approx -55.6$

39.



(1) 開關 S 打開後的電壓增益 A_V

近似解： $A_{V1} = -\frac{R_C}{R_E} = -\frac{10\,k\Omega}{1\,k\Omega} \approx -10$

(2) 開關 S 閉合後的電壓增益 A_V

$A_{V2} = \frac{v_o}{v_i} = -\beta \times \frac{R_C}{r_\pi} = -100 \times \frac{10\,k\Omega}{1\,k\Omega} = -1000$

由此可以得知旁路電容 C_E 可提高電壓增益(在本題中電壓增益增加了約 100 倍)

40. (1) 開關 S_1 與 S_2 皆閉合時：

$A_V = -\frac{\beta \times R_C}{r_\pi} = \frac{-50 \times 6\,k\Omega}{1\,k\Omega} = -300$

輸出電壓爲 $6\text{ V}+(-300)\times 1\sin(\omega t)\text{ mV}=5.7\text{ V}\sim 6.3\text{ V}$

(2) 開關 S_1 打開，而開關 S_2 打開時：

$$A_V\approx -\frac{R_C}{R_E}=-\frac{6\text{ k}\Omega}{2\text{ k}\Omega}=-3$$

(3) 輸出電壓爲 $6\text{ V}-3\times 1\sin(\omega t)\text{ mV}$ ，所以範圍爲 $\pm 3\text{ mV}$

(4) 開關狀態無論如何變化，直流電壓不變

第四部分：電子學實習

43. $R_{S(\min)}=\dfrac{6\text{ V}-1.5\text{ V}}{50\text{ mA}}=90\,\Omega$

45. (1) $R_{BB}=\dfrac{20\text{ k}}{1+5}=\dfrac{20\text{ k}}{6}\,\Omega$

$$V_{BB}=-12\times\frac{4\text{ k}}{20\text{ k}+4\text{ k}}=-2\text{ V}$$

(2) $I_C\fallingdotseq I_E=\dfrac{-0.7+2}{\dfrac{20\text{ k}}{600}+1\text{ k}}\fallingdotseq 1.3\text{ mA}$

46. $R_B\downarrow I_B\uparrow I_C\uparrow V_{CE}\downarrow$(工作點可趨近於負載線中點)

47. (B) 斜率不變

(C) 僅將開關 SW_1 閉合；輸出有直流成分

(D) 直流工作點與電容器的打開或閉合無關

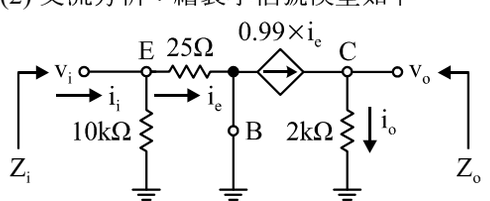
48. (1) 直流分析：(此電路爲共基極偏壓組態)

① $I_E=\dfrac{10.7\text{ V}-0.7\text{ V}}{10\text{ k}\Omega}=1\text{ mA}$

$I_C=\alpha\times I_E=0.99\times 1\text{ mA}=0.99\text{ mA}$

② 集極飽和電流 $I_{C(sat)}=\dfrac{10\text{ V}-0.5\text{ V}}{2\text{ k}\Omega}=4.75\text{ mA}$

(2) 交流分析：繪製小信號模型如下



① 輸入阻抗 $Z_i=10\text{ k}\Omega\,//\,25\,\Omega\approx 25\,\Omega$

② 輸出阻抗 $Z_o=\infty\,//\,R_C=\infty\,//\,2\text{ k}\Omega=2\text{ k}\Omega$

③ 電壓增益 $A_V=\dfrac{v_o}{v_i}=\dfrac{0.99\times 2\text{ k}\Omega}{25\,\Omega}=79.2$

④ 電流增益 $A_i=\dfrac{i_o}{i_i}=\dfrac{10\text{ k}\Omega}{10\text{ k}\Omega+25\,\Omega}\times 0.99\approx 0.99$