103 學年度四技二專第三次聯合模擬考試
電機與電子群　專業科目(一)　詳解

103-3-03-4、103-3-04-4

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
C	B	C	A	C	D	B	B	C	D	C	A	B	D	A	C	B	A	B	D	A	B	B	D	A
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	D	B	D	A	D	C	C	B	B	D	C	A	D	A	B	C	D	C	B	A	A	C	B	D

第一部分：基本電學

1. $W = FS = Pt = IVt$，$\because \eta = \frac{W_o}{W_i} = \frac{FS}{IVt}$

   $\therefore I = \frac{FS}{Vt\eta} = \frac{200\times10}{100\times5\times0.8} = 5\ A$

2. $\frac{R_{\text{甲}}}{R_{\text{乙}}} = \frac{\ell_{\text{甲}}}{\ell_{\text{乙}}}\times\frac{A_{\text{乙}}}{A_{\text{甲}}} = \frac{L}{4L}\times\frac{2S}{S} = \frac{1}{2}$

   又 $V = IR$，$\therefore V \propto R$，$\frac{V_{\text{乙}}}{V_{\text{甲}}} = \frac{2}{1}$

3. 黃、黑、金、金 $\Rightarrow 40\times10^{-1}\pm5\% = 4\ \Omega\pm5\%$

   $R_{min} = 4\ \Omega\times(1-5\%) = 3.8\ \Omega$

   $\therefore P_{max} = \frac{V^2}{R} = \frac{10^2}{3.8} = 26.3\ W$

4. $I_T = \frac{6}{\frac{R}{3}} = \frac{18}{R}\ A$，$V_C = I_T\times\frac{R}{2} = \frac{18}{R}\times\frac{R}{2} = 9\ V$

   $V_A = I_T\times R = \frac{18}{R}\times R = 18\ V$

   $E = V_A + V_B + V_C = 6+9+18 = 33\ V$

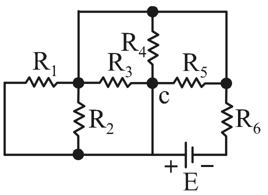
5. 合併同電位點如右圖

   $R_T = \frac{10}{5} + R_6 = 2+10 = 12\ \Omega$

   $I_T = \frac{E}{R_T} = \frac{60}{12} = 5\ A$

   $I_{R3} = \frac{I_T}{5} = \frac{5}{5} = 1\ A$

   $P_{R3\Omega} = I^2R = 1^2\times10 = 10\ W$



6. $\because V_1 = 0.5\ E$，$\therefore R_1 = R_2$

   $R_T = [(2R_2 // R_2) + R_1] = [(2R_2 // R_2) + R_2] = \frac{5}{3}R_2\ \Omega$

   $I_T = \frac{E}{R_T} = \frac{E}{\frac{5}{3}R_2} = \frac{3E}{5R_2}\ A$

   $I_2 = I_T\times\frac{3E}{5R_2}\times\frac{R_2}{R_2+2R_2} = \frac{E}{5R_2}\ A$

   $\therefore V_2 = I_2\times R_2 = \frac{E}{5R_2}\times R_2 = \frac{1}{5}E$

7. $R_T = 1+(3//9)+(5//15)+2 = 1+6+2 = 9\ \Omega$

   $I_T = \frac{E}{R_T} = \frac{108}{9} = 12\ A$，$I_1 = I_T\times\frac{3}{9+3} = 3\ A$

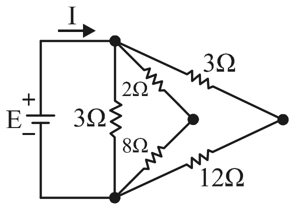
8. 因 $12\times2 = 3\times8$，電橋達平衡，$10\ \Omega$ 電阻可移除

   $I_{10\Omega} = 0\ A$，$P_{10\Omega} = 0\ W$

   $R_T = 3//(2+8)//(3+12) = 3//6 = 2\ \Omega$

   $\therefore E = I\times R_T = 2\times6 = 12\ V$

原圖



9. $\begin{cases}(3+12)I_1 - 12I_2 = 12\\ I_2 = -6\end{cases}$，$I_1 = -4\ A$

   化簡得 $I = I_1 - I_2 = -4-(-6) = 2\ A$

10. $V_a = \frac{9+0+\frac{12}{2+2}}{\frac{1}{4}+\frac{1}{2+2}} = 24\ V$

    $I_X = \frac{E-V_a}{2+2} = \frac{12-24}{4} = -3\ A$

11. 球內之電場強度為 0，球表面之電場強度最強

12. $\because W = \frac{1}{2}CV^2$，並聯 $\Rightarrow$ V 相同，$\therefore W\propto C$

    $W_1：W_2：W_3 = 2：3：6$

13. $H = \frac{NI}{\ell} = \frac{100\times1}{1} = 1\times10^2$ 牛頓/韋伯

    $B = \mu H = 4\pi\times10^{-7}\times1\times10^2 = 4\pi\times10^{-5}$ 韋伯/平方公尺

    $\phi = A\times B = \pi\times(0.05)^2\times4\pi\times10^{-5} \fallingdotseq 9.87\times10^{-7}$ 韋伯

14. $L = N\frac{\Delta\phi}{\Delta I} = N\frac{\phi}{I} = 500\times\frac{2\times10^6\times10^{-8}}{4} = 2.5\ H$

    (注意單位)

    $\because L = \frac{\mu AN^2}{\ell} = \frac{N^2}{R}$，$\therefore L\propto N^2$

    $\therefore L' = L(\frac{N'}{N})^2 = 2.5\times(\frac{750}{500})^2 = 5.625\ H$

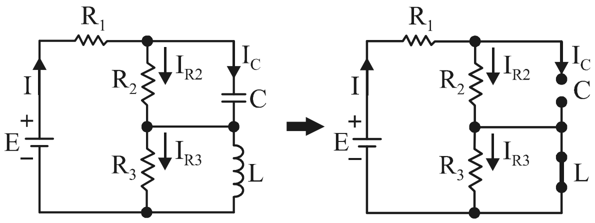
15. $H = \frac{I}{2\pi r}$，$\therefore H\propto\frac{1}{r}$，$\frac{H_1}{H} = \frac{8}{4} = 2$

16. 開關閉合很久達穩態後，電感器視為短路，電容器視為斷路，如下圖所示 8 kΩ 電阻被旁路

$\therefore I_C = 0\,\text{mA}$

$\therefore R_T = R_1 + R_2 = 10\text{ k} + 4\text{ k} = 14\,\text{k}\Omega$

$\therefore I = \dfrac{V}{R_T} = \dfrac{28}{14\text{ k}} = 2\,\text{mA} = I_{R2}$



17. 先求 20 μF 兩端之戴維寧等效電路

$E_{TH} = V_{60k} = 90 \times \dfrac{60\text{ k}}{30\text{ k} + 60\text{ k}} = 60\text{ V}$

$R_{TH} = 10\text{ k} + (30\text{ k} \,//\, 60\text{ k}) = 30\text{ k}\Omega$

$\therefore i_C(t) = \dfrac{60}{30\text{ k}} \times e^{-\frac{0.6}{30k \times 20\mu}} = 2e^{-1}\text{ mA}$

18. $v_R(0) = -(v_R + E_2) = -(60 + 30) = -90\text{ V}$

$\tau = 500 \times 10\,\mu = 5\text{ mS}$

$v_R(t) = v_R(0) \times e^{-\frac{t}{\tau}} = -90 \times e^{-\frac{t}{5\times 10^{-3}}} = -90 \times e^{-200t}$ 伏特

19. $V_m = \sqrt{2}\,V_{rms} = 100\sqrt{2}\text{ V}$，$V_{av} = \dfrac{V_m}{\pi} = \dfrac{100\sqrt{2}}{\pi} = 45\text{ V}$

20. $\theta = \omega t = 2\pi f t$，$\therefore 18° = 2\pi \times 100 \times \dfrac{180°}{\pi} \times t$

$\therefore t = 0.5\text{ ms}$

21. $\overline{Z} = \dfrac{\overline{E}}{\overline{I}} = \dfrac{100}{10} = 10\,\Omega = R + jX_L = 8 + jX_L$

得 $X_L = \sqrt{10^2 - 8^2} = 6\,\Omega$

得 $L = \dfrac{6}{2 \times 3.14 \times 60} \cong 16\text{ mH}$

因此 $L \geq 16\text{ mH}$

22. $\overline{Z}_1 = R + j(X_L - X_C) = 40 + j(30 - 60)$

$= 40 - j30 = 50\angle -37°\,\Omega$

當 $f' = 2f \Rightarrow X'_L = 2X_L = 60\,\Omega$，$X'_C = \dfrac{1}{2}X_C = 30\,\Omega$

$\therefore \overline{Z}_2 = 40 + j(60 - 30) = 40 + j30 = 50\angle 37°\,\Omega$

$\therefore Z_1 = Z_2 \Rightarrow I_2 = I_1$，故為 1 倍，但 $\overline{Z}_1 \neq \overline{Z}_2$

23. $I_R = \dfrac{P}{E} = \dfrac{3.6\text{ k}}{120} = 30\text{ A}$

$I_X = \sqrt{I^2 - {I_R}^2} = \sqrt{50^2 - 30^2} = 40\text{ A}$

24. $P_{max} = P + S = EI(\cos\theta + 1) = \dfrac{110}{\sqrt{2}} \times \dfrac{5}{\sqrt{2}}(\cos 30° + 1)$

$= 513\text{ W}$

25. $p(\dfrac{1}{100}) = 1000 - 2000\cos(628 \times \dfrac{1}{100} \times \dfrac{180°}{\pi} + 60°)$

$= 1000 - 2000\cos 60° = 0\text{ W}$

第二部分：電子學

26. $V(t) = 50\sqrt{2} + 60\sin t - 60\cos(t - 30°) + 80\sin 3t$

$= 50\sqrt{2} + \underline{60\sin t - 60\sin(t + 60°)} + 80\sin 3t$

$= 50\sqrt{2} + \underline{60\sin(t - 60°)} + 80\sin 3t$

$V_{rms} = [(50\sqrt{2})^2 + (\dfrac{60}{\sqrt{2}})^2 + (\dfrac{80}{\sqrt{2}})^2]^{\frac{1}{2}} = \sqrt{10000} = 100\text{ V}$

27. (A) 逆向漏電流隨溫度上升而上升
(B) 擴散電容只有在順向偏壓時才存在
(C) 電表的探針和二極體的內建電位會互相抵消，因此無法直接測得內建電位

28. $V_i > 5.7\text{ V}$，D 導通，$V_o = 5.7\text{ V}$

$V_i < 5.7\text{ V}$，D 截止，$V_o = V_i$

29. D_1 截止、D_2 導通，$I = 0$

因此 $\dfrac{5 - V_o}{5\text{ k}} = \dfrac{V_o - (-5)}{2.5\text{ k}}$，故 $V_o = -\dfrac{5}{3}\text{ V}$

30. 二次側電壓 $V_2 = \dfrac{120}{5} = 24\text{ V}$

負載峰值電壓 $V_P = 24\sqrt{2} - 0.7 = 34 - 0.7 = 33.3\text{ V}$

負載 R_L 的直流電壓 $V_{dc} \fallingdotseq \dfrac{V_p}{\pi} = \dfrac{33.3}{\pi} = 10.6\text{ V}$

31. 二次側電壓 $V_2 = \dfrac{120}{5} = 24\text{ V}$

二次側峰值電壓 $V_P = 24\sqrt{2} = 34\text{ V}$

負載電流 $I_L = \dfrac{V_P}{R_L} = \dfrac{34}{5\text{ k}} = 6.8\text{ mA}$

$V_{r(P-P)} = \dfrac{I_L}{2f_i \times C} = \dfrac{6.8 \times 10^{-3}}{2 \times 60 \times C} = 0.566\text{ V}$

$C \fallingdotseq 100\,\mu\text{F}$

33. (A) 在飽和區時，I_C 隨 V_{CE} 增加而增加；在主動區時，I_C 才是幾乎和 V_{CE} 無關
(B) 在截止區時，I_B 趨近於 0，V_{CE} 不必一定趨近於 0
(D) 電流增益 $I_C = \beta_{dc} I_B$ 僅在主動區成立

34. $I_C \fallingdotseq I_E = \dfrac{V_{CC} - V_{BE}}{R_C + \dfrac{R_B}{\beta_{dc}}}$ ……①

當 $\beta_{dc} = 100$ 時，$I_C = 4.77\text{ mA}$

由①式可得 $R_B = 200\text{ k}\Omega$

當 $\beta_{dc} = 300$ 時，由①式可得 $I_C \fallingdotseq 8.58\text{ mA}$

35. $V_B = \dfrac{V_{CC} \times R_2}{R_1 + R_2} = -1.8\text{ V}$

$V_E = V_B + V_{EB} = -1.1\text{ V}$

$I_C = I_E = \dfrac{-V_E}{R_E} = 1.1\text{ mA}$

$V_C = V_{CC} + I_C R_C = -6.04\text{ V}$

$V_{CE} = V_C - V_E = -4.94\text{ V}$

36. 功率增益：CE > CB > CC

37. $V_{BQ} = \frac{10 \times 2.2\ k}{10\ k + 2.2\ k} = 1.8\ V$，$V_{EQ} = 1.8 - 0.7 = 1.1\ V$

$I_{EQ} \fallingdotseq \frac{1.1}{180 + 820} = 1.1\ mA$，$r_e = \frac{25\ mV}{1.1\ mA} = 22.7\ \Omega$

$Z_{in(base)} = (1 + 200)(180 + 22.7) = 40.7\ k\Omega$

$Z_{in(stage)} = 10\ k \parallel 2.2\ k \parallel 40.7\ k = 1.72\ k\Omega$

$V_{in} = 50\ mV \times \frac{1.72\ k}{600 + 1.72\ k} = 37\ mV$

$Z_{out(collector)} = 3.6\ k \parallel 10\ k = 2.65\ k\Omega$

$V_{out} = -37\ mV \times \frac{2.65\ k}{180 + 22.7} = -485\ mV$

38. $V_{BQ} = 30 \times \frac{10\ k}{10\ k + 10\ k} = 15\ V$

$I_{EQ} \fallingdotseq \frac{15}{100} = 150\ mA$

$r_e = \frac{25\ mV}{150\ mA} = 0.167\ \Omega$

$Z_{out} = 100 \parallel [0.167 + \frac{(10\ k \parallel 10\ k \parallel 600)}{300}] = 1.91\ \Omega$

40. $\frac{V_o}{V_{i2}} = 240 \times \frac{8.2\ k}{5.1\ k + 8.2\ k} = 148$

$\frac{V_{i2}}{V_{i1}} = \frac{1 \times 26}{12 + 26} = 0.68$

$\frac{V_{i1}}{V_{in}} = \frac{10\ k}{1\ k + 10\ k} = 0.91$

$\frac{V_o}{V_{in}} = (\frac{V_o}{V_{i2}})(\frac{V_{i2}}{V_{i1}})(\frac{V_{i1}}{V_{in}}) = 91.6$

41. Q_1爲 CB 放大器，$\frac{V_o}{V_x} = \frac{\alpha R_c}{r_e} = g_m R_c$

Q_2爲 CE 放大器，$\frac{V_x}{V_{in}} = -1$

$\frac{V_o}{V_{in}} = (\frac{V_o}{V_x})(\frac{V_x}{V_{in}}) = -g_m R_c$

42. MOSFET 操作速度較 BJT 慢

43. 假設 Q 操作在飽和區，則 $I_D = I_{DSS}(1 - \frac{V_{GS}}{V_P})^2$

即 $2\ mA = 8\ mA(1 + \frac{V_{GS}}{4})^2$，可得 $V_{GS} = -2\ V$

$\because V_G = 0$，$\therefore V_S = 2\ V$，$V_D = V_S + V_{DS} = 8\ V$

$V_{GD} = V_G - V_D = 0 - 8 = -8\ V < -4 = V_P$

(Q 確實操作在飽和區)

$R_S = \frac{V_S}{I_D} = \frac{2}{2\ m} = 1\ k\Omega$

$R_D = \frac{10 - V_D}{I_D} = \frac{10 - 8}{2\ m} = 1\ k\Omega$

44. Q_1 必操作在飽和區，且 $I_{G1} = I_{G2} = 0$

$V_{G1} = V_{G2} = V_{GS1} = V_{GS2} = V_{D1}$，因此

$I_{D1} = \frac{10 - V_{D1}}{15\ k}$ ……①

$I_{D1} = 0.1m(V_{D1} - 2)^2$ ……②

由①②式可解得 $V_{D1} = 4\ V$，$I_{D1} = 0.4\ mA$

$V_{GS2} = V_{D1} = 4\ V$，假設 Q_2 操作在飽和區，因 Q_1 與 Q_2 特性相同，所以 $I_{D2} = 0.1m(4 - 2)^2 = 0.4\ mA$

$V_{D2} = 10 - 0.4\ m \times 10\ k = 6\ V$

$V_{GD2} = V_{G2} - V_{D2} = 4 - 6 = -2\ V < 2 = V_t$

(Q_2 確實操作在飽和區)

46. $g_{m0} = \frac{2I_{DSS}}{|V_P|} = 5\ mS$

$g_m = g_{m0}(1 - \frac{V_{GSQ}}{V_P}) = 2.25\ mS$

$V_o = g_m R_D V_i = 324\ mV$

47. $g_m = 2K(V_{GSQ} - V_t) = 1.63\ mS$

$\frac{V_o}{V_i} \fallingdotseq -g_m(r_o \parallel R_D \parallel R_G) = -3.2$

48. (A) 當負載電阻等於 10 kΩ 時，此運算放大器的輸出電壓最大峰對峰值(MPP)約於 27 V，因此飽和電壓爲 ±13.5 V

(B) 輸入電壓爲直流時，此運算放大器的開路電壓增益約爲 100,000 倍

(C) 欲使運算放大器進入負飽和

$V_i \geq \frac{13.5}{100000} = 135\ \mu V$

(D) 此電路無負回授，虛短路不成立

49. (A) 增益爲 0 dB(或增益爲 1)時，此時的頻率稱爲單位增益頻寬 $f = f_{unity} = 1\ MHz$

(B) 因 $f_{unity} = 1\ MHz$ 爲單位增益頻寬，所以當頻率爲 1 MHz 時，$V_o = V_i = 10\ mV_{P-P}$

(C) 直流增益 $A_0 = 20\log\left|\frac{-R_2}{R_1}\right| = 20\ dB$

(D) 此電路最佳工作頻率範圍在 0 至 50 kHz 之間

50. 此電路爲反相加法器

$V_{out} = -(V_3 + 0.5V_2 + 0.25V_1 + 0.125V_0)$

輸出電壓的最大值發生在 $V_3 = V_2 = V_1 = V_0 = 1$ 時

$V_{out(max)} = -(1 + 0.5 + 0.25 + 0.125) = -1.875\ V$