

109 學年度四技二專第四次聯合模擬考試 電機與電子群 專業科目(一) 詳解

109-4-03-4、109-4-04-4

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

第一部分：電子學

1. 正弦波： $10\sqrt{2}\sin(314t+37^\circ)+10\sqrt{2}\sin(314t-127^\circ)$
 $=10\angle 37^\circ+10\angle -127^\circ=8+j6-6-j8$
 $=2-j2=2\sqrt{2}\angle -45^\circ$

正弦波 $V_{rms}=2\sqrt{2}V$

有效值 $V_{rms}=\sqrt{(2\sqrt{2})^2+(2\sqrt{2})^2}=4V$

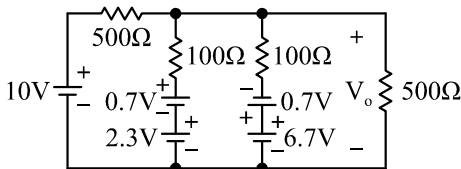
2. (C) 將磷元素摻入純矽半導體時，其總電子數等於總質子數

3. 設 D_1 、 D_2 皆導通

$$V_o = \left(\frac{10}{500} + \frac{0.7+2.3}{100} + \frac{-0.7+6.7}{100} \right) \times (500 // 500 // 100 // 100)$$

$$= \left(\frac{2}{100} + \frac{3}{100} + \frac{6}{100} \right) \times \frac{250}{6} = \frac{11}{100} \times \frac{250}{6} \doteq 4.6V$$

$\therefore 2.3V < 4.6V < 6.7V$ ，故假設成立 $V_o \doteq 4.6V$



4. $\frac{N_1}{N_2} = \frac{V_1}{V_2} \Rightarrow \frac{1}{2} = \frac{50}{V_2} \Rightarrow V_2 = 100V$

$$V_{rms2} = \frac{100}{2} = 50V$$

$$I_{rms2} = \frac{50}{10k} = 5mA$$

$\therefore P = 50 \times 5m = 250mW > 150mW$

$\therefore I_{rms2} = 0A$

5. $\therefore Q = C \times V_{r(p-p)} = I_{dc} \times T$

(1) $C \times V_{r(p-p)} = 40\mu C$ ， $V_{r(p-p)} = \frac{40\mu C}{20\mu F} = 2V$

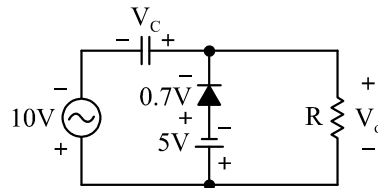
$$V_{r(rms)} = \frac{V_{r(p-p)}}{2\sqrt{3}} = \frac{2}{2\sqrt{3}} = \frac{1}{\sqrt{3}}V$$

(2) $I_{dc} \times T = 40\mu$

$$\frac{V_{dc}}{R_L} \times \frac{1}{f_o} = 40\mu$$
， $\frac{V_{dc}}{2k} \times \frac{1}{2 \times 100} = 40\mu$ ， $V_{dc} = 16V$

$$\therefore r\% = \frac{1}{16} \times 100\% \doteq 3.6\%$$

6. (1) 當輸入 $-10V$ 時



電容 C 充電 $V_c = 10 - 5 - 0.7 = 4.3V$

而 $V_o = -5 - 0.7 = -5.7V$

(2) 當輸入 $+10V$ 時

\therefore 電容放電，二極體 OFF

$$\therefore V_o = 10 + 4.3 = 14.3V$$

故 V_o 在 $-5.7V \sim 14.3V$ 範圍中

7. (A) 射極與集極對調時，增益降低，耐壓亦降低
- (B) 不可以使用兩個二極體來取代雙極性接面電晶體
- (C) NPN 電晶體為雙載子電晶體
8. \therefore 射基極順向偏壓，而集基極逆向偏壓
- \therefore 工作於作用區
9. \therefore 圖中只有 I_c 有變化， V_{CE} 固定

$$I_{C(sat)} = \frac{V_{CC}}{R_C}$$
，故只有 R_C 改變

10. (C) 於射極電阻並接一個旁路電容目的為提高電壓增益

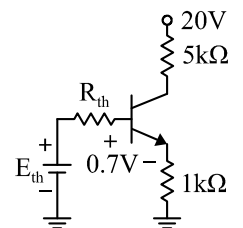
11. (B) 當光敏電阻被遮住時，LED 亮

12. $R_{th} = 90k // 10k = 9k\Omega$

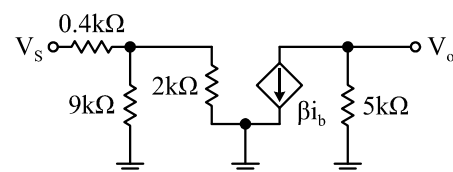
$$E_{th} = 20 \times \frac{10}{90+10} = 2V$$

$$I_B = \frac{2-0.7}{9k+91k} = 0.013mA$$

$$r_\pi = \frac{V_T}{I_B} = \frac{26m}{0.013m} = 2k\Omega$$



13. $|A_{VS}| = \left| \frac{V_o}{V_s} \right| = \left| \frac{V_o}{V_i} \times \frac{V_i}{V_s} \right|$
 $= \left| -90 \times \frac{5k}{2k} \times \frac{9k // 2k}{0.4k + (9k // 2k)} \right| = \left| -225 \times \frac{45}{56} \right| \doteq 181$



$$14. I_B = \frac{20.7 - 0.7}{800\text{ k} + (1 + 99) \times 2\text{ k}} = 20\ \mu\text{A}$$

$$r_\pi = \frac{V_T}{I_B} = \frac{26\text{ m}}{20\ \mu} = 1.3\text{ k}\Omega$$

$$Z_o = 2\text{ k} // \frac{1.3\text{ k}}{(1 + 99)} \doteq 13\ \Omega$$

$$15. (A) A_{VT(\text{dB})} = 25\text{ dB} + 15\text{ dB} + 20\log 100 = 80\text{ dB}$$

$$\Rightarrow A_{VT} = 10^4$$

$$(B) V_o = 12\text{ m} \times 10^4 = 120\text{ V}, V_L = 120 \times 3 = 360\text{ V}$$

$$\left(\frac{1}{3}\right)^2 = \frac{20}{R_L} \Rightarrow R_L = 180\ \Omega$$

$$\therefore I_L = \frac{360}{180} = 2\text{ A}$$

$$(C) \left(\frac{1}{3}\right)^2 = \frac{20}{R_L} \Rightarrow R_L = 180\ \Omega$$

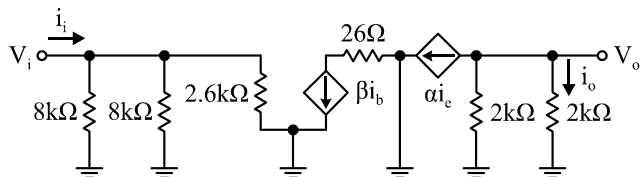
$$(D) V_L = 12\text{ m} \times 10^4 \times 3 = 360\text{ V}$$

$$16. r_e = 2.6\text{ k} \times (1 + 99) = 26\ \Omega$$

$$A_v = -99 \times \frac{26}{2.6\text{ k}} \times \frac{99}{100} \times \frac{2\text{ k} // 2\text{ k}}{26} = -37.7$$

$$A_i = A_v \times \frac{Z_i}{Z_L} = -37.7 \times \frac{8\text{ k} // 8\text{ k} // 2.6\text{ k}}{2\text{ k}} \doteq -29.7$$

$$|A_p| = |A_v \times A_i| = |-37.7 \times -29.7| \doteq 1120$$



17. (A) 增強型 MOSFET 與 I_{DSS} 無關

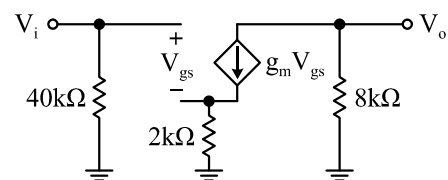
(B) 場效電晶體高頻響應差

(C) 稱為定電流區

$$18. V_{GS} = 27 \times \frac{60\text{ k}}{120\text{ k} + 60\text{ k}} - 2\text{ k} \times 2\text{ m} = 5\text{ V}$$

$$g_m = 2 \times 0.5\text{ m} \times (5 - 3) = 2\text{ mS}$$

$$|A_v| = \left| \frac{V_o}{V_i} \right| = \left| \frac{-g_m \times 8\text{ k}}{1 + g_m \times 2\text{ k}} \right| = \left| \frac{-2\text{ m} \times 8\text{ k}}{1 + 2\text{ m} \times 2\text{ k}} \right| = 3.2$$



19. (A)(D) 共源極組態

(C) 共閘極組態

$$20. Z_i \doteq R_s // \frac{1}{g_m} = 4\text{ k} // \frac{1}{1\text{ m}} = 0.8\text{ k}\Omega$$

21. (1) OPA1 為比較器

$$V_- = \left(\frac{12}{6\text{ k}} + \frac{8}{4\text{ k}} + \frac{6}{12\text{ k}} \right) \times (6\text{ k} // 4\text{ k} // 12\text{ k})$$

$$= 4.5\text{ m} \times 2\text{ k} = 9\text{ V} < 11\text{ V}$$

$$\therefore V_{o1} = +15\text{ V}$$

(2) OPA2 為反相放大器

$$V_{o2} = -\frac{2\text{ k}}{6\text{ k}} \times 15 = -5$$

(3) OPA3 為非反相放大器

$$V_o = \left(1 + \frac{2\text{ k}}{5\text{ k}} \right) \times -5 = -7$$

22. (A) 第一級為非反相極密特電路

23. (A) 無穩態多諧振盪器

(B) 工週期 50% 之無穩態多諧振盪器

(D) 雙穩態多諧振盪器

$$24. T_1 = 0.7(R_1 + R_2)C = 0.7(8\text{ k} + 8\text{ k}) \times 0.05\ \mu = 0.56\text{ ms}$$

$$T_2 = 0.7R_2C = 0.7 \times 8\text{ k} \times 0.05\ \mu = 0.28\text{ ms}$$

$$T = T_1 + T_2 = 0.56\text{ ms} + 0.28\text{ ms} = 0.84\text{ ms}$$

25. $\therefore f_i < f_L$

$$\therefore f_L = \frac{1}{2\pi R_1 C} = \frac{1}{2 \times 3.14 \times 2\text{ k} \times 0.1\ \mu} \doteq 796\text{ Hz}$$

故(A) 832 Hz > 796 Hz 不適合

第二部分：基本電學

26. (A) 小西瓜：一電子帶電量等於 1.602×10^{-19} 庫倫

(B) 妙妙：價電子吸收能量後成為自由電子

(D) 蕨蕨： 3×10^9 靜電庫倫等於 1 庫倫

$$27. \eta\% = \frac{P_i - P_{\text{Loss}}}{P_i} \times 100 = \frac{150 \times 3 - P_{\text{Loss}}}{150 \times 3} \times 100, P_{\text{Loss}} = 45\text{ W}$$

$$\therefore 1\text{ 度電} = 1\text{ kW-hr} \quad \therefore 0.045 \times 5 = 0.225\text{ 度}$$

$$28. H = ms\Delta T = 0.24\text{ Pt}$$

$$= 200 \times 1 \times (100 - 79) = 0.24 \times \frac{220^2}{55} \times t - 1.2t$$

$$t = 20\text{ s}$$

$$29. \text{室溫 } 25^\circ\text{C} \text{ 時, } \frac{75}{(R // R) + R} = 20, R = 2.5\ \Omega$$

$$\text{室溫 } t_2 \text{ 時, } \frac{75}{(R // R) + R} = 5, R = 10\ \Omega$$

$$\frac{T_0 - 25}{T_0 - 75} = \frac{2.5}{10} \Rightarrow T_0 = -125 \text{ 代入 } \textcircled{1}$$

$$\frac{|T_0| + 25}{|T_0| + t_2} = \frac{2.5}{10} \dots\dots \textcircled{1}, t_2 = 475^\circ\text{C}$$

$$30. 20I_1 + 7I_2 + 6I_3 = -2$$

$$a_{11} = 20$$

$$7I_1 + 9I_2 - 2I_3 = 11$$

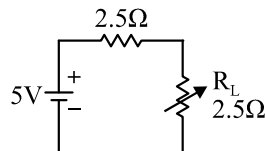
$$a_{22} = 9$$

$$6I_1 - 2I_2 + 12I_3 = -3$$

$$a_{33} = 12$$

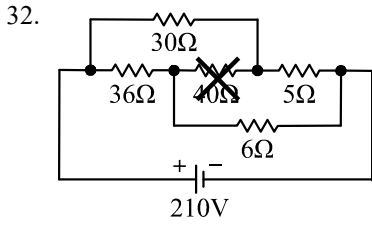
$$20 + 9 - 48 = -19$$

31. (A)(B)



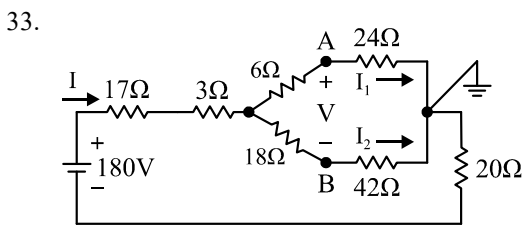
當 $R_L = 2.5 \Omega$ ，則 $P_{\max} = \frac{5^2}{4 \times 2.5} = 2.5 \text{ W}$

(D) 兩個電阻分別流過 2 A 與 4 A，所以總消耗功率為 100 W，由兩個電壓源提供，所以兩個電壓源總共應提供 100 W。 $20 \text{ V} \times 4 \text{ A} + 10 \text{ V} \times 2 \text{ A} = 100 \text{ W}$



6Ω 上 $I = \frac{210}{42} = 5 \text{ A}$

$P_{6\Omega} = I^2 R = 25 \times 6 = 150 \text{ W}$

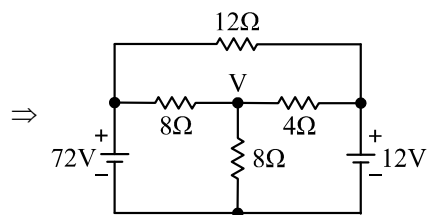
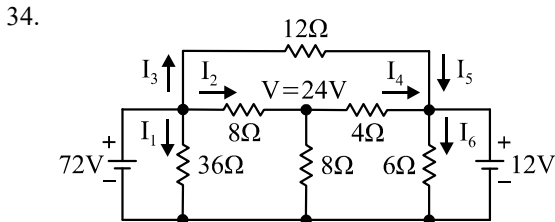


$R_T = 60 \Omega$ ， $I = \frac{180}{60} = 3 \text{ A}$

$I_1 = 3 \times \frac{60}{30+60} = 2 \text{ A}$ ， $I_2 = 3 \times \frac{30}{30+60} = 1 \text{ A}$

$V = V_{AB} = V_A - V_B$ ， $V_A = 2 \times 24 = 48 \text{ V}$

$V_B = 1 \times 42 = 42 \text{ V}$ ， $V = 48 - 42 = 6 \text{ V}$



$\frac{V-72}{8} + \frac{V}{8} + \frac{V-12}{4} = 0$ ， $V = 24 \text{ V}$

$I_1 = \frac{72}{36} = 2 \text{ A}$ ， $I_2 = \frac{72-24}{8} = 6 \text{ A}$ ， $I_3 = \frac{72-12}{12} = 5 \text{ A}$

$I_4 = \frac{24-12}{4} = 3 \text{ A}$ ， $I_5 = \frac{72-12}{12} = 5 \text{ A}$ ， $I_6 = 2 \text{ A}$

(A) 72 V 提供功率

$P = V(I_1 + I_2 + I_3) = 72 \times (2 + 6 + 5) = 936 \text{ W}$

(B) $P_{4\Omega} = V \times I_4 = (24-12) \times 3 = 36 \text{ W}$

(C) $P_{12\Omega} = V \times I_3 = (72-12) \times 5 = 300 \text{ W}$

(D) 12 V 消耗功率

$P = V \times (I_4 + I_5 - I_6) = 12 \times (3 + 5 - 2) = 72 \text{ W}$

35. $C_1 = 8.85 \times 10^{-12} \times 10 \times \frac{10^{-2}}{10^{-2}} = 8.85 \times 10^{-11} \text{ F}$

$C_2 = 8.85 \times 10^{-12} \times \frac{10^{-2}}{10^{-2}} = 8.85 \times 10^{-12} \text{ F}$

$C_{\text{ab串}} = C_1 // C_2 \doteq 8.04 \text{ pF}$

36. $V_A = 9 \times 10^9 \frac{72 \times 10^{-9}}{3} - 9 \times 10^9 \frac{18 \times 10^{-9}}{3} = 162 \text{ V}$

$V_B = 9 \times 10^9 \frac{72 \times 10^{-9}}{3} - 9 \times 10^9 \frac{18 \times 10^{-9}}{9} = 198 \text{ V}$

$V_C = 9 \times 10^9 \frac{72 \times 10^{-9}}{6} - 9 \times 10^9 \frac{18 \times 10^{-9}}{6} = 81 \text{ V}$

$W = QV_{AB} = 4(V_A - V_B) = 4(162 - 198) = -144 \text{ J}$

37. (B) 為為：磁場強度大小比較 $D > C > B > A$

38. 互消， $L_T = \frac{L_1 L_2 - M^2}{L_1 + L_2 + 2M} = \frac{16 \times 4 - 9}{20 + 2 \times 3} = \frac{55}{26}$

39. $e = L \frac{di}{dt} = L \frac{\Delta I}{\Delta t}$

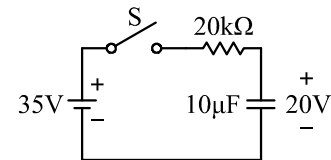
$t_1 \rightarrow t_2$ ， $\frac{\Delta I}{\Delta t} = \frac{0}{t_2 - t_1} = 0$

$e = 0$ ，所以電感器感應電勢為 0

40. $V_C(t) = E + (V_0 - E)e^{-\frac{t}{RC}} = 35 + (20 - 35)e^{-5t}$

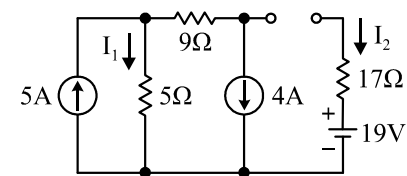
$\rightarrow t = 0.6$ 代入 $= 35 - 15e^{-3} \text{ V}$

$\tau = RC = 60 \text{ k} // 30 \text{ k} = 20 \text{ k} \times 10 \mu = 200 \text{ ms} = 0.2 \text{ s}$



41. 穩態時，L 視為短路，C 視為開路

$I_1 = 1 \text{ A}$ ， $I_2 = 0 \text{ A}$



42. $45 // 45 // 90 = \frac{90}{2+2+1} = 18 \Omega$

$P = \frac{V^2}{R}$ ， $75 = \frac{V^2}{12}$

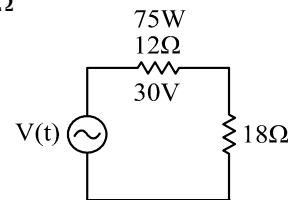
$\Rightarrow V_{12\Omega(\text{有效值})} = 30 \text{ V}$

$30 = V(t)_{(\text{rms})} \frac{12}{12+18}$

$V(t)_{(\text{rms})} = 75 \text{ V}$

$75 = \sqrt{\frac{(50\sqrt{3})^2 \times t_1}{t_2}} \Rightarrow 3t_2 = 4t_1$

$D\% = \frac{t_1}{t_2} \times 100\% = 75\%$



43. ① $V(t) = 3 + \sin(\omega t + 180^\circ)$

③ 平均值 3 V

④ 有效值 $V_{\text{rms}} = \sqrt{3^2 + \left(\frac{1}{\sqrt{2}}\right)^2} = \sqrt{9.5} \text{ V}$

44. $\omega = 5$ 時, $X_L = 5 \times 0.4 = 2 \Omega$, $X_C = \frac{1}{5 \times 0.1} = 2 \Omega$

達並聯諧振

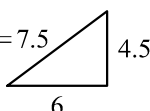
(A) 電源提供虛功率 0 VAR

(B) 電源提供平均功率 $\frac{\left(\frac{200}{\sqrt{2}}\right)^2}{2} = 10 \text{ kW}$

(C) 電源提供視在功率 = 平均功率 = 10 kVA

(D) $\omega = 5$ 時, 達並聯諧振, $Z = 2 \Omega$

此時 Z 最大, I 最小

45. 

P.F. = $\frac{6}{7.5} = 0.8$

功率因數與電壓大小的改變無關

46. (A) $|\bar{Z}| = 6 + [(6 + j6) // (6 - j20 + j14)] = 12 \Omega$

(B) $|\bar{I}| = \frac{120 \angle 0^\circ}{12} = 10 \text{ A}$

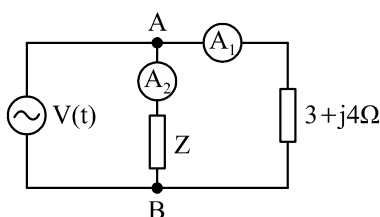
(C) $\bar{I}_1 = 10 \times \frac{6 - j6}{6 + j6 + 6 - j6}$

$= 10 \times \frac{6\sqrt{2} \angle -45^\circ}{12} = 5\sqrt{2} \angle -45^\circ \text{ A} = 5 - j5 \text{ A}$

(D) $\bar{I}_2 = 10 \times \frac{6 + j6}{6 + j6 + 6 - j6}$

$= 10 \times \frac{6\sqrt{2} \angle 45^\circ}{12} = 5\sqrt{2} \angle 45^\circ \text{ A} = 5 + j5 \text{ A}$

47.



$\bar{S} = 400 + j300 \text{ VA} = 10^2 \times 3 + 10^2 \times j4 + 2^2 \times R + 2^2 \times X$

$R = 25$, $X = -j25$

$\bar{Z} = 25 - j25 \Omega = 25\sqrt{2} \angle -45^\circ \Omega$

48. (A) $BW = 1040 - 960 = 80 \text{ Hz}$

(B) $f_o = \frac{1040 + 960}{2} = 1000 \text{ Hz}$

(C) $BW = \frac{f_o}{Q} \Rightarrow Q = \frac{f_o}{BW} = \frac{1000}{80} = 12.5$

(D) $Q = \frac{1}{R} \sqrt{\frac{L}{C}}$

49. $BW = \frac{f_o}{Q} = \frac{1}{\frac{1}{R} \sqrt{\frac{L}{C}}} = \frac{2\pi\sqrt{LC}}{R\sqrt{C}}$
 $= \frac{R}{2\pi L} = \frac{16}{2\pi \times \frac{4}{\pi}} = \frac{16}{8} = 2 \text{ Hz}$

50. (D) 在具有相同損失的條件下, 單相三線的總用銅量為單相兩線的 37.5%