102 學年四技二專第二次聯合模擬考試
電機與電子群　專業科目（一）　詳解

102-2-03-4
102-2-04-4

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

第一部份：基本電學

1. $\because Q = It$ ，$\therefore I = \dfrac{Q}{t} = \dfrac{5}{10} = 0.5\ A$

   $\therefore P = IV = 0.5 \times (60-20) = 20\ W$

2. $W = 200\times6 + 800\times(8-6) + 200\times(12-8)$
   $+600\times(14-12) + 200\times(18-14) + 1200\times(22-18)$
   $+300\times(24-22) = 11000\ W\text{-}H = 11$ 度
   一個月共 $W_T = 11\times30 = 330$ 度
   共需付 $3\times(330-30) + 50 = 950$ 元

3. $\because R = \rho\dfrac{\ell}{A}$ ，又 $E = I\times R$ ，且 $I \propto \dfrac{1}{R}$

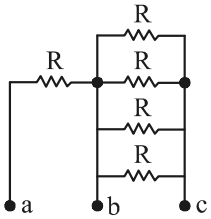
   則 $R \propto \ell$ ，$I \propto \dfrac{1}{\ell}$ ，$I \propto A$

   $\therefore I_a : I_b : I_c = \dfrac{1}{R_a} : \dfrac{1}{R_b} : \dfrac{1}{R_c} = \dfrac{A_a}{\ell_a} : \dfrac{A_b}{\ell_b} : \dfrac{A_c}{\ell_c}$

   $= \dfrac{1}{2} : \dfrac{1}{1} : \dfrac{2}{1} = 1 : 2 : 4$

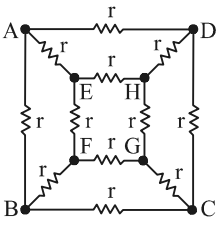
4. 電流源 5 A 與 3 Ω 並接，欲求等效並聯電壓，即求 3 Ω 的電壓降，首先將其轉換成等效電壓源
   總電壓 $E = 3\times4 + 5\times3 = 27\ V$
   極性相同，總電阻 $R_T = 4+3+2 = 9\ \Omega$
   流經負載電流 $I = \dfrac{27}{9} = 3\ A$
   依流入節點電流 = 流出節點
   則流經 3 Ω 之電流 $I_{3\Omega} = 5 - I = 5-3 = 2\ A$
   則並聯電壓爲 3 Ω 之電壓降 $V_{3\Omega} = 2\times3 = 6\ V$

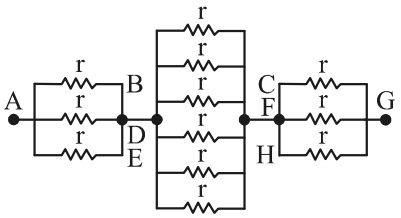
5. 合併同電位點，等效圖爲：
   依等效圖，$R_{ab} = R = 20\ \Omega$

   $R_{ac} = R_{ab} + R_{bc} = 20 + \dfrac{20}{4} = 25\ \Omega$
   $\therefore R_{ab} + 2R_{ac} = 20 + 25\times2 = 70\ \Omega$

6. $R_{AG} = \dfrac{r}{3} + \dfrac{r}{6} + \dfrac{r}{3} = \dfrac{5r}{6} = \dfrac{5}{6}\times12 = 10\ \Omega$

7. (A) $R_{ca} = 1 + [2\,//\,(1+3)] + 1 = \dfrac{10}{3}\ \Omega$

   (B) $R_{bc} = 1 + [3\,//\,(2+1)] + 1 = \dfrac{7}{2}\ \Omega$

   (C) $R_{ab} = 1 + [1\,//\,(2+3)] + 1 = \dfrac{17}{6}\ \Omega$

   (D) $\therefore 2R_{ab} + R_{ca} = 2\times\dfrac{17}{6} + \dfrac{10}{3} = 9\ \Omega$

8. 利用測得電路之開路電壓，應等於供應之電源電壓 E 之觀念求解，電源電壓 $E = V_{ab} = 48\ V$ ，開關閉合，電路電流 $I = 6\ A$ ，電路總電阻 $R_T = \dfrac{E}{I} = \dfrac{48}{6} = 8\ \Omega$
   (若有源電路內阻 $+R_{L1}$，當 a、c 間短路，R_L 沒作用)，
   短路電流 $I_S = \dfrac{48}{(8-4)} = 12\ A$

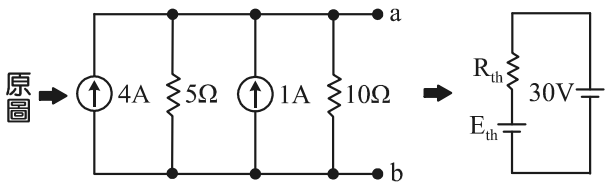
9. 先將圖之右側電流源轉換爲電壓源，即 $V = BR_b$ ，內阻 R_b 不變，極性爲上正下負，利用 KVL 定律：
   $A - R_bB = I(R_a + R_b)$ ，則電流 $I = \dfrac{A - R_bB}{R_a + R_b}$

10. $V_a = \dfrac{\dfrac{40}{8} - \dfrac{8}{4} + \dfrac{16}{8}}{\dfrac{1}{8} + \dfrac{1}{4} + \dfrac{1}{8}} = 10\ V$ ，$\because V_a = V_{4\Omega} + (-8)$
    則 4Ω 之電壓降 $V_{4\Omega} = 10 + 8 = 18\ V$

11. $\begin{cases}(4+8)I_a + 4I_b = 4\\ 4I_a + (4+2)I_b = 4-12\end{cases} \Rightarrow \begin{cases}12I_a + 4I_b = 4\\ 4I_a + 6I_b = -8\end{cases}$
    化簡得 $I_a = 1\ A$ ，$I_b = -2\ A$ ，則 $5I_a - I_b = 5 - (-2) = 7\ A$

12. $E_{TH} = (\dfrac{20}{5} + 1)\times(10\,//\,5) = \dfrac{50}{3}\ V$ ，$R_{TH} = 5\,//\,10 = \dfrac{10}{3}\ \Omega$

    $I = \dfrac{30 - E_{TH}}{R_{TH}} = \dfrac{30 - \dfrac{50}{3}}{\dfrac{10}{3}} = 4\ A$ ，$\therefore P = IV = 4\times30 = 120\ W$



13. 保留 5 A 電流源時 $I_A = 5$ A

保留 10 V 電壓源時 $I_V = 0$

故 $I_{1\Omega} = 5 + 0 = 5$ A ，$\therefore P = I_\Omega^2 \times R = 5^2 \times 1 = 25$ W

14. 利用節點電壓法：

$$\begin{cases} (\frac{1}{2}+\frac{1}{3})V_1 - \frac{1}{2}V_2 = 10 + 2 \\ -\frac{1}{2}V_1 + (\frac{1}{2}+\frac{1}{2})V_2 = -10 \end{cases} \Rightarrow \begin{cases} 5V_1 - 3V_2 = 72 \\ -V_1 + 2V_2 = -20 \end{cases}$$

$\Rightarrow$ 化簡得 $V_1 = 12$ V ， $V_2 = -4$ V

$$\therefore a = \frac{V_1}{V_2} = \frac{12}{-4} = -3$$

$$\therefore I_1 = \frac{V_1 - 0}{R_1} = \frac{12 - 0}{3} = 4 \text{ A}$$

$$\therefore I_2 = \frac{V_2 - V_1}{R_2} = \frac{-4 - 12}{2} = -8 \text{ A}$$

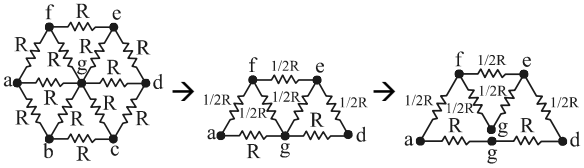
$$\therefore b = \frac{I_2}{I_1} = \frac{-8}{4} = -2$$

$$\therefore 4a + 2b = 4 \times (-3) + 2 \times (-2) = -16$$

15. $R_X = R_{Th} = R_N = 4\,\Omega$ ， $E_{Th} = E_{ab} = 12 + 4 \times 5 = 32$ V

$$I_N = \frac{32}{4} = 8 \text{ A} \text{ ，} P_{L\max} = \frac{E_{TH}^{\ 2}}{4R_{TH}} = \frac{32^2}{4 \times 4} = 64 \text{ W}$$

16. $R_{ad} = (2+2) // \{1 + [(1+1) // 1] + 1\} = 1.6\,\Omega$



17. $H = \frac{I}{2\pi r} = \frac{1}{2\pi \times 0.1} = \frac{5}{\pi}$ AT/m

$B = \mu H = 4\pi \times 10^{-7} \times \frac{5}{\pi} = 2 \times 10^{-6}$ Wb/m^2

$F = QvB = 5 \times 10^{-3} \times 10^5 \times 2 \times 10^{-6} = 1 \times 10^{-3}$ N

18. 電容串聯總電容值會越串越小，故若欲最小電容值，需求串聯總電容值

$C_{min} = C_1$串C_2串$C_3 = 4\mu$串10μ串20μ

$$= \frac{20\mu}{5+2+1} = \frac{20}{8}\mu\text{F} = \frac{5}{2}\mu\text{F}$$

比較得 $A = 2$ ， $B = 5$ ，$\therefore 2A + B = 2 \times 2 + 5 = 9$

則答案滿足條件

19. $\varphi = D \times A = \epsilon_0 \times \varepsilon \times A = Q$

$$\therefore Q = 8.85 \times 10^{-12} \times 1 \times 4\pi \times (\frac{0.2}{2})^2 \times 4 \times 10^{-5}$$

$= 4.44 \times 10^{-17}$ 庫侖

又因每一個電子所荷的電荷量 $e = 1.602 \times 10^{-19}$ 庫倫

故該球之核外電子數爲 $n = \frac{Q}{e} = \frac{4.44 \times 10^{-17}}{1.602 \times 10^{-19}} = 277$ 個

20. $\because I = \frac{Q}{t}$ ， $v = \frac{\ell}{t}$ ，$\therefore \ell = vt$

1 個電子 $\approx 1.602 \times 10^{-19}$ 庫侖

$$F = I\ell B\sin\theta = \frac{Q}{t} \times t \times v \times B \times \sin\theta = Q \times v \times B \times \sin\theta$$

$$= 1.602 \times 10^{-19} \times 10 \times 10 \times \sin 90° = 1.6 \times 10^{-17} \text{ NT}$$

21. $F = I\ell B = 10 \times 0.4 \times 0.5 = 2$ NT

$$P = \frac{W}{t} = \frac{F \times S}{t} = 2 \times \frac{4}{0.2} = 40 \text{ W}$$

22. (A) $\mu = \frac{B}{H} = \frac{10^{-2}}{10^3} = 10^{-5}$ H/m

(B) $H = \frac{NI}{\ell} = \frac{10 \times 10^3}{2 \times 10^{-1}} = 5 \times 10^4$ AT/m

(C) $B = \mu_0 \times H = 10^{-5} \times 5 \times 10^4 = 0.5$ Tesla

(D) $\phi = BA = 0.5 \times 2 \times 10^{-2} = 1 \times 10^{-2}$ Wb

23. 由題意知充電已至平衡狀態，故 C_1 、 C_2 視爲斷路

$$\therefore V_{7\Omega} = 72 \times \frac{7}{2+7} = 56 \text{ V}$$

$$\therefore Q_2 = C_2 \times V_{7\Omega} = 56 \times 3\,\mu = 168\,\mu\text{C}$$

24. (A) 不影響

(B) 不影響

(C) 總阻抗變小，I 變大

(D) $I = 0$ A

25. (A) $i = \frac{24}{2+6} = 3$ A

(B) $i_L = \frac{24}{2 + (6 // 3)} = 6$ A

(C) $W_L = \frac{1}{2} i_L^{\ 2} L = \frac{1}{2} \times (6 \times \frac{6}{6+3})^2 \times 3 = 24$ J

(D) $v_L = V_{TH} = 24 \times \frac{6}{2+6} = 18$ V

26. CMOS(Complementary Metal-Oxide Semiconductor，互補性氧化金屬半導體)中的「M」代表金屬

27. $\because C = \frac{\in A}{d}$ ，$\therefore C \propto \frac{1}{d}$ ，當外加逆向電壓增加時，空乏區寬度將增加，空乏區形成之電容值隨之減少

28. $I_D = I_S(e^{\frac{V_D}{\eta V_T}} - 1) = 5\,\mu \times (e^{\frac{0.26}{2 \times 26\text{ m}}} - 1) = 5\,\mu \times (e^5 - 1)$

$\cong 5\,\mu \times 148 = 0.74$ mA

29. 電路可化簡爲：

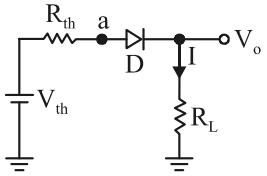
$$(V_{th} = V_+ \times \frac{R_2}{R_1 + R_2} = 12.5 \text{ V} \times \frac{20\text{ k}\Omega}{5\text{ k}\Omega + 20\text{ k}\Omega} = 10 \text{ V}) > 0 \text{ V}$$

二極體順向導通 $R_{th} = R_1 // R_2 = 5\text{ k}\Omega // 20\text{ k}\Omega = 4\text{ k}\Omega$

$$V_o = V_{th} \times \frac{R_L}{R_{th} + R_L} = 10 \times \frac{16\text{ k}\Omega}{4\text{ k}\Omega + 16\text{ k}\Omega} = 8 \text{ V}$$

$$I = \frac{V_{th}}{R_{th} + R_L} = \frac{10 \text{ V}}{4\text{ k}\Omega + 16\text{ k}\Omega} = 0.5 \text{ mA}$$

$P_{RL} = I^2R_L = (0.5m)^2 \times 16k = 4\ mW$



30. $\because V_i = 12V_{P-P}$，$\therefore V_{ip} = 6\ V$ 又 $V_z = 5.1\ V$
故輸入已達稽納之崩潰電壓 6 V，$\therefore V_o = V_z = 5.1\ V$

31. 由最大功率轉移定理知當變壓器初級線圈等效阻抗等於 $R_S(500\ \Omega)$時，電路之阻抗完全匹配，可讓揚聲器獲得最大之功率，此時初級線圈之有效電壓值爲

$$\because V_{1(rms)} = \frac{Vm}{\sqrt{2}} \times \frac{R_S}{R_S + R_L} = \frac{10\sqrt{2}}{\sqrt{2}} \times \frac{500}{500+500} = 5\ V$$

初級線圈之功率爲 $P_{max} = \frac{V^2}{R_L} = \frac{5^2}{500} = 50\ mW$

因理想變壓器無損失，則揚聲器亦可獲得最大之功率爲 50 mW

32. (甲) $\because V_o = 0\ V$，$\therefore P_{L1} = \frac{V^2}{R} = \frac{0^2}{1\,k} = 0\ W$

(乙) $\because V_o = 0\ V$，$\therefore P_{L2} = \frac{V^2}{R} = \frac{0^2}{1\,k} = 0\ W$

(丙) $\because V_o = 2\ Vm = 20\ V$，$\therefore P_{L3} = \frac{V^2}{R} = \frac{20^2}{1\,k} = 0.4\ W$

(丁) $\because V_o = 0\ V$，$\therefore P_{L4} = \frac{V^2}{R} = \frac{0^2}{1\,k} = 0\ W$

33. 欲降低輸出電壓漣波因數的效果有下列方式：(1) 輸入端由半波整流器改爲全波整流器、(2) 增加電感值、(3) 增加 C_1 之容值、(4) 增加 C_2 之容值
(A) 輸入端由半波整流器改爲全波整流器
$\because r = \frac{V_{rms}}{V_{dC}}$ 全波整流的 V_{dC} 大於半波整流
(B) $\because X_L = 2\pi fL$，增加電感量，X_L 亦增加，則 r 下降
(C) $\because X_C = \frac{1}{2\pi fC}$，增加 C 值，$X_C$ 下降，則 r 下降

34. (A) C_1 及 C_2 爲隔離電容器
(B) C_3 爲去交連電容器
(C) C_E 爲旁路電容器
(D) C_E 及 C_3 爲提高電壓增益

35. 影響低頻響應有：旁路電容、交連電容
影響高頻響應有：極際電容、雜散電容、電晶體之 h_{FE}

36. $\beta = \frac{\alpha}{1-\alpha} = \frac{0.99}{1-0.99} = 99$
$I_C = \beta I_B + (1+\beta)I_{CBO} = 99 \times 20\,\mu + (1+99) \times 5\,\mu$
$= 2480\ \mu A = 2.48\ mA$

37. 由圖(b)知 $V_{CEQ} = 6\ V$，$I_{CQ} = 1.5\ mA$
$\therefore I_B = \frac{I_{CQ}}{\beta} = \frac{1.5\ m}{100} = 15\ \mu A$

$I_B = \frac{V_{CC} - V_{BE}}{R_B + R_E(1+\beta)} = \frac{12 - 0.6}{R_B + 1\,k(1+100)} = 15\ \mu A$
化簡得 $R_B = 659\ k\Omega$，故選 $R_B = 660\ k\Omega$ 電阻較適當

38. $\because V_{CE} = V_{CC} - I_C(R_C + R_E)$
當 V_{CC} 定值時，I_C 減少，則 V_{CE} 增加

39. $I_B = \frac{V_{CC} - V_{BE}}{R_B + R_E(1+\beta)} = \frac{10 - 0.7}{750\,k + 2.5\,k(1+100)} = 9.3\ \mu A$
$I_E = (1+\beta)I_B = (1+100) \times 9.3\ \mu A \approx 0.93\ mA$
$Z_o = r_e = \frac{26\ mV}{I_E} = \frac{26\ mV}{0.93\ mA} \approx 28\ \Omega$

40. $A_V = -\frac{R_C}{R_E} = -\frac{5.1\,k}{6.8\,k} = -0.75$

41. $A_V = \frac{V_o}{V_i} = -g_m(R_D \,//\, r_d) = -2\ m \times (15\,k \,//\, 30\,k) = -20$

42. $r_e = \frac{r_\pi}{1+\beta} = \frac{1\,k}{100} \approx 10\ \Omega$
$Z_i = R_{B1} \,//\, r_\pi \approx r_\pi \approx 1\ k\Omega$
$Z_o = R_{B1} \,//\, R_C \approx R_C \approx 3\ k\Omega$
$A_V = -\frac{R_{B1} \,//\, R_C}{r_e} \approx -\frac{R_C}{r_e} - \frac{3\,k}{10} = -300$
$A_i = \left| A_V \right| \times \frac{Z_i}{Z_o} = 300 \times \frac{1\,k}{3\,k} = 100$

43. 靈頓放大器是(1) 由兩個射極隨耦器串聯所組成，具有強化共集極(CC)電路的特性
(2) 高電流增益，低電壓增益
(3) 高輸入阻抗，低輸出阻抗
(4) 適用於阻抗匹配

44. $f_{TL} = f_L \times \frac{1}{\sqrt{2^{\frac{1}{n}} - 1}} = 32\,k \times \frac{1}{\sqrt{(2^{\frac{1}{2}}) - 1}}$
$= 32\,k \times \frac{1}{0.64} = 50\ kH_Z$
$f_{TH} = f_L \times \sqrt{2^{\frac{1}{n}} - 1} = 2M \times \sqrt{2^{\frac{1}{2}} - 1}$
$= 200\,k \times 0.64 = 128\ kH_Z$
$BW = f_{TH} - f_{TL} = 128\,k - 50\,k = 78\ kH_Z$

45. $dB_T = dB_1 + dB_2 = 20 + 40 = 60\ dB$，又 $dB_V = 20 \log A_V$
$\therefore 60 = 20 \log A_V$，得 $A_V = 1000$
又 $\because A_V = \frac{V_o}{V_i} = \frac{V_o}{0.1\ m} = 1000$
$\therefore V_o = 1000 \times 0.1\ m = 0.1\ V$
$\therefore P_{O(rms)} = \frac{V_{O(rms)^2}}{R} = \frac{(\frac{0.1}{\sqrt{2}})^2}{4} \approx 1.25\ mW$

46. V_{DS} 很小，靠近原點可做壓控電阻

47. N 通道 $V_{DS} \geq V_{GS} - V_p \Rightarrow V_D - V_S \geq V_G - V_S - V_p$
$\Rightarrow V_D \geq V_G - V_p \Rightarrow V_D \geq V_G - (-4) \Rightarrow V_D \geq V_G + 4$
代入僅(D)選項對，其中(A)選項 $\left| V_{GS} \right| \geq \left| V_p \right|$ 不合

理，故不選

48. 由 $I_D = I_{DSS}(1-\frac{V_{GS}}{V_p})^2$

代入爲 $4\text{ m} = 16\text{ m}(1-\frac{V_{GS}}{-4})^2$ ，$\frac{1}{4} = (1-\frac{V_{GS}}{-4})^2 = (1-\frac{1}{2})^2$

$\therefore \frac{1}{2} = \frac{V_{GS}}{-4}$ ，$\therefore V_{GS} = -2\text{ V}$

49. $\because I_D = K(V_{GS}-V_T)^2$

$\Rightarrow K = \frac{I_D}{(V_{GS}-V_T)^2} = \frac{3\text{ m}}{(6-3)^2} = \frac{1}{3}\text{ mA/V}$

$\therefore g_m = 2\,K(V_{Gs}-V_T) = 2\times\frac{1\text{ m}}{3}\times(9-3) = 4\text{ mS}$

50. $I_D = k(V_{GS}-V_T)^2 = 0.5\text{ m}(4-1)^2 = 4.5\text{ mA}$

$V_{DS} = V_{DD} - I_D(R_D+R_S) = 20 - 4.5\text{ m}(2\text{ k}+1\text{ k}) = 6.5\text{ V}$