108 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

108-3-03-4、108-3-04-4

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

第一部分：電子學

1. (A) 三角波的波形因數 F.F.是 1.15
2. (D) P 型半導體呈現電中性
3. (C) 空乏區內的電場方向是由 N 側指向 P 側
4. 此電路 D_1 ON 、 D_2 ON

   左邊迴圈電流 $\dfrac{10-0}{5\text{ k}}=2\text{ mA}$

   右邊迴圈電流 $\dfrac{0-(-10)}{10\text{ k}}=1\text{ mA}$

   $\therefore I=2\text{ m}-1\text{ m}=1\text{ mA}$
5. $V_{1\text{ m}}=110\sqrt{2}\text{ V}$ ， $V_{2\text{ m}}=55\sqrt{2}=77.8\text{ V}$

   半波倍壓電路， $V_{AC}=3V_{2m}=3\times 77.8=233\text{ V}$
6. 波形輸出平均值 $V_{o(av)}=\dfrac{103+97}{2}=100\text{ V}$

   漣波最大值 $V_{r(m)}=3\text{ V}$

   漣波有效值 $V_{r(rms)}=\dfrac{3}{\sqrt{3}}=\sqrt{3}\text{ V}$

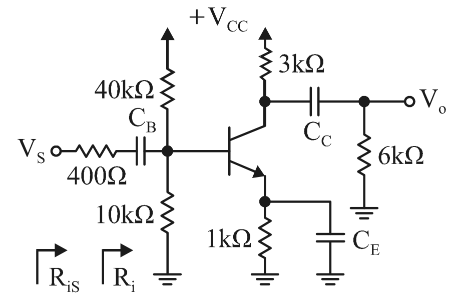
   漣波因數百分比 $r\%=\dfrac{V_{r(rms)}}{V_{o(av)}}\times 100\%=\dfrac{\sqrt{3}}{100}\times 100\%$

   $=\sqrt{3}\%$
7. (A) $\alpha=\dfrac{\beta}{\beta+1}$
8. B、E 接面為順向偏壓；B、C 接面為逆向偏壓，故電晶體工作於主動放大區
9. $I_C=\beta I_B$ 不變， $R_C\downarrow$ ， $V_{CE}=V_{CC}-I_C(R_C+R_E)$ 變大故工作點往 D 點移動
10. 電晶體飽和， $V_{CE(sat)}=-0.2\text{ V}$ ，即 $V_{EC(sat)}=0.2\text{ V}$

    $V_o=V_{CC}-V_{EC(sat)}=10-0.2=9.8\text{ V}$
11. $R_{iS}\cong 4\text{ k}+(300\text{ k}\,//\,1\text{ k})\cong 5\text{ k}\Omega$
12. $I_E=\dfrac{0-V_{BE}-(-V_{EE})}{R_E}=\dfrac{10}{10\text{ k}}=1\text{ mA}$

    $r_e=\dfrac{V_T}{I_E}=\dfrac{25\text{ m}}{1\text{ m}}=25\ \Omega$

    $A_V=\dfrac{V_o}{V_i}=\dfrac{-i_cR_C}{-i_er_e}\doteqdot\dfrac{R_C}{r_e}=\dfrac{5\text{ k}}{25}=200$

    $V_{o(p-p)}=V_{i(p-p)}\times A_V=0.4\text{ V}$
13. 

    $R_i=(40\text{ k}\,//\,10\text{ k}\,//\,2\text{k})=1.6\text{ k}\Omega$

    $R_{iS}=0.4\text{ k}\Omega+1.6\text{ k}\Omega$

    $A_{VS}=\dfrac{V_o}{V_S}=\dfrac{V_{ib}}{V_S}\times\dfrac{V_o}{V_{ib}}=\dfrac{1.6\text{ k}}{0.4\text{ k}+1.6\text{ k}}\times\dfrac{-i_c\times(3\text{ k}\,//\,6\text{ k})}{i_br_\pi}$

    $=\dfrac{1.6}{2}\times(-250)=-200$
14. $Z_o=R_E\,//\,(\dfrac{i_{b2}r_{\pi2}+i_{b1}r_{\pi1}}{i_{e2}})=R_E\,//\,(r_{e2}+\dfrac{r_{e1}}{1+\beta_2})\cong r_{e2}+\dfrac{r_{e1}}{\beta_2}$
15. CE： Q_2 ， CC： Q_1 、 Q_3 、 Q_4 、 Q_5
16. 第二級增益 $20\text{ dBm}=10\log\dfrac{P_o}{1\text{ mW}}$　$\therefore P_o=100\text{ mW}$

    $P_o=\dfrac{{V_o}^2}{R}$ ， $V_o=\sqrt{P_o\times R}=\sqrt{100}=10\text{ V}$

    第一級電壓增益為 $20\text{ dB}=20\log\dfrac{V_x}{V_i}=20\log\dfrac{0.1}{V_i}$

    $\therefore V_i=0.01\text{ V}$

    $A_{VT}=\dfrac{V_o}{V_i}=\dfrac{10}{0.01}=1000$

    $A_{VT(dB)}=20\log A_{VT}=60\text{ dB}$
17. (A) P 通道 JFET： $V_{GS(P)}=3.5\text{ V}$

    夾止飽和條件： $V_{GS}<V_{GS(P)}$ 、 $V_{GD}>V_{GS(P)}$

    (B) N 通道 JFET： $V_{GS(P)}=-3.5\text{ V}$

    夾止飽和條件： $V_{GS}>V_{GS(P)}$ 、 $V_{GD}<V_{GS(P)}$

    (C) N 通道空乏型 MOSFET： $V_{GS(P)}=-3.5\text{ V}$

    夾止飽和條件： $V_{GS}>V_{GS(P)}$ 、 $V_{GD}<V_{GS(P)}$

    (D) P 通道空乏型 MOSFET： $V_{GS(P)}=3.5\text{ V}$

    夾止飽和條件： $V_{GS}<V_{GS(P)}$ 、 $V_{GD}>V_{GS(P)}$
18. $I_D=I_{DSS}(1-\dfrac{V_{GS}}{V_{GS(P)}})^2=12\text{ m}(1-\dfrac{-2}{-4})^2=3\text{ mA}$

N 通道 JFET：夾止飽和條件：$V_{GD} < V_{GS(P)}$

$\therefore V_D > 2\ V$

$V_{DD} = I_D R_D + V_D = 3\ m \times 1.5\ k + V_D \quad \therefore V_{DD} > 6.5\ V$

19. 電晶體特性均相同

所以 $V_{DS1} = V_{DS2} = V_{DS3} = 4\ V = V_{GS1} = V_{GS2} = V_{GS3}$

$I_D = I_{D3} = K(V_{GS3} - V_T)^2 = 0.3\ m \times (4-1)^2 = 2.7\ mA$

20. $V_D = V_{DD} - I_D R_D = 10 - 1\ k \times I_D$ ，$V_S = I_D R_S = 1\ k \times I_D$

$V_{DS} = V_{GS} = 10 - 2\ k \times I_D$

$I_D = k(V_{GS} - V_t)^2 = 0.75\ m(10 - 2\ k \times I_D - 2)^2$

$I_D = 3\ mA$ ，$V_{GS} = 4\ V$ ，$g_m = 2\ k(V_{GS} - V_t) = 3\ mS$

21. $$\frac{A_{V1}}{A_{V2}} = \frac{-\dfrac{2\ m \times 4.5\ k}{1 + 2\ m \times 0.5\ k}}{-\dfrac{2\ m \times 4.5\ k}{1 + 2\ m \times (0.5\ k + 1.5\ k)}} = \frac{5}{2}$$

22. $V_{GS} = 0 - I_D R_S = -2\ V$

$$g_m = \frac{-2I_{DSS}}{V_{GS(P)}}(1 - \frac{V_{GS}}{V_{GS(P)}}) = \frac{-16\ m}{-4} \times (1 - \frac{-2}{-4}) = 2\ mS$$

$$A_V = \frac{V_o}{V_i} = \frac{-g_m R_D}{1 + g_m R_S} = \frac{-8}{1+2} = \frac{-8}{3}$$

$Z_i = R_G = 1\ M\Omega$ ，$Z_o = R_D = 4\ k\Omega$

$$A_i = -A_V \times \frac{R_i}{R_o} = \frac{8}{3} \times \frac{1\ M}{4\ k} = \frac{2000}{3}$$

23. 一周波形內於(0°~30°、150°~360°)時 $V_i < 5\ V$ ，輸出高態電壓

工作週期 $\dfrac{(30° - 0°) + (360° - 150°)}{360°} = \dfrac{240°}{360°} = \dfrac{2}{3}$

24. 隨耦電路 $A_V = 1$ ，$A_{V(dB)} = 20 \log 1 = 0\ dB$

25. $A_V = (1 + \dfrac{63\ k}{4.5\ k}) = 15$ ，臨界電壓 $V_+ = \dfrac{V_o}{A_V} = \dfrac{5}{15} = \dfrac{1}{3}\ V$

$\dfrac{1}{3} = 0.5 \times \dfrac{R_x}{15\ k + R_x}$ ，$R_x = 30\ k\Omega$

第二部分：基本電學

26. 電子往低電位移動需做功

$W = QV = |(6.25 \times 10^{17} \times 1.6 \times 10^{-19})| \times |(50 - 40)|$

$= 0.1 \times 10 = 1\ J$

27. 系統總輸出：$2000 - 880 = 1120\ W$

系統總效率：

$$\eta = \frac{P_o}{P_i} = \frac{1120}{2000} = 0.56 = \eta_A \times \eta_B = 0.8 \times \eta_B$$

$\therefore \eta_B = 0.7 = 70\%$

28. 材料電阻係數 $\rho = \dfrac{1.724 \times 10^{-8}}{0.1724} = 10^{-7}\ \Omega\text{-m}$

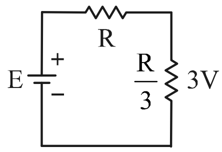
$$R = \rho \frac{\ell}{A} = 10^{-7} \times \frac{100}{2 \times 10^{-6}} = 5\ \Omega$$

29. 總電阻：$R_T = 25 + 100 + 25 = 150\ \Omega$

總電流：$I = \dfrac{V}{R_T} = \dfrac{10}{150} = \dfrac{1}{15}\ A$

負載電阻：$R_L = \dfrac{V}{I} = \dfrac{4}{\frac{1}{15}} = 60\ \Omega$

30. $I = \dfrac{3}{\frac{R}{3}} = \dfrac{9}{R}$



$E = \dfrac{9}{R} \times (R + \dfrac{R}{3}) = \dfrac{9}{R} \times \dfrac{4R}{3} = 12\ V$

31. 利用重疊定理，流過 5 V 電壓源電流為

$2 + 1 = 3\ A$ ，故提供 $P = IV = 15\ W$

5 Ω 電阻兩端電壓 5 V，故消耗功率 $P = \dfrac{V^2}{R} = 5\ W$

2 A 電流源兩端電壓 5 V，故消耗 $P = IV = 10\ W$

32. $I = \dfrac{V}{R} = \dfrac{10}{5} = 2\ A$

$P = I^2 R_P$ ，$R_P = \dfrac{P}{I^2} = \dfrac{8}{2^2} = 2\ \Omega$

$E = I \times R_T = 2 \times (5 + 1 + 2) = 16\ V$

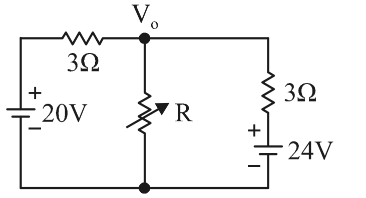
33. 利用戴維寧等效電路轉換為諾頓等效電路計算

諾頓等效電阻 $R_N = 10\ \Omega$

戴維寧等效電壓 $E_{TH} = 4 \times 10 + 10 = 50\ V$

諾頓等效電流 $I_N = \dfrac{E_{TH}}{R_N} = 5\ A$

34.



欲使 20 V 電池輸出電壓則 V_o 電壓應小於 20 V。利用節點電壓法列出克希荷夫電流方程式

$\dfrac{20 - V_o}{3} = \dfrac{V_o}{R} + \dfrac{V_o - 24}{3}$ ，$R(20 - V_o) = 3V_o + R(V_o - 24)$

$44R = (3 + 2R)V_o$ ，$V_o = \dfrac{44R}{3 + 2R} < 20$

$4R < 60 \quad \therefore R < 15\ \Omega$

35. $V_b = -18\ V$ ，利用節點電壓法求 V_a

$4 + \dfrac{-18 - V_a}{12} = \dfrac{V_a - 12}{6}$ ，$V_a = 18\ V$

$V_b = -18\ V$ ，$V_c = -18 + 24 = 6\ V$

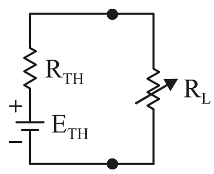
$\therefore$ 4 A 電流源兩端電位差 $V_{ac} = 18 - 6 = 12\ V$

故 $P = IV = 4 \times 12 = 48\ W$

36. $R_{TH} = 2\ \Omega$ ，$E_{TH} = 5 \times 2 + 10 = 20\ V$

當 $R_L = R_{TH} = 2\ \Omega$ 時

有最大功率 $P_{MAX} = I^2 R = 5^2 \times 2 = 50\ W$



37. 開關閉合後 $Q_T = 20\,\mu - 10\,\mu = 10\,\mu C$，$V_1$ 極性爲下正上負，當 $V_1 = V_2$ 時電荷不再移動，故 C_1 與 C_2 爲並聯，$C_T = 5\,\mu + 5\,\mu = 10\,\mu F$，$V = \frac{Q}{C} = \frac{10\,\mu}{10\,\mu} = 1\,V$

$V_1 = -1\,V$

38. $E_1 = E_2$，$K\frac{4\times10^{-6}}{r^2} = K\frac{1.6\times10^{-5}}{(15-r)^2}$

$\frac{1}{r^2} = \frac{4}{(15-r)^2}$，$r = 5\,m$

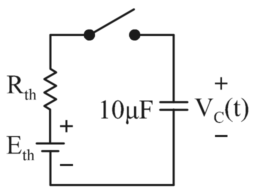
39. (A) 特斯拉(Tesla)爲磁通密度 M.K.S.制單位
(B) 1 韋伯(Wb) = 10^8 馬克斯威(Maxwell)
(D) 欲了解帶電導體在磁場中運動的受力方向可利用弗萊銘左手定則

40. 電路爲並聯互消

$L_T = \frac{L_1 \times L_2 - M^2}{L_1 + L_2 + 2M} = \frac{4\times6-1}{4+6+2} = \frac{23}{12}\,H$

41. 電路趨於穩定後，$V_{C1} = V_{C2} = E$，$\frac{V_{C1}}{V_{C2}} = 1$

42. 開關未閉合，電路趨於穩定後電容兩端充滿 15 V 電壓，開關閉合，戴維寧等效電路如下圖所示



$R_{th} = 1\,k // 1\,k = 0.5\,k\Omega$

$E_{th} = \frac{E_1R_2 + E_2R_1}{R_1 + R_2} = \frac{40\,k}{2\,k} = 20\,V$

$\tau = RC = 0.5\,k \times 10\,\mu = 5\,m(sec)$

電容器兩端電壓爲 15 V 加上 5 V 電動勢對電容器充電

$V_C(t) = 15 + 5(1 - e^{-\frac{10\,m}{5\,m}}) = 20 - 5e^{-2}$

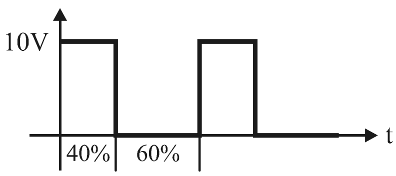
43. $v(t) = V_m \sin(\omega t + \theta_1)$

$i(t) = I_m \cos(\omega t - \theta_2) = I_m \sin(\omega t - \theta_2 + 90°)$

相位差爲：$(\theta_1) - (-\theta_2 + 90°) = \theta_1 + \theta_2 - 90°$

44. 波形輸出如下圖所示

$V_{rms} = \sqrt{(\frac{10^2 \times 0.4 + 0^2 \times 0.6}{1})} = \sqrt{40}\,V$



45. $\overline{V_T} = 600\angle 90° - 600\angle 30°$

$= 600\angle 90° + 600\angle 210° = 600\angle 150°\,V$

$\overline{Z} = 40 - j30 = 50\angle -37°\,\Omega$

$\overline{I} = \frac{\overline{V_T}}{\overline{Z}} = \frac{600\angle 150°}{50\angle -37°} = 12\angle 187°\,A$

46. 開關未閉合前，電路功率因數 $PF = 0.6 = \frac{R}{Z} = \frac{12}{Z}$

$\therefore Z = 20 = 12 - jX_C$，$X_C = -j16\,\Omega$

開關閉合後，電路功率因數 $PF = 0.6$

$\therefore X_C // X_L = j16\,\Omega$，$\frac{16X_L}{-j16 + jX_L} = j16$

$X_L = 16 - X_L \quad \therefore X_L = 8\,\Omega$

47. $\overline{X_L} = j\omega L = j1\,\Omega$；$\overline{X_C} = -j\frac{1}{\omega C} = -j1\,\Omega$

$Z = (1 // j1) + (-j1) = \frac{j1}{1+j1} - j1 = \frac{1}{2} - j\frac{1}{2}\,\Omega$

48. $\overline{Z} = \frac{\overline{E}}{\overline{I}} = \frac{100\angle 30°}{5\angle -7°} = 20\angle 37° = 16 + j12\,\Omega$ (串聯)

將 $16 + j12$ 化爲並聯等效，$R = \frac{16^2 + 12^2}{16} = 25\,\Omega$

49. $i(t) = 5\sin(314t)$

$v(t) = -40\cos(314t + 30°) = 40\cos(314t - 150°)$

$= 40\sin(314t - 60°)$

i(t)超前 v(t)，電路呈電容性

$\omega = 314\,rad/sec$，$f_v = f_i = 50\,Hz$，$f_p = 100\,Hz$

$\overline{I} = 2.5\sqrt{2}\angle 0°\,A$，$\overline{V} = 20\sqrt{2}\angle -60°\,V$

$P = IV\cos\theta = 50\,W$，$S = IV = 100\,VA$

$P_{MAX} = P + S = 150\,W$

50. $S = 500\sqrt{2}\,VA$，$PF = 0.707$ (落後)

$\therefore Q_C = 500\,VAR$，$Q_C = 500 = \frac{V^2}{X_C} = \frac{(50\sqrt{2})^2}{X_C}$

$X_C = \frac{(50\sqrt{2})^2}{500} = 10\,\Omega$，$X_C = \frac{1}{\omega C}$

$\therefore C = \frac{1}{\omega X_C} = \frac{1}{5000\times10} = 20\,\mu F$