Student ID #: 341 048 783

Question 2 (12 points)

For the full-wave rectifier shown in Figure P2, R = 150 Ω. A filter capacitor is connected in parallel with R. Assume $V_\gamma = 0.7$ V. The **peak** output voltage is to be 12 V and the **ripple** voltage is to be no more than 0.3 V. The input frequency is 60 Hz.

(a) Determine the required **rms** value of v_S.
(b) Determine the required filter capacitance value.
(c) Determine the peak current through the diodes.

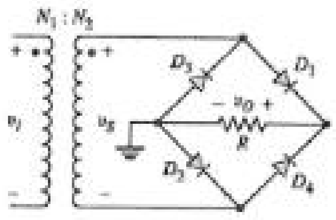


Figure P2

Solution

a) $V_s = V_m + 2V_\gamma = 13.4 V_p$ ∴ $V_{rms} = 9.475$ V 2

b) $V_r = \dfrac{V_M}{2fRC} \Rightarrow C = \dfrac{V_m}{2fRV_r} = 2222.2\,\mu F$ 4

c) * $I_D = \dfrac{V_s - 2V_\gamma}{R} = \dfrac{13.4 - 1.4}{150} = 0.08A$

Details: KVL in +ve cycle

$V_S - V_\gamma - V_o - V_\gamma = 0$

$V_o = V_s - 2V_\gamma$

$V_o = 13.4 - 2(0.7) = 12.$

∴ $I_{D(P)} = \dfrac{12}{150} = 0.08$

wrong formula

1/2

8 1/2

Student ID #: 341 048 783

Question 4 (25 points)

For the common-gate circuit shown in Figure P4, the NMOS transistor parameters are: $V_{TN} = 1$ V, $K_n = 3$ mA/V^2, and $\lambda = 0$.

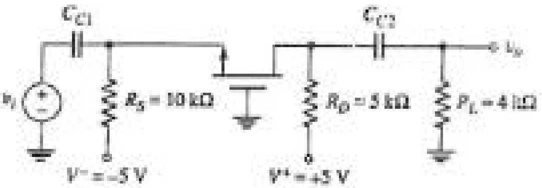


Figure P4

(a) Draw the dc equivalent circuit.
(b) Calculate I_{DQ} , V_{DSQ} and V_{GSQ}.
(c) Draw the ac equivalent circuit.
(d) Calculate the small-signal parameters g_m and r_o.
(e) Draw the small-signal equivalent circuit.
(f) Derive and calculate the small-signal voltage gain $A_v = V_o/V_i$.

Solution

b)

$I_{DQ} = K_n[V_{GS} - V_{TN}]^2$ ~ ① (assume in sat. region)

KVL in L_1

$V^+ - I_D R_D - V_{DS} - I_D R_S - V^- = 0$

$5 - 5I_D - V_{DS} - 10I_D + 5 = 0$

$-15I_D + 10 = V_{DS}$ ~ ③

KVL in L_2

$-V_{GS} + - I_D R_S - V^- = 0$

$V_{GS} = -10I_D + 5$ ~ ②

22

$I_{DQ} = K_n[V_{GS}^2 - 2V_{GS}V_{TN} + V_{TN}^2]$

$I_{DQ} = K_n V_{GS}^2 - 2V_{GS}K_n V_{TN} + K_n(V_{TN})^2$

substitute ② in ①

$I_{DQ} = K_n(-10I_{DQ}+5)^2 - 2(-10I_{DQ}+5)K_n V_{TN} + K_n V_{TN}^2$

$I_{DQ} = 3[100I_{DQ}^2 + 100I_{DQ} + 25] + 60I_{DQ} - 30 + 3$

$I_{DQ} = 300I_{DQ}^2 + 300I_{DQ} + 75 + 60I_{DQ} - 27$

$300I_{DQ}^2 + 241I_{DQ} - 27 = 0$ 2½

$I_{D1} = -0.9$ mA $I_{D2} = 0.09067$ mA ≈ 0.1

a)

2

$I_{DQ} = 0.1$ 2½

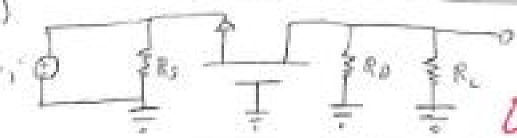
from ② : $V_{GSQ} = -10(0.1) + 5 = +4$ V 1

2½

from ③ $V_{DSQ} = -15(0.1) + 10 = 8.5$ V 1

check! $V_{DS(sat)} = V_{GS} - V_{TN} = +4 - 1 = +3$ ∴ it is in sat. region

c)

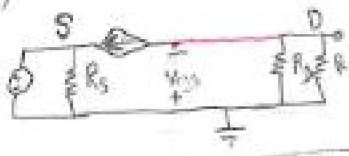


2

d) $g_m = 2\sqrt{K_n I_{DQ}} = 1.095$ mA/V 1 ½

$r_o = \frac{1}{\lambda I_{DQ}} = \infty$ 1

e)



4

f) $V_o = -g_m V_{gs} R_D // R_L$

$V_{gs} = -V_i$

$A_v = \frac{V_o}{V_i} = g_m R_D // R_L$ because g_m is wrong

$\boxed{A_v = -0.61}$ 1

5

Islamic University in Madinah, Faculty of Engineering, Electrical Engineering Department

EE 212 - Final Exam - Fall Semester 2016-2017

Student ID #: 340 048 783

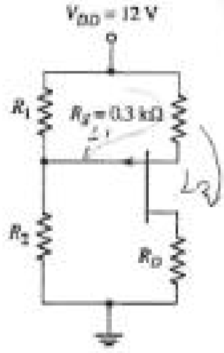


Figure P3

Question 3 (15 points)

For the JFET circuit shown in Figure P3, the transistor parameters are $I_{DSS} = 7$ mA, and $V_P = 3$ V. Let $R_1 + R_2 = 100$ kΩ. Assume that $I_{DQ} = 5.0$ mA and $V_{SDQ} = 6$ V. Calculate

(a) V_{GSQ}

(b) R_D, R_1 and R_2.

Solution

$V_G = 12\left(\frac{R_2}{R_1+R_2}\right) \Rightarrow V_G = \frac{12R_2}{100}$

KVL in L_1

$V_{DD} - I_D R_S - V_G = 0$

$12 - (5\times0.3) - \frac{12R_2}{100} = 0$

11

$10.5 = \frac{12R_2}{100}$

$12R_2 = 1050$

$\boxed{R_2 = \frac{1050}{12} = 87.5\,K\Omega}$

2

$\Rightarrow V_G = 12\left(\frac{87.5}{100}\right) = 10.5$ V

KVL in L_2

$12 - I_D R_S - V_{GSQ} - I_D R_D = 0$ — ①

this should be V_{SDQ}

$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$

$= 7\left[1 - \frac{V_{GS}}{3}\right]^2$

$= 7\left[1 - \frac{2}{3}V_{GS} + \frac{V_{GS}^2}{9}\right]$

$5 = 7 - \frac{14}{3}V_{GS} + \frac{7}{9}V_{GS}^2$

$\Rightarrow \frac{7}{9}V_{GS}^2 - \frac{14}{3}V_{GS} + 2 = 0$

approach OK

wrong value chosen!

$V_{GS_1} = 5.5$ $\quad V_{GS_2} = 0.46$ → correct answer 4

$\therefore \boxed{V_{GSQ} = 5.5V}$

substitute in ①:

$12 - 5\times0.3 - 5.5 - 5\times R_D = 0$

$= 5 = 5R_D$

3

$\Rightarrow \boxed{R_D = 1\,K\Omega}$ because V_{GS} is wrong

$V_G = 12\left(\frac{R_2}{R_1+R_2}\right)$

$V_G = 10.5$, $R_2 = 87.5$

$\Rightarrow 10.5 = 12\left(\frac{87.5}{R_1+87.5}\right)$

$R_1 + R_2 = 100$

$\therefore R_1 = 100 - R_2$

$R_1 = 100 - 87.5$

$\boxed{R_1 = 12.5\,K\Omega}$

2

because V_{GS} is wrong

Student ID #: 342 048 733

Question 2 (15 points)

Four infinite uniform sheets of charges are located in free space as given below:
4 nC/m^2 at x = 3, -4 nC/m^2 at x = -3, 2 nC/m^2 at x = -1, -2 nC/m^2 at x = 5.
Find E and D fields at point A(1, 2, -3), B(-2, 3, 5), and C(-3, 2,4).

Solution

$E_T = E_1 + E_2 + E_3 + E_4$ E for sheet of charge: $E = \frac{\rho_s}{2\varepsilon_0} a_N$

~~$E_1 = \ldots$ V/m~~ ~~$E_2 = -225$~~

$E_1 = \frac{4\times10^{-9}}{2\times 8.854\times10^{-12}} \times \frac{1-3}{2} = \frac{-2}{2} a_x = -225 a_x$ V/m

$E_2 = \frac{-4\times10^{-9}}{2\times 8.854\times10^{-12}} \times \frac{1-(-3)}{4} a_x = -225 \times +1 a_x = -225 a_x$ V/m

$E_3 = \frac{2\times10^{-9}}{2\times 8.854\times10^{-12}} \times \frac{1-(-1)}{2} = 112.9 a_x$ V/m

$E_4 = \frac{-2\times10^{-9}}{2\times 8.854\times10^{-12}} \times \frac{1-5}{4} = -112 \times -1 a_x = 112.9 a_x$ V/m

9

E_T at Point A $= -225.89 + 225.89 + 112.9 + 112.9 =$ ~~225.8 a_x V/m~~ $-225.8 a_x$ V/m

E_T at Point B $= E_1 + E_2 + E_3 + E_4$ B(-2, 3, 5)

$E_1 = 225.89 \times \frac{-2-3}{5} a_x = -225.89 a_x$

$E_2 = -225.89 \times \frac{-2+3}{1} = 225.89 a_x$

$E_3 = 112.9 \times \frac{-2+1}{1} a_x = -112 a_x$

$E_4 = -112.9 \times \frac{-2-5}{7} = 112 a_x$

E_T at Point B = 0

Student ID #: 342 048 783

Question 1 (15 points)

A vector F is given as F = 10 a_r + 5 a_θ – 10 a_ϕ. Covert vector F to rectangular coordinates at a point P (1,2,4).

Solution

$F_x = 10 a_r \cdot a_x + 5 a_\theta \cdot a_x - 10 a_\phi \cdot a_x$

$a_r \quad a_\theta \quad a_\phi$

a_x

a_y

a_z

$F_y = 10 a_r \cdot a_y + 5 a_\theta \cdot a_y - 10 a_\phi \cdot a_y$

$F_z = 10 a_r \cdot a_z + 5 a_\theta \cdot a_z - 10 a_\phi \cdot a_z$

15

$x = r \sin\theta \cos\phi$

$y = r \sin\theta \sin\phi$

$z = r \sin\theta$

$\theta = \cos^{-1}\left(\frac{z}{r}\right)$, $r \to \sqrt{x^2+y^2+z^2}$

$\phi = \tan^{-1}\left(\frac{y}{x}\right)$

$\phi = \tan^{-1}\left(\frac{2}{1}\right) = 63.4^\circ$

$\theta = \cos^{-1}\left(\frac{4}{\sqrt{1+4+16}}\right) = 29.2^\circ$

$F_x = 10 \sin\theta \cos\phi + 5 \cos\theta \cos\phi + 10 \sin\phi$

$= 2.18 + 1.95 + 8.94 = 13.07 a_x$

$F_y = 10 \sin\theta \sin\phi + 5 \cos\theta \sin\phi - 10 \cos\phi$

$= 4.36 + 3.9 - 4.48 = 3.78 a_y$

$\therefore F = 13.07 a_x - 3.78 a_y + 6.29 a_z$

$F_z = 10 \cos\theta - 5 \sin\theta - 0$

$= 8.73 - 2.44 = 6.29 a_z$

Islamic University Faculty of Engineering Department of Electrical Engineering		الجامعة الإسلامية كلية الهندسة قسم الهندسة الكهربائية

EE 282 – ELECTROMAGNETIC FIELD THEORY

Fall Semester 2016-2017

Midterm Exam 1

Exam Date: 03/11/2016 ; Exam Duration: 90 minutes

Student's Full Name: Aamer Al-Khateeb

Student ID #: 342 048 783 **Section #: 2893 Signature:**

Instructions:

- Write your student ID number on the top of each page
- Write the solution in the space provided under each question
- Show all the details of your analysis and calculations

Question No.	Points Assigned	Points Awarded
1. [CO_1, PI_1_62, SO_1]	15	15
2. [CO_2, PI_1_46, SO_1]	15	09
3. [CO_3, PI_5_23, SO_5]	15	05
Total	45	29

Instructor's Full Name	Dr. Imdad Khan
Signature	

29

Islamic University Faculty of Engineering Department of Electrical Engineering		الجامعة الإسلامية كلية الهندسة قسم الهندسة الكهربائية

EE 282 – ELECTROMAGNETIC FIELD THEORY

Fall Semester 2016-2017

QUIZ 1

Grade: 15 / 15

Name, Family Name : Aamer Al-Khateeb

ID No.: 342 048 783 **Section No.:** 2893 **Signature:** [signature]

Quiz Duration: 20 minutes. **Max Marks: 15**

Instructions: Write "the correct" answer in the space provided under each question.

Question: [CO_1, PI_1_62, SO_1]

Three points are given in rectangular coordinate system as A(2,-3,5), B(-2,4,6) and C(1,0,-7).

1. Find the position vectors of the three points. (3)
2. Find the vector component of vector **AB** in the direction of vector **AC**. (6)
3. Find a unit vector which is normal to the surface containing the origin and the points A and B. (6)

Solution

1) $P_A = 2a_x - 3a_y + 5a_z$, $P_B = -2a_x + 4a_y + 6a_z$, $P_c = a_x - 7a_z$ (3)

2) $R_{AB} = (-2-2)a_x + (4+3)a_y + (6-5)a_z = -4a_x + 7a_y + a_z$

$R_{AC} = (1-2)a_x + (0+3)a_y + (-7-5)a_z = -a_x + 3a_y - 12a_z$

to find the vector component of AB in direction of AC we do dot product Between AB and unit vector as: $(AB \cdot a_{AC})a_{AC}$

$a_{AC} = \frac{AC}{|AC|} = \frac{-a_x + 3a_y - 12a_z}{\sqrt{1^2 + 3^2 + 12^2}} = \frac{-a_x}{\sqrt{154}} + \frac{3a_y}{\sqrt{154}} - \frac{12}{\sqrt{154}}a_z$

$\therefore AB \cdot a_{AC} = \frac{+4}{\sqrt{154}} + \frac{21}{\sqrt{154}} - \frac{12}{\sqrt{154}} = \boxed{\frac{13}{\sqrt{154}}}$ then we multiply by a_{AC} (6)

$\left(\frac{13}{\sqrt{154}}\right)a_{AC} = \boxed{\frac{-13}{154}a_x + \frac{39}{154}a_y - \frac{156}{154}a_z}$ } equal

$= -0.08a_x + 0.25a_y - 1.01a_z$ ⟶ continue

Student ID #: 342 048 783

Question 6 (25 points)

For the BJT transistor circuit shown in Figure P6, the parameters are $\beta = 100$ and $V_A = 100$ V. Find the dc voltages at the base and emitter terminals.

(a) Draw the dc equivalent circuit.
(b) Calculate I_{BQ} and I_{CQ}.
(c) Calculate R_C such that $V_{CEQ} = 3.5$ V.
(d) Draw the ac equivalent circuit.
(e) Calculate the small-signal parameters r_π, g_m, and r_o.
(f) Draw the small-signal equivalent circuit.
(g) Derive and calculate the small-signal voltage gain $A_v = V_o/V_s$.

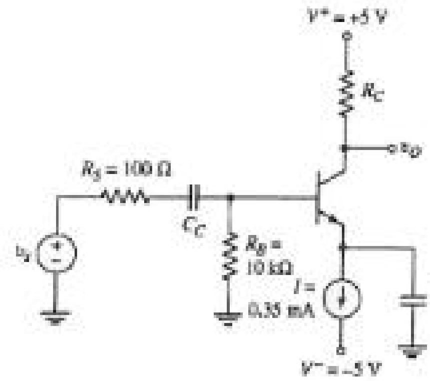


Figure P6

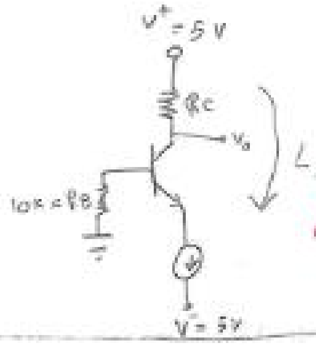
Solution

b) $I_E = (1+\beta) I_{BQ}$

$\therefore I_{BQ} = I_E/(1+\beta) = 3.47\,\mu A$ ✓ 3

$I_{CQ} = \beta I_{BQ} = 0.347$ mA ✓ 3

a)



✓ 2

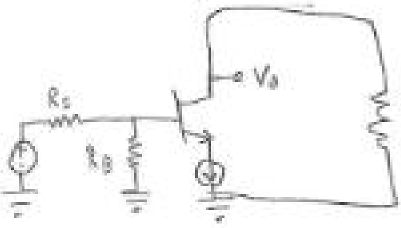
c) KVL in L_1:

$V^+ - I_C R_C - V_{EC} - V^- = 0$

$R_C = \dfrac{V^+ - V_{CE} - V^-}{I_C} = 18.73\ k\Omega$ 2

calc. mistake

D)



✓ 2

e) $r_\pi = \dfrac{\beta V_T}{I_{CQ}} = 7.5\ k\Omega$ ✓ 1

$g_m = \dfrac{I_{CQ}}{V_T} = 13.35$ mA/V ✓ 1

$r_o = \dfrac{V_A}{I_{CQ}} = \dfrac{100}{0.347} = 288\ k\Omega$ ✓ 1

f)

✓ 2½

This is npn

g) $V_o = -g_m v_\pi (r_o // R_C)$

$v_\pi = -v_i \left(\dfrac{R_i}{R_i + R_s}\right)$ ✓ $R_i = r_\pi // R_B = 4.29\ k\Omega$

$A_v = \dfrac{v_o}{v_i} = -g_m (r_o // R_C) \left(\dfrac{R_i}{R_i + R_s}\right) = -229.4$ ✓ 5½

(Not logical answer)

but if I assume $R_S = 100\ k\Omega$, A_v will be $= -9.66$

which seems logical.

calc. mistake due to R_C

23

Student ID #: 342 049 783

Question 5 (15 points)

For the BJT transistor circuit shown in Figure P5, the parameters are β = 120 and $V_{EB}(on) = 0.7$ V.

(a) Calculate I_{BQ}, I_{CQ} and V_{ECQ}.

(b) Sketch the dc load line indicate the Q-point.

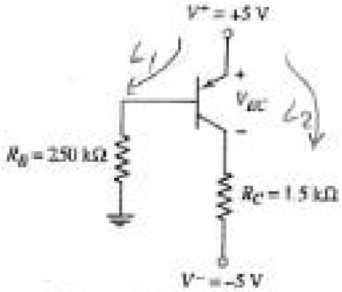


Figure P5

Solution

KVL in L_1 yields:

a) $I_B = \dfrac{V^+ - V_{EB}}{R_B} = 17.2\,uA$ 2

$I_{CQ} = \beta I_{BQ} = 2.064\,mA$

$I_{EQ} = (1+\beta) I_{BQ} = 2.0812\,mA$ 2

KVL in L_2:

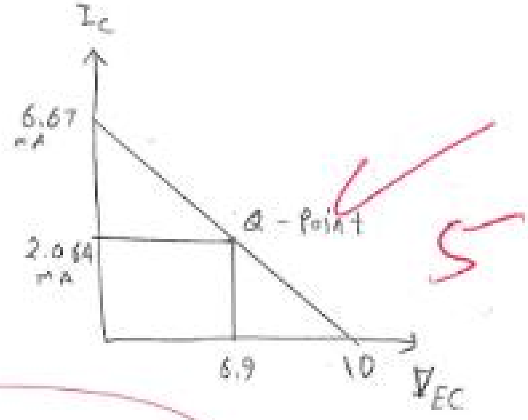
$V^+ - V_{EC} - I_C R_C - V^- = 0$

$5 - V_{EC} - (2.064 \times 1.5) + 5 = 0$

$V_{EC} = 10 - 3.096 = \underline{6.904}$ 4

LL eq: $V_{EC} = 10 - 1.5 I_C$

15



Islamic University Faculty of Engineering Department of Electrical Engineering		الجامعة الإسلامية كلية الهندسة قسم الهندسة الكهربائية

EE 212 - ELECTRONICS II

Fall Semester 2016-2017

Final Exam

Exam Date: January 15, 2017; Exam Duration: 120 minutes

Student's Full Name: Aamer Al-Khateeb

Student ID #: 342048783 **Section #: 2888 Signature:**

Instructions:

- Write your student ID number on the top of each page
- Write the solution in the space provided under each question
- Show all the details of your analysis and calculations

Question No.	Points Assigned	Points Awarded
1. [CO_1, PI_1_45, SO_1]	8	8
2. [CO_3, PI_5_51, SO_5]	12	8.5
3. [CO_8, PI_5_52, SO_5]	15	11
4. [CO_10, PI_5_54, SO_5]	25	22
5. [CO_5, PI_5_49, SO_5]	15	15
6. [CO_7, PI_5_53, SO_5]	25	23
Total	100	87.5/100

Instructor's Full Name	Prof. Kemal Fidanboylu
Signature	

Question 3 (15 points)

1. Derive Maxwell's first equation. What is the integral form of Maxwell's first equation? (10)
2. Given $D = 3x^3yz\, a_x + x^2y^2z^2\, a_y - 2xz^3\, a_z$ C/m², find the divergence of D and the volume charge density at point P(2,3,5). (5)

Solution

1) $\int \text{Div} \cdot D = Q$

2) $D = 3x^3yz\,a_x + x^2y^2z^2\,a_y - 2xz^3\,a_z$

div D

$\frac{\partial D_x}{\partial x} = 9x^2yz$

$\frac{\partial D_y}{\partial y} = 2x^2yz^2$

$\frac{\partial D_z}{\partial z} = -6xz^2$

$\therefore \text{div } D = 9x^2yz + 2x^2yz^2 - 6xz^2$

$\rho_v = \text{div } D$

ρ_v at $P(2,3,5) = (9 \times 2^2 \times 3 \times 5) + (2 \times 2^2 \times 3 \times 5^2) + (-6 \times 2 \times 5^2)$

$= 540 + 600 + -300 = 840\ C/m^3$

$\therefore \rho_v = 840\ C/m^3$

5