Banha University
Faculty of Computers and Informatics

Second Term 2012/2013
First Year General (corrective)

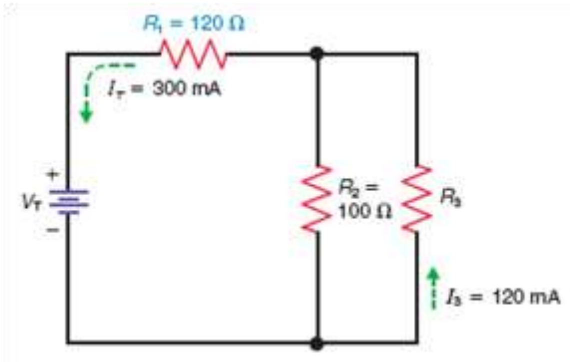
Solutions to the Questions for the Term Examination

Subject: Electronics (corrective) Allowed time: 3 Hours

Answer all questions. No. of questions: 5 No. of pages: 2

Solution to Question 1

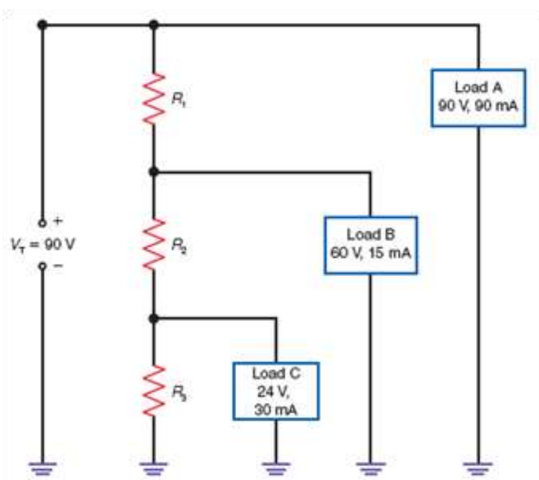
a) For the circuit (1), find the voltages across the resistors, the current I_2, the values of R_3, the voltage of the battery V_T.



Answer

By Kirchhoff current law, $I_2 = I - I_3 = 300 - 120 = 180$ mA
The voltage across R_2 and R_3: $V_{23} = I_2R_2 = (180m)*(100) = 18$ V
$R_3 = V_{23}/I_3 = 18/120m = 150\ \Omega$
$V_T = I_T R_1 + V_{23} = (300m)*(120) + 18 = 36 + 18 = 54$ V

b) Design the voltage divider shown in circuit (2), if the bleeder current is 15 mA.



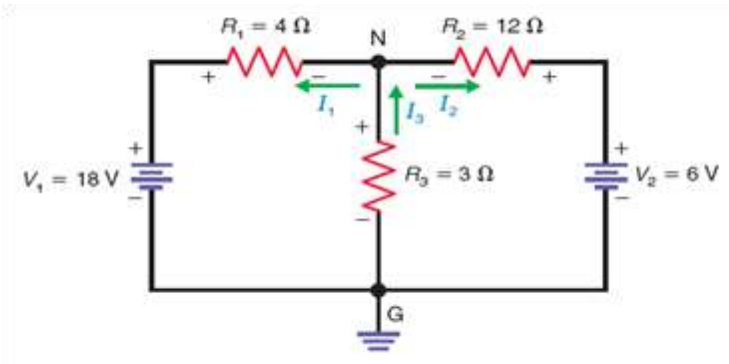
Answer

The bleeder current passes through R_3.
$R_3 = V_C/I_3 = 24/15m = 1.6\ k\Omega$

$I_2 = I_C + I_3 = 15 + 15 = 30$ mA
$R_2 = V_B/I_2 = 60/30m = 2$ kΩ
$I_1 = I_B + I_2 = 15 + 30 = 45$ mA
$R_1 = V_A/I_1 = 90/45m = 2$ kΩ

Solution to Question 2

a) Find the branch currents in circuit (3), V_{NG} and check the power balance.



Answer

Applying KCL at junction N:

$$I_1 - I_2 - I_3 = 0 \quad (1)$$

Applying KVL to the left loop:

$$-18 + 4 I_1 + 3 I_3 = 0 \quad (2)$$

Applying KVL to the right loop:

$$-6 + 12 I_2 + 3 I_3 = 0 \quad (3)$$

Substituting I_2 from equation (1) into equation (3), then

$$-6 + 12 (I_1 - I_3) + 3I_3 = 0$$
$$-6 + 12 I_1 - 9 I_3 = 0$$
$$-2 + 4 I_1 - 3 I_3 = 0 \quad (4)$$

Summing equations (2) and (4),

$$-20 + 8 I_1 = 0$$
$$I_1 = 20/8 = 2.5 \text{ A}$$

From equation (4),

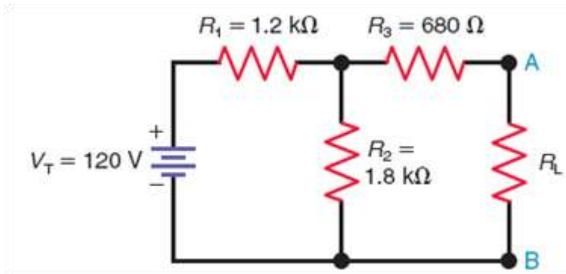
$$I_3 = (-2 + (4)*(2.5))/3 = 8/3 = 2.667 \text{ A}$$

From equation (1),

$$I_2 = I_1 - I_3 = 20/8 - 8/3 = -4/24 = -1/6 \text{ A} = -0.1667 \text{ A}$$

The $V_{NG} = I_3R_3 = (8/3)*(3) = 8$ V

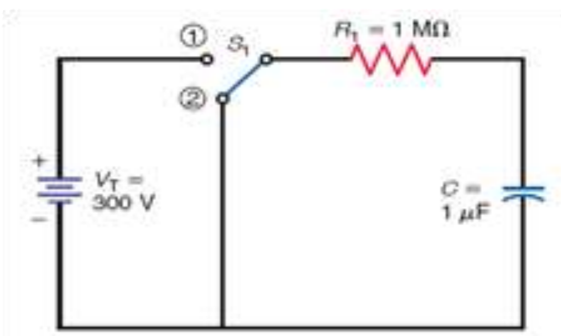
b) Find the value of R_L for maximum power transfer in circuit (4). What is this maximum power?



Answer
Apply Thevenin's thgeorem,
Remove R_L,
$I_2 = 120/(1.2+1.8)k = 120/3k = 40$ mA
$V_{th} = I_2R_2 = (40m)*(1.8k) = 72$ V
$R_{th} = R_1//R_2 + R_3 = [(1.2)*(1.8)/3]k + 680$
$= 720 + 680 = 1400\ \Omega = 1.4\ k\Omega$
For maximum power transfer, $R_L = R_{th} = 1.4\ k\Omega$
The maximum power $P_{max} = V_{th}^2/4R_{th} = (72)^2/4*1400 = 0.9257$ W

Solution to Question 3

a) Assume that the capacitor *C* in circuit (5) is initially uncharged. If S1 is moved to Position 1, how much is the capacitor voltage V_C at t = 1.5, 2.5 and 3.5 s. If the capacitor is fully charged with S1 in Position 1, and then S1 is moved to Position 2, how much is the resistor voltage at t = 1.5, 2.5 and 3.5 s.



`**Answer**
When S is moved to position (1), the capacitor is charging.

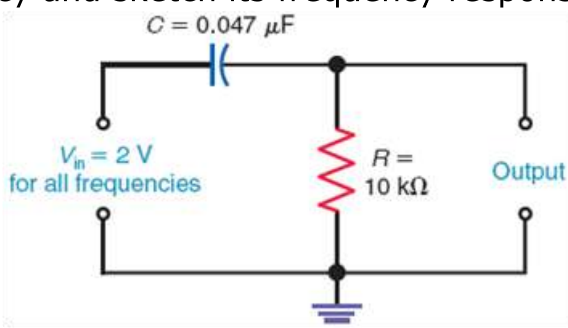
The capacitor voltage is $V_C(t) = V_T\ (1 - e^{-t/RC})$
RC = (1 M)*(1μ) = 1 s
$V_C(1.5) = 300\ (1 - e^{-1.5}) = 233.06$ V
$V_C(2.5) = 300\ (1 - e^{-2.5}) = 275.375$ V
$V_C(3.5) = 300\ (1 - e^{-3.5}) = 290.94$ V

When S is moved to position (2), the capacitor is discharging.

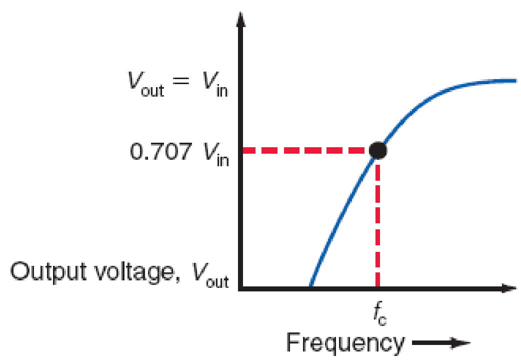
The capacitor voltage is $V_C(t) = V_T\ e^{-t/RC}$

$V_C(1.5) = 300\ e^{-1.5} = 69.9$ V
$V_C(2.5) = 300\ e^{-2.5} = 24.63$ V
$V_C(3.5) = 300\ e^{-3.5} = 9.059$ V

b) For the filter shown in circuit (6), what is its type? Find the cutoff frequency and sketch its frequency response.



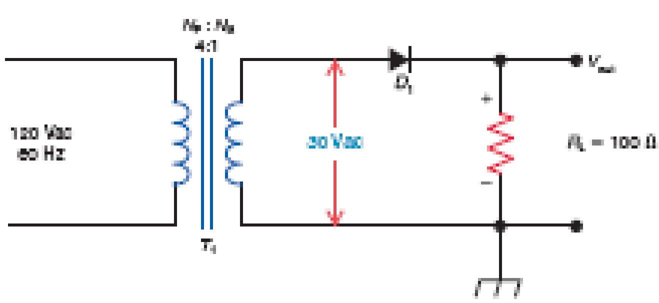
This is high pass filter.
The cutoff frequency $f_{cutoff} = 1/2\pi RC = 1/2\pi(10\times10^3)*(0.047\times10^{-6})$
$= 388.8$ Hz
The frequency response $V_{out} = V_{in}\ R/\sqrt{R^2+(1/2\pi fC)}$
$= V_{in}\ 2\pi fRC/\sqrt{1+(2\pi fRC)^2}$

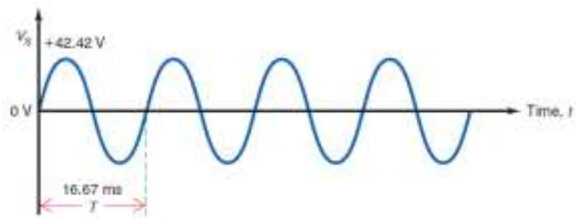


Solution to Question 4

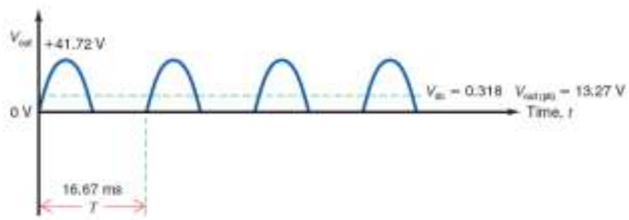
a) Draw the half-wave rectifier circuit V_S, V_{outp}, V_{dc}, I_L, I_{diode}, PIV to rectify AC voltage of 220 V, 50 Hz. The transformer ratio is 3:1 and R_L = 100 Ω. Use second approximation for diode. If a 1000 μF capacitor is added to the output, calculate V_{ripple}, V_{dc}, I_L, PIV.

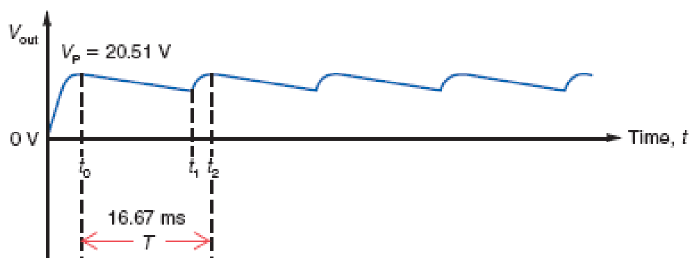
Answer





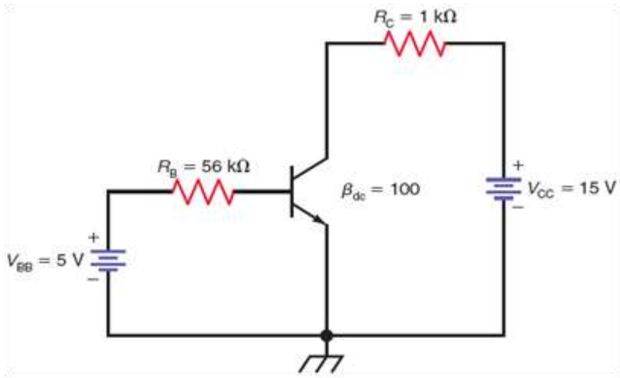
(b)





$V_s = V_p\, N_s/N_p = 220*(1/3) = 73.33$ V
$V_{speak} = V_s\sqrt{2} = 73.33*\sqrt{2} = 103.7$ V
$V_{outpeak} = 103.7 - 0.7 = 103$ V
$V_{dc} = V_{outpeak}/\pi = 103/\pi = 32.8$ V
$I_L = V_{dc}\,/R_L = 32.8/100 = 0.328$ A $= 328$ mA
PIV = 103.7 V
$V_{ripple} = V_{outpeal}(1 - e^{-t/RLC})$
$R_L\, C = (100)*(1000x10^{-6}) = 0.1$ s
$t = 1/50 = 0.02$ s
$V_{ripple} = 103\ (1 - e^{-0.02/0.1}) = 18.67\ V_{p-p}$
$V_{dc} = V_{outpeak} - V_{ripple}/2 = 103 - 18.67/2 = 93.665$ V
$I_L = V_{dc}/R_L = 93.665/100 = 0.93665$ A $= 936.65$ mA
PIV = 103.7 V

b) Find I_B, I_C, I_E and V_{CE} in circuit (7).



Answer

Applying KVL to the base circuit,

$- 5 + 56k\ I_B + 0.7 = 0$

$I_B = (5 - 0.7)/56k = 0.07679$ mA $= 76.79$ μA

$I_C = \beta\ I_B = (100)*(0.07679m) = 7.679$ mA

$I_E = I_B + I_C = 0.07679 + 7.679 = 7.\ 75579$ mA

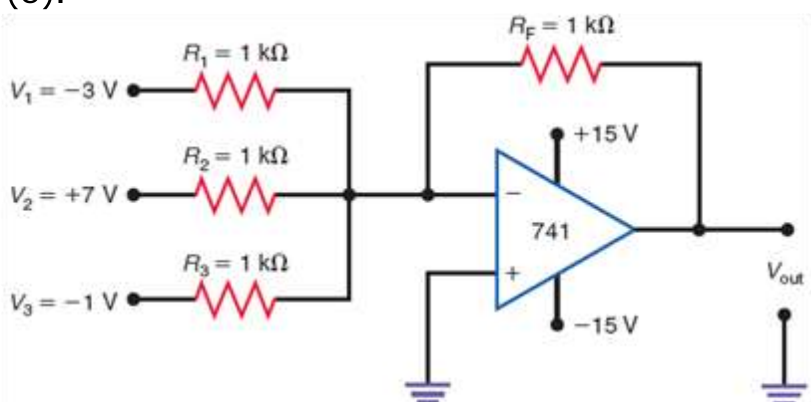
Applying KVL to the collector circuit,

$- 15 +1k\ I_C + V_{CE} = 0$

$V_{CE} = 15 - (1k)*(7.5579\ m) = 15 - 7.6 = 7.4$ V

Solution to Question 5

a) Calculate the output voltage for the operational amplifier shown in ciruit (8).



$V_{out} = - (R_F/R_1\ v_1 + R_F/R_1\ v_1 + R_F/R_1\ v_1)$

$= - R_F/R\ (v_1 + v_2 + v_3)$

$= - (1k/1k)(-3 +7 -1) = -3$ V

b) Choose the correct answer, Justify your choice.

1. A 2.2kΩ R_1 is in parallel with a 3.3kΩ R_2. If these two resistors carry a total current of 7.5 mA, how much is the applied voltage ?

(a) 16.5 V (b)24.75 V **(c) 9.9 V** (d)41.25 V.

$R = R_1//R_2 = (2.2k)*(3.3k)/(2.2k + 3.3k) = 1.32$ kΩ

$V = IR = (7.5\ m)*(1.32k) = 9.9$ V

2. A Norton equivalent circuit consists of a 100μA current source, I_N, in parallel with a 10kΩ resistance R_N. If this circuit is converted into a Thevenin equivalent circuit, how much is V_{TH}?

(a) 1 kV (b) 10 V **(c) 1 V** (d) It cannot be

$V_{Th} = I_N R_N = (100\mu)*(10k) = 1V$

3. In RLC resonance circuit, what value of capacitance is needed to provide a resonant frequency of 1 MHz if L equals 50 μH?

(a) 506.6 pF (b) 506.6 μF (c) 0.001μF (d) 0.0016 μF.

$F = 1/2\pi\sqrt{LC}$

$C = 1/4\pi^2 f^2 L = 1/4\pi^2(10^6)^2(50x10^{-6}) = 5.071x10^{-10}$ H = 507.1 pH

4. A reverse-biased diode acts like ......

(a)closed switch **(b) open switch**

(c) small resistance (d) none of the above.