Benha University
Faculty of Engineering at Shoubra
Electrical Engineering Department
Third Year (Communications)

Final Term Exam (Fall 2016)
Date: Monday (2/1/2017)
Subject: Electronic Circuits (A)
Duration: 4 hours

- **Significant equations sheet is attached.**
- **Answer all the following questions**

- **No. of questions : 5**
- **Total Mark: 90 Marks**

Model Answer

Question (1) (12 Marks)

Choose the correct answer (put your answer in a table format):

a) Which of the h-parameters corresponds to βr_e in a common-collector configuration?
1- h_{ic} 2- h_{fb} 3- h_{fe} 4- h_{ie}

b) The loaded voltage gain of an amplifier is always greater than the no-load level.
1- True 2- False

c) A change in frequency by a factor of _____ is equivalent to 5 octaves.
1- two 2- twenty 3- ten 4- thirty two

d) By how much does the output signal vary for a class A power amplifier?
1- 360° 2- 180° 3- between 180° and 360° 4- Less than 180°

e) To start-up, the oscillator should have a closed loop gain ….. unity.
1- less than 2- equals 3- greater than

f) A current-shunt feedback amplifier …… the input impedance.
1- increases 2- decreases 3- doesn't change

Question (2) (18 Marks)

1- Mention the reasons for the decay in the low and high frequency responses in each one of the following
   a. RC coupled amplifier.
   b. Transformer coupled amplifier.
   c. Direct coupled amplifier.

Answer:

	the reasons for the decay in the low frequency response	in high frequency response
RC coupled amplifier.	Large coupling and bypass capacitors e.g. C_S, Cc and C_E	Parasitic capacitances of network and active devices and frequency dependence of the gain of the transistor, FET, or tube
Transformer coupled amplifier.	The shorting effect across the input terminals of the transformer of the magnetizing inductive reactance at low frequencies ($X_L = 2\pi fL$). The gain must obviously be zero at f =0 because at this point there is no longer a changing flux established through the core to induce a secondary or output voltage.	The stray capacitance between the turns of the primary and secondary windings.

Direct coupled amplifier.	No decay occurs, it's dc amplifier.	Parasitic capacitances of network and active devices and frequency dependence of the gain of the transistor, FET, or tube

2- What are the sources for the start-up signal in oscillator circuits?

Answer:

Initially, a small positive feedback voltage develops from

1- thermally produced broad-band noise in the resistors or other components or
2- from power supply turn-on transients.

3- What are the improvements obtained from using negative feedback amplifiers?

Answer:

Some improvements are:

1. Higher input impedance.
2. Lower output impedance.
3. Better stabilized voltage gain.
4. Improved frequency response.
5. Reduced noise.
6. More linear operation.

4- Determine the voltage gain, input, and output impedance with feedback for current-series feedback amplifier having A = -150, Z_i = 40 kΩ, and Zo = 25 kΩ for feedback of β=-0.15.

Answer:

$A_f = A/(1+\beta A) = -150/ (1+(-150*-0.15)) = -150/23.5 = -6.38$

$Z_{if} = Z_i*(1+\beta A) = 40K*23.5 = 940\ K\Omega$

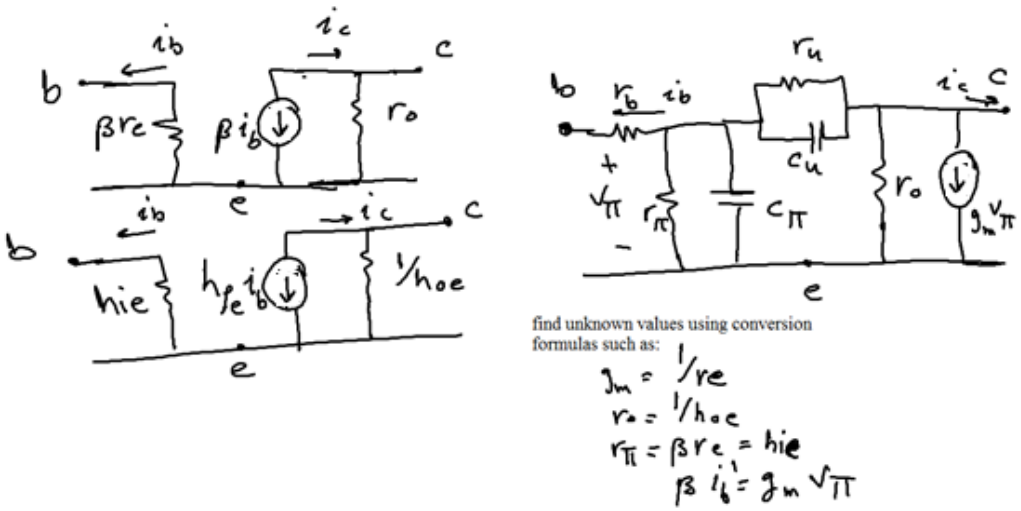
$Z_{of} = Z_o * (1+\beta A) = 25K*23.5 = 587.5\ K\Omega$

Question (3) (20 Marks)

1- Sketch the following for a common-emitter ***npn*** transistor:
   a. the approximate hybrid model,
   b. hybrid π model and
   c. r_e model.

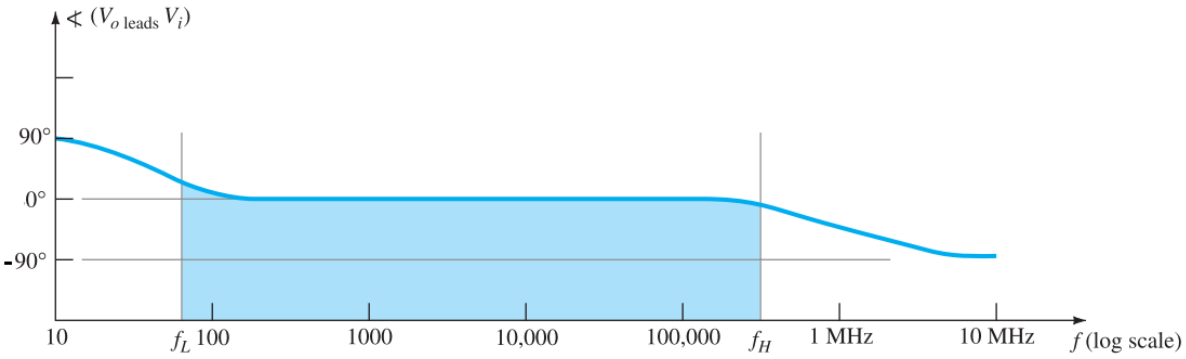
(Given r_b= 3Ω, r_π= 1.6kΩ, r_u= 20MΩ, C_u= 1pF, C_π= 5pF, β= 100, h_{oe}= 18 μS.)

Answer:



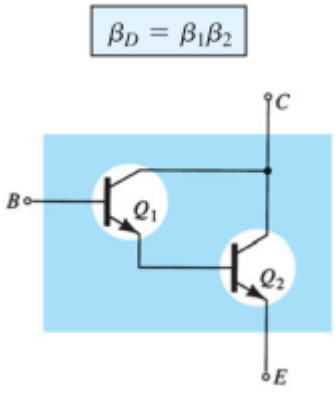
2- Sketch (free hand) the complete phase response of a common base amplifier.

Answer:



3- Sketch the Darlington pair transistor symbol, and mention its advantages.

Answer:



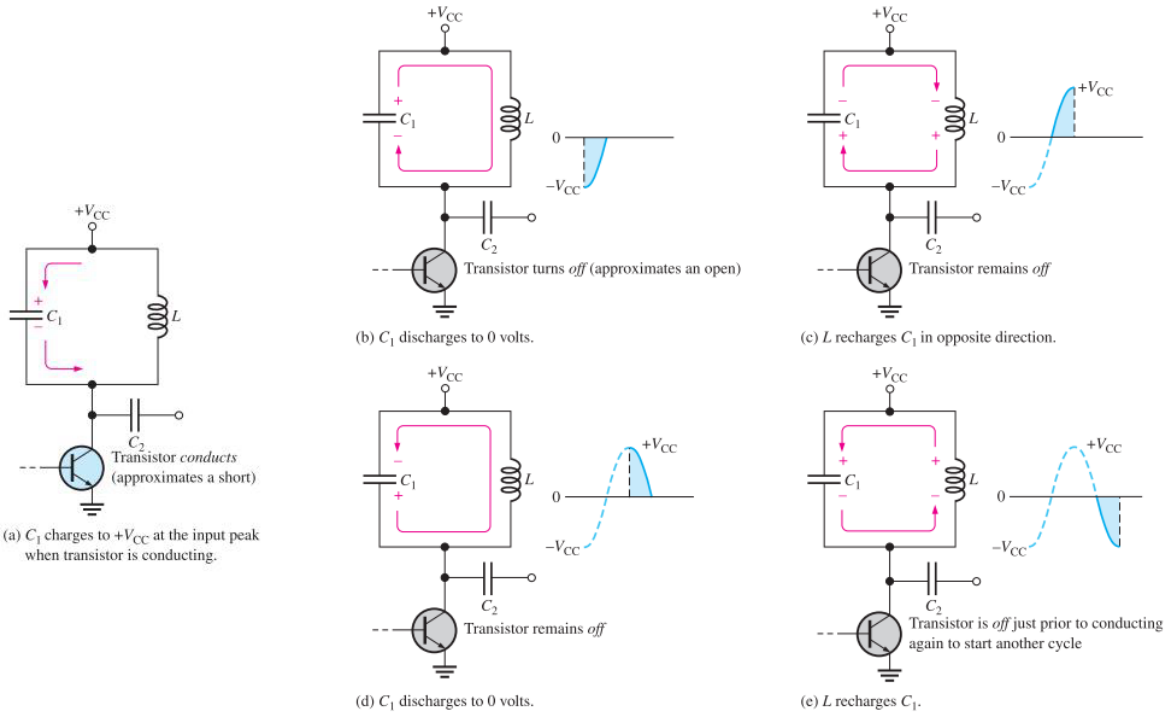
A very popular connection of two bipolar junction transistors for operation as one "super-beta" transistor is the Darlington connection

Advantages:

- ✓ It has input impedance much larger than that obtained with a single-transistor network.
- ✓ The current gain is also larger

4- Illustrate the resonance action in tuned amplifiers.

Answer:



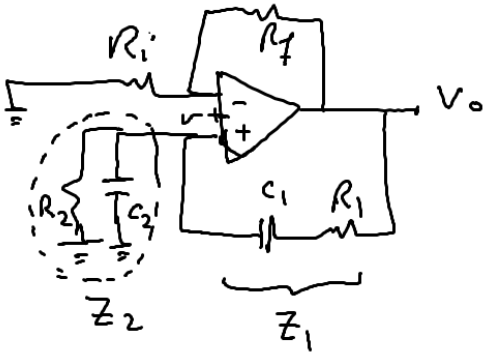
5- Derive an equation for the wien-bridge oscillation frequency.

Answer:

$$Z_1 = R_1 - j/\omega C_1$$

$$Z_2 = R_2 \,//\, -j/\omega C_2 = \frac{R_2 * -j/\omega C_2}{R_2 - j/\omega C_2}$$

$$= \frac{R_2}{j\omega R_2 C_2 + 1}$$



$$\beta = \frac{V+}{V_o} = \frac{R_2}{(R_1 + R_2 + R_2\frac{C_2}{C_1}) + j(\omega R_1 R_2 C_2 - 1/\omega C_1)}$$

img term $= 0 \;\therefore\; \omega_o R_1 R_2 C_2 - 1/\omega C_1 = 0 \Rightarrow \omega_o = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}}$

$$\therefore f_o = 1/2\pi\sqrt{R_1 R_2 C_1 C_2} \quad @\ \begin{matrix} R_1 = R_2 \\ C_1 = C_2 \end{matrix} \;\therefore f_o = 1/2\pi RC \;\#$$

Question (4) (15 Marks)

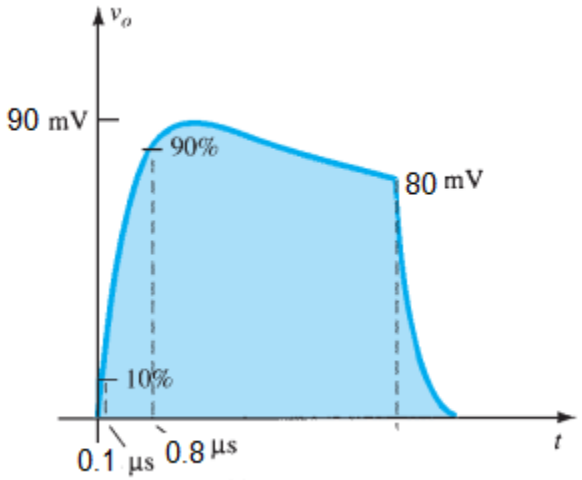
1- Calculate the resonance frequency of a Hartley oscillator if the tank circuit has Q=8 and its components values are L_1= 1.5 mH, L_2=10 mH and C=470pF.

Answer:

$L_T = L_1 + L_2 = 1.5 + 10 = 11.5$mH

$$f_r = \frac{1}{2\pi\sqrt{L_T C}}\sqrt{\frac{Q^2}{Q^2 + 1}}$$ → so, f_r =67.93 kHz

2- The application of a 10-mV, 100-kHz square wave to an amplifier resulted in the output waveform of Fig. 1,



a. Determine the bandwidth of the amplifier.

Answer:

B.W.= f_H-f_L

From (b) → f_H= 500kHz, f_L=3.5kHz

So, B.W.= 496.5 kHz

b. Calculate the low and high cutoff frequencies.

Answer:

From the figure,

t_r=0.8-0.1=0.7 μs

P=(90-80)/90= 1/9

So, f_L=(P/π)fs=3.5kHZ

f_H=0.35/tr=500kHz

c. If we construct a multistage amplifier by cascading 3 stages of the above amplifier, calculate the new bandwidth.

Answer:

n=3,

$f_1' = f_1/\sqrt{2^{1/n} - 1}$ = 6.87 kHz

$f_2' = (\sqrt{2^{1/n} - 1})f_2$ = 254.9 kHz

B.W.' = 254.9-6.87 = 248.9 kHz

3- For the power amplifier circuit of Fig. 2:

a. What's the name of this type?

Answer: Class A transformer coupled power amplifier

b. What's the theoretical maximum efficiency of this circuit?

Answer: 50%

c. Calculate the efficiency of that circuit for a supply of 12 V and output of V(p) = 6 V.

Answer:

$$\%\,\eta = 50\left(\frac{V_{CE_{max}} - V_{CE_{min}}}{V_{CE_{max}} + V_{CE_{min}}}\right)^2 \%$$

$$V_{CE_{max}} = V_{CE_Q} + V(\text{p}) = 12\text{ V} + 6\text{ V} = 18\text{ V}$$
$$V_{CE_{min}} = V_{CE_Q} - V(\text{p}) = 12\text{ V} - 6\text{ V} = 6\text{ V}$$

$$\%\,\eta = 50\left(\frac{18\text{ V} - 6\text{ V}}{18\text{ V} + 6\text{ V}}\right)^2 \% = \mathbf{12.5\%}$$

d. What transformer turns ratio is required to match a 16- Ω speaker load so that the effective load resistance seen at the primary is 10 kΩ?

Answer:

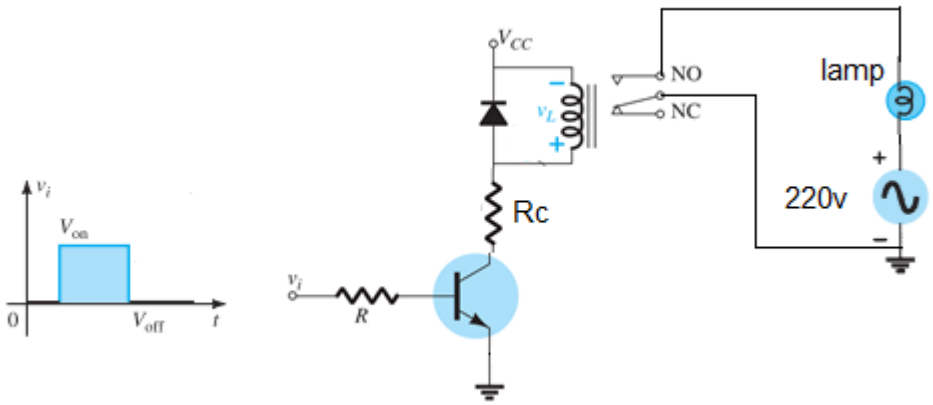
$$\left(\frac{N_1}{N_2}\right)^2 = \frac{R_L'}{R_L} = \frac{10\text{ k}\Omega}{16\ \Omega} = 625$$
$$\frac{N_1}{N_2} = \sqrt{625} = \mathbf{25{:}1}$$

Question (5) (25 Marks)

1- Design a transistor switch circuit to drive a 220v lamp, the switch is driven by a microcontroller signal with duty cycle equals 65%. Sketch the collector waveform.

Answer:

We design the shown circuit



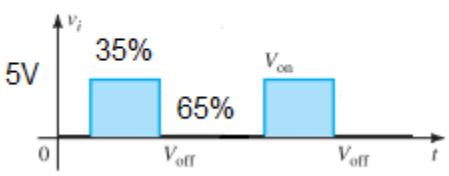
We use Vcc= 5V

For the transistor to operate as a switch, this constraint should be followed:

$$I_{C_{sat}} = \frac{V_{CC}}{R_C} \qquad I_B > \frac{I_{C_{sat}}}{\beta_{dc}} \qquad I_B = \frac{V_i - 0.7\text{ V}}{R_B}$$

Assume RC & Ic_{sat} and find RB or vice versa

collector waveform



2- Design an amplifier circuit with the following specifications:

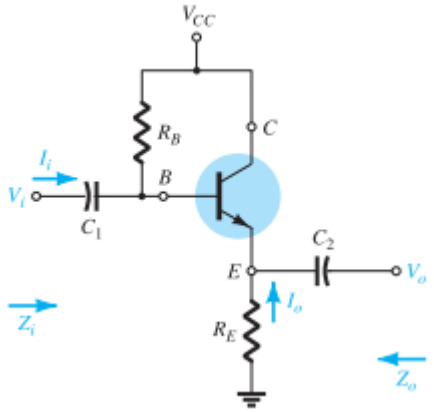
- The amplifier consists of two RC coupled stages with total gain of 20 dB.
- The first stage is an emitter follower circuit to match between a mic signal with internal resistance of 500Ω and the second stage.
- The mic signal frequency band is between 400 Hz and 4.5 KHz.
- The second stage is a common emitter amplifier that drives a 1KΩ load through a 10 uF capacitor.

Plot the low and high frequency responses of that amplifier taking into consideration the effect of each stage on the other.

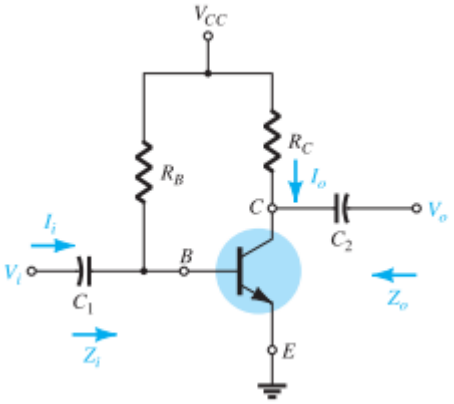
Answer:

Many designs are acceptable but it should follow these constraints:

1st stage: common collector

Gain =1, Zi_1> 500*10 R_{L1}= Z_{i2} Fl<400Hz/10 fH>4.5K *10	

2nd stage: common emitter

Gain = 20dB. Z_{o2}< (1K/10) Fl<400Hz/10 fH>4.5K *10 Use C=10u to find Fl	

Good Luck,
Dr. Ahmad El-Banna