Helwan University
Basic Electronics
Dr. Eman F. Sawires

Sheet (1)
1^{St} year
Com. & Sys Eng. Dept.

Q1] Find the dc transmission, the corner frequency f_0, and the transmission at f = 2 MHz for the low pass STC circuit shown in Fig. 1.

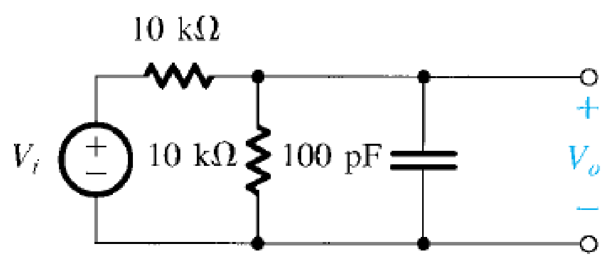

Fig. 1.

Ans.: –6 dB; 318 kHz; –22 dB

Q2] Find the transfer function $T(s)$ of the circuit in Fig. 2. What type of STC network is it?

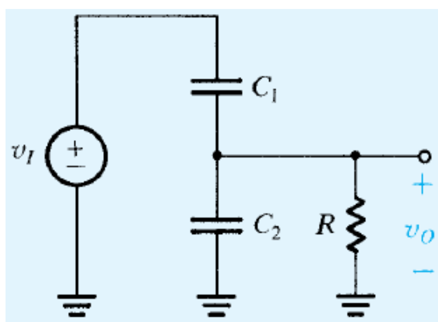

Fig. 2.

Ans.:

$$T(s) = \frac{C_1}{C_1 + C_2}\,\frac{s}{s + [1/(C_1 + C_2)R]};\ \text{HP}$$

Q3] For the situation discussed in Fig. 2, if R = 10 kΩ, find the capacitor values that result in the circuit having a high-frequency transmission of 0.5 V/V and a corner frequency ω_0 = 10 rad/s.

Ans. : $C_1 = C_2 = 5\ \mu F$

Q4] In Fig.3, a common-emitter amplifier has $C_{C1} = C_E = C_{C2} = 1$ µF, $R_B = 100$ kΩ, $R_{\text{sig}} = 5$ kΩ, $g_m = 40$ mA/V, $r_\Pi = 2.5$ kΩ, $R_C = 8$ kΩ, and $R_L = 5$ kΩ. Assuming that the three capacitors do not interact, find f_{P1}, f_{P2}, and f_{P3}, and hence estimate f_L.

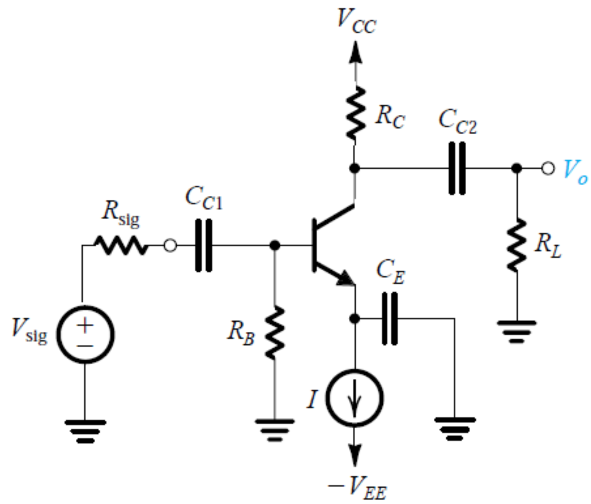

Fig.3

<u>Ans. :</u> 21.4 *Hz*, 2.21 K*Hz*, 12.2 *Hz*

Q5] In Fig. 4, a CS amplifier has $C_{C1} = C_S = C_{C2} = 1$ µF, $R_G = 10$ MΩ, $R_{\text{sig}} = 100$ kΩ, $g_m = 2$ mA/V, $R_D = R_L = 10$ kΩ. Find A_M, f_{P1}, f_{P2}, f_{P3}, and f_L.

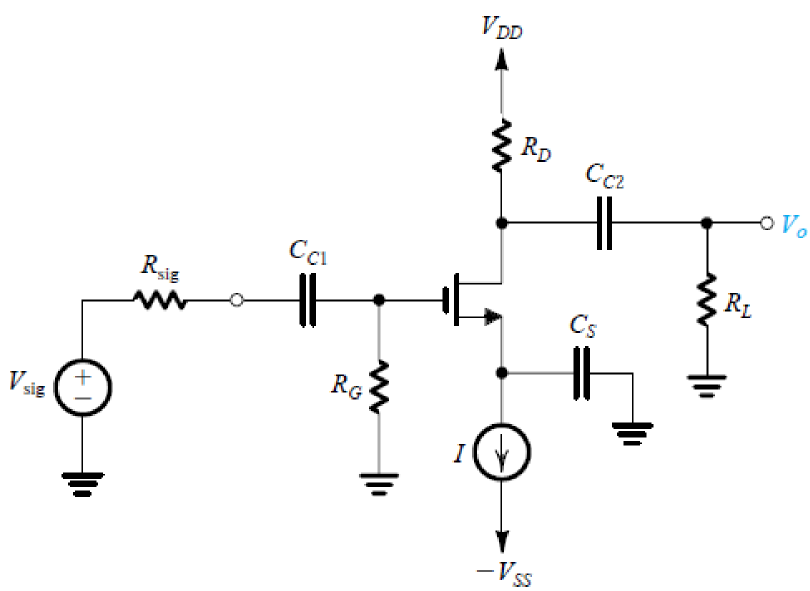

Fig.4

<u>Ans. :</u> -9.9 *V/V*, 0.016 *Hz*, 318 *Hz*, 8 *Hz*, 318 *Hz*

Q6] Select appropriate values for the coupling capacitors C_{C1} and C_{C2} and the bypass capacitor C_S for a CS amplifier for which $R_G = 4.7\ M\Omega$, $R_D = R_L = 15\ k\Omega$, $R_{sig} = 100\ k\Omega$, and $g_m = 1\ mA/V$. It is required to have f_L at 100 Hz and that the nearest break frequency be at least a decade lower.

Ans. : 3.3nF, 0.53µF, 1.6µF

Q7] For the common-emitter amplifier of Fig. 5, neglect r_o, and assume the current source to be ideal.
(a) Derive an expression for the midband gain.
(b) Derive expressions for the break frequencies caused by C_E and C_C.
(c) Give an expression for the amplifier voltage gain $A(s)$.
(d) For $R_{sig} = R_C = R_L = 10\ k\Omega$, $\beta = 100$, and $I = 1\ mA$, find the value of the midband gain.
(e) Select values for C_E and C_C to place the two break frequencies a decade apart and to obtain a lower 3-dB frequency of 100 Hz while minimizing the total capacitance.
(f) Sketch a Bode plot for the gain magnitude.
(g) Find the phase shift at 100 Hz.

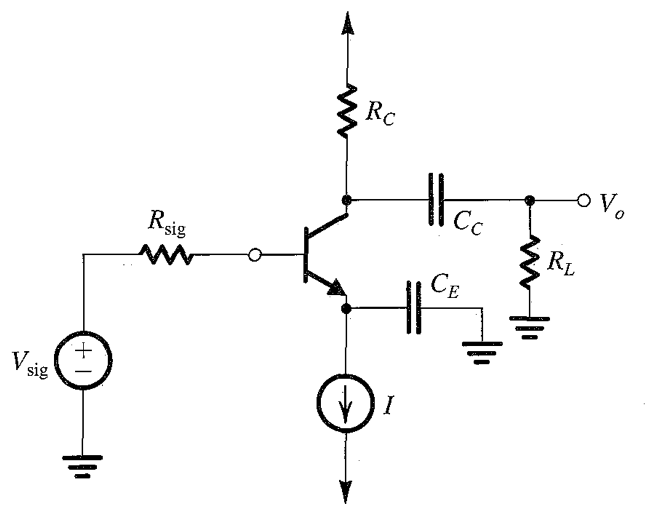

Fig. 5.

Ans. : -40 V/V, 12.7µF, 0.8µF, -129.3°

Q8] The NMOS transistor in the discrete CS amplifier circuit of Fig. 6 is biased to have g_m = 1 mA/V. Find A_M, f_{P1}, f_{P2}, f_{P3}, and f_L.

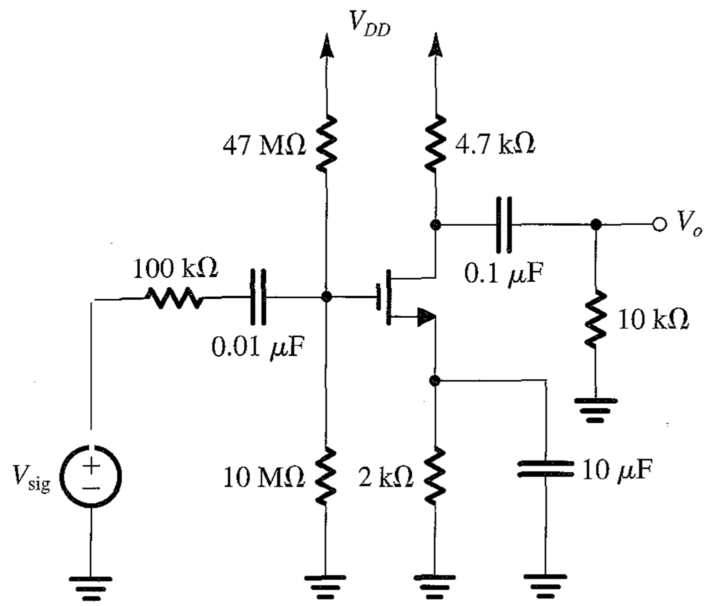

Fig. 6.

Ans. : -3.16 V/V, 1.9 *Hz*, 23.9 *Hz*, 108.3 *Hz*, 108.3 *Hz*

Q9] A discrete MOSFET common-source amplifier has R_{in} = 2 MΩ, g_m = 4 mA/V, r_o = 100 kΩ, R_D = 10 kΩ, C_{gs} = 2 pF, and C_{gd} = 0.5 pF. The amplifier is fed from a voltage source with an internal resistance of 500 kΩ and is connected to a 10-kΩ load. Find:

(a) the overall midband gain A_M

(b) the upper 3-dB frequency f_H

Ans. : -15.2 V/V, 33.1 K*Hz*

Q10] The NMOS transistor in the discrete CS amplifier circuit of Fig. 6 is biased to have g_m = 1 mA/V and r_o = 100 kΩ. Find A_M. If C_{gs} = 1 pF and C_{gd} = 0.2 pF, find f_H.

Ans. : -3.06 V/V, 874.99 K*Hz*

Q11] The analysis of the high-frequency response of the common-source amplifier, presented in the text, is based on the assumption that the resistance of the signal source, R_{sig}, is large and, thus, that its interaction with the input capacitance C_{in} produces the "dominant pole" that determines the upper 3-dB frequency f_H. In some situations, however, the CS amplifier is fed with a very low R_{sig}. To investigate the high-frequency response of the amplifier in such a case, Fig. 7 shows the equivalent circuit when the CS amplifier is fed with an ideal voltage source V_{sig} having $R_{sig} = 0$. Note that C_L denotes the total capacitance at the output node. By writing a node equation at the output, show that the transfer function V_o/V_{sig} is given by

$$\frac{Vo}{V\text{sig}} = -g_m R_L{}' \frac{1 - s(C_{gd}/g_m)}{1 + s(C_L + C_{gd})R_L{}'}$$

At frequencies $\omega \ll (g_m/c_{gd})$, the s term in the numerator can be neglected. In such case, what is the upper 3-dB frequency resulting? Compute the values of A_M and f_H for the case: $C_{gd} = 0.5$ pF, $C_L = 2$ pF, $g_m = 4$ mA/V, and $R_L' = 5$ kΩ.

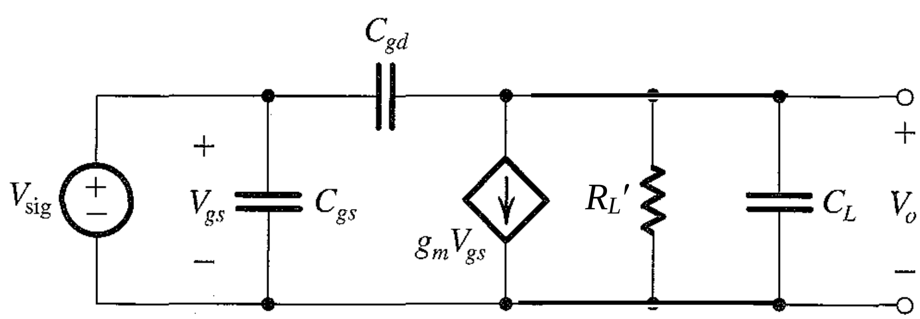

Fig. 7.

Ans. : -20 V/V, 12.7 M*Hz*

Q12] Consider the common-emitter amplifier of Fig. 8 under the following conditions: $R_{sig} = 5$ kΩ, $R_1 = 33$ kΩ, $R_2 = 22$ kΩ, $R_E = 3.9$ kΩ, $R_C = 4.7$ kΩ, $R_L = 5.6$ kΩ, $V_{CC} = 5$ V. The dc emitter current can be shown to be $I_E \approx 0.3$ mA, at which $\beta_o = 120$, $r_o = 300$ kΩ, and $r_x = 50$ Ω. Find the input resistance R_{in} and the midband gain A_M. If the transistor is specified to have $f_T = 700$ MHz and $C\mu = 1$ pF, find the upper 3-dB frequency f_H. (V_T= 25mV)

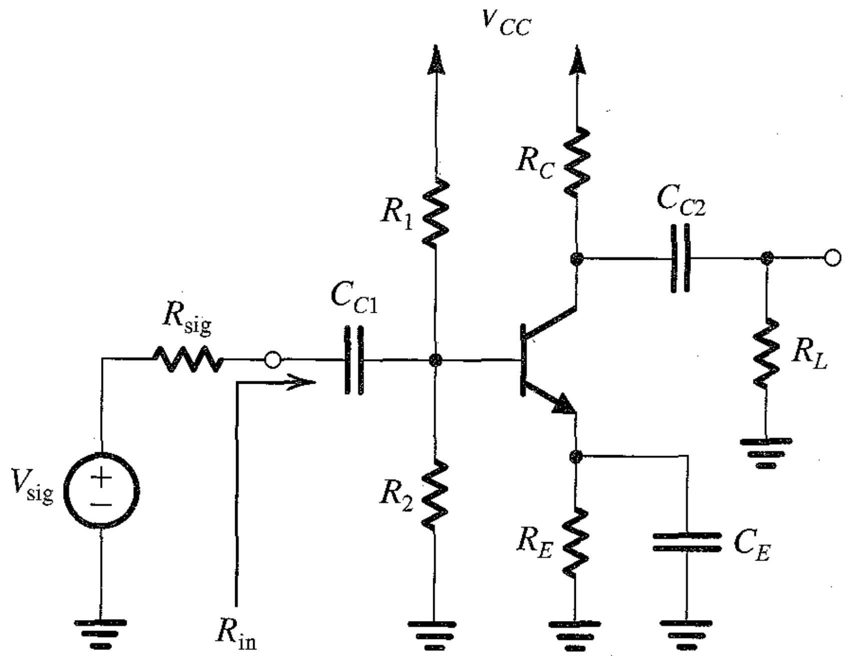

Fig.8

<u>**Ans. :**</u> 5.7 KΩ, -16.11 V/V, 1.79 M*Hz*

Q13] For a version of the CE amplifier circuit in Fig. 8, $R_{sig} = 10$ kΩ, $R_1 = 68$ kΩ, $R_2 = 27$ kΩ, $R_E = 2.2$ kΩ, $R_C = 4.7$ kΩ, and $R_L = 10$ kΩ. The collector current is 0.8 mA, $\beta = 200$, $f_T = 1$ GHz, and $C_\mu = 0.8$ pF. Neglecting the effect of r_x and r_o, find the midband voltage gain and the upper 3-dB frequency f_H.

<u>**Ans. :**</u> -32.8 V/V, 572 K*Hz*

Best wishes