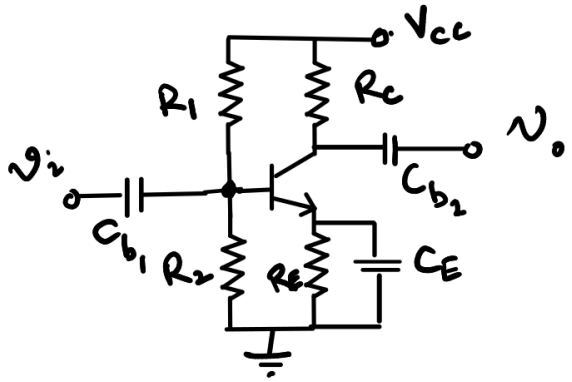
PH3104 End Semester

Full marks : 40 **Time : 2 hours 30 minutes**

Attempt all questions

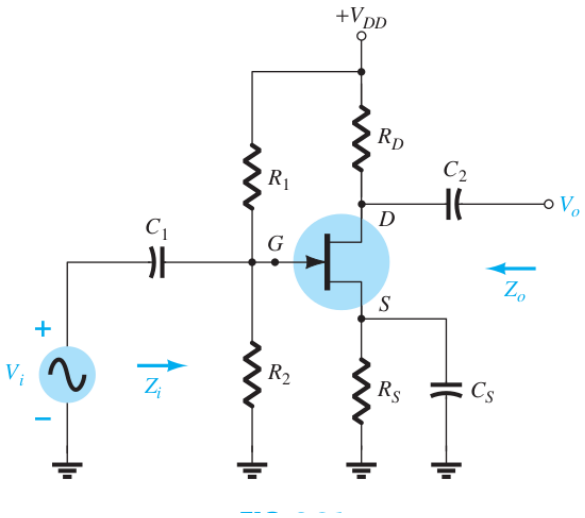
Q 1) a) In a common base BJT circuit the input port is between the emitter and the base, and the output between the base and the collector. Express the common base h parameters h_{ib}, h_{rb}, h_{fb} and h_{ob} in terms of the corresponding common emitter h parameters, h_{ie} and h_{fe} (you can neglect h_{re} and h_{oe}).

b) In the circuit below $R_1 = 20$ k, $R_2 = 10$ k, $R_C = R_E = 1$ k.



If the β for the BJT is 100, determine the bias currents and voltages. You can take $V_{BE} = 0.7\,\text{V}$ [4 + 3]

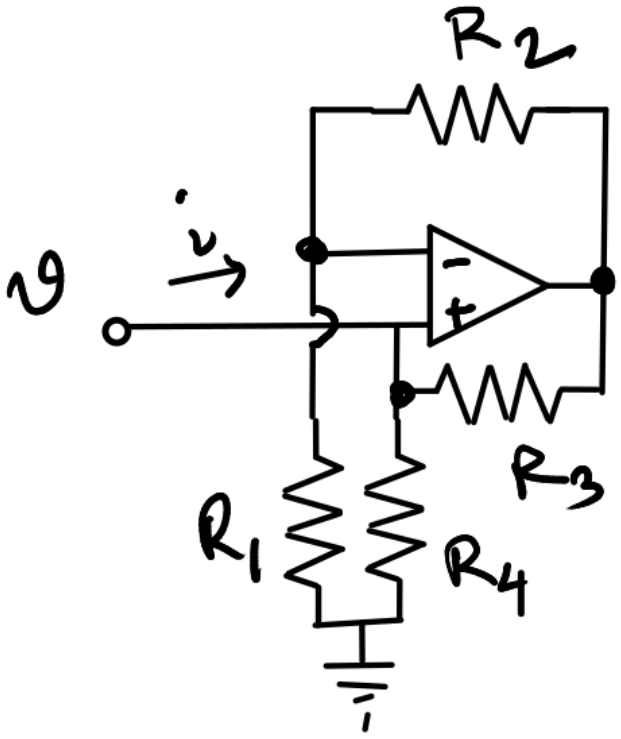
Q 2) Consider the JFET based amplifier shown below.



a) Draw the equivalent small signal ac circuit for mid-band frequencies.

b) Determine expressions for Z_i, Z_o and A_V for the circuit in terms of the circuit parameters and the effective parameters g_m and r_d for the JFET. [2 + 3]

Q 3) In the OP-AMP circuit shown below, the saturation voltages for the OP-AMP are ± 11 V.



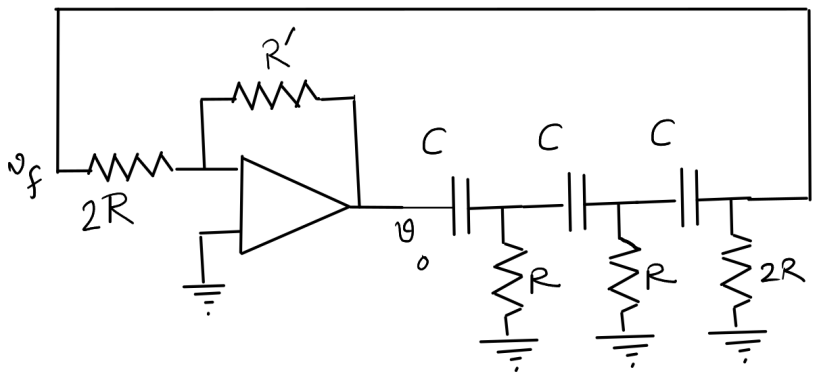
Plot the graph of i versus v for the range $v = -2$ V to $v = +2$ V for the following two cases :

a) $R_1 = R_3 = R_4 = 1$ k,$R_2 = 10$ k.

b) $R_1 = R_2 = R_3 = R_4 = 1$ k.

Explain your reasoning. Label the axes and scales appropriately. [3 + 3]

Q 4) Consider the phase shift oscillator shown below



a) Determine the feedback ratio $\beta = \frac{v_f}{v_o}$ as a function of $\xi = \frac{1}{\omega CR}$. *Hint : you can use nodal analysis - or any other method of choice!*

b) Use this expression to determine the oscillation frequency and the minimum value of R' for the circuit to oscillate. $[6 + 2]$

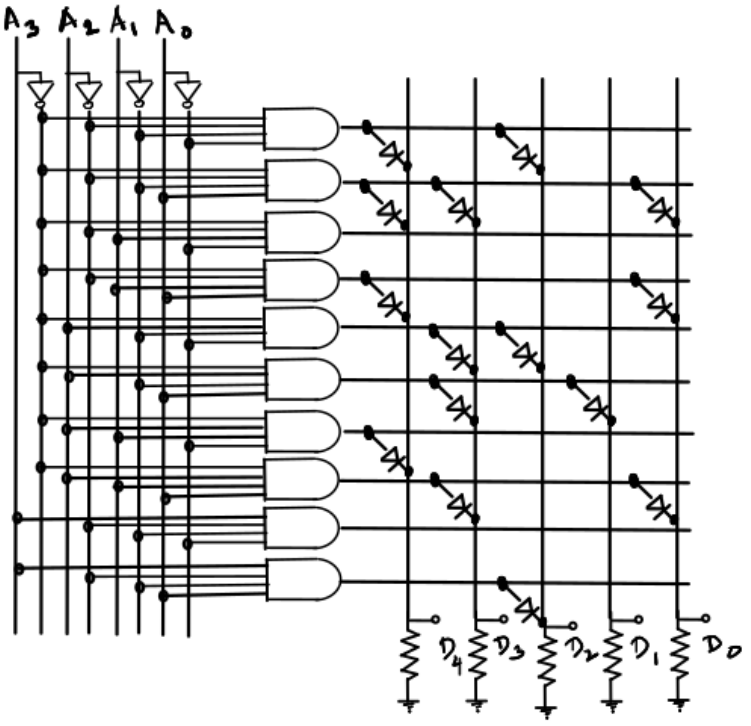
Q 5 a) The truth table of a 4-input Boolean function is given below (The Xs in the output column denote don't cares).

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	X
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	X
1	1	0	1	1
1	1	1	0	1
1	1	1	1	X

Use the Karnaugh map technique to write down the simplest form of the Boolean function which implements this. Choose the don't care conditions wisely!

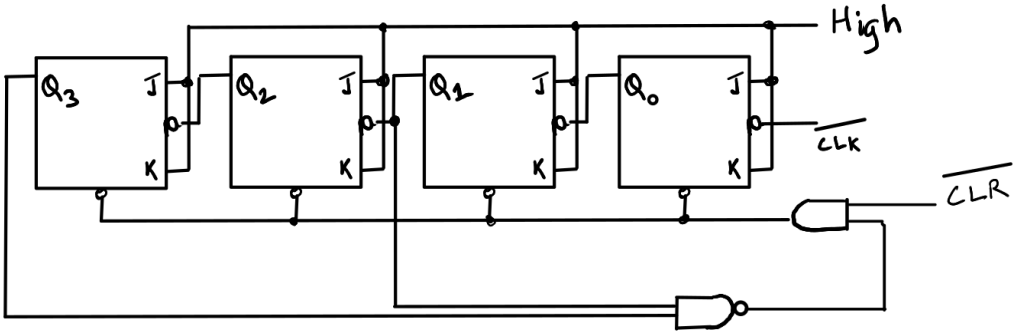
b) Implement this function using 2-input NAND gates only!

c) Write down the truth table for the circuit shown below (here D_4, D_3, D_2, D_1, D_0 are the outputs, while A_3, A_2, A_1, A_0 are inputs).



Explain what circuits like this can be used for. [4 + 3 + 3]

Q 6) The circuit below is a small modification of the ripple counter that was discussed in class. Specifically the outputs Q_1 and Q_3 are fed back to a NAND gate, the output of which is fed to an AND gate, along with the $\overline{CLR}$ signal.



Explain how the output nibble (the binary number $Q_3Q_2Q_1Q_0$) will change with successive clock pulses. [4]