Ref: PG/IEE/PE/T/115A

M.TECH. INSTRUMENTATION AND ELECTRONICS ENGINEERING 2024-25
FIRST YEAR FIRST SEMESTER EXAM
BASICS OF ELECTRONIC SYSTEM DESIGN

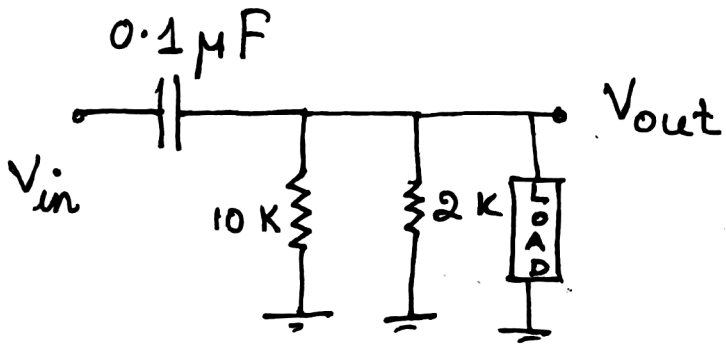
Time: 3Hrs. Full Marks: 100

Module 1: CO1: Answer all questions in module1

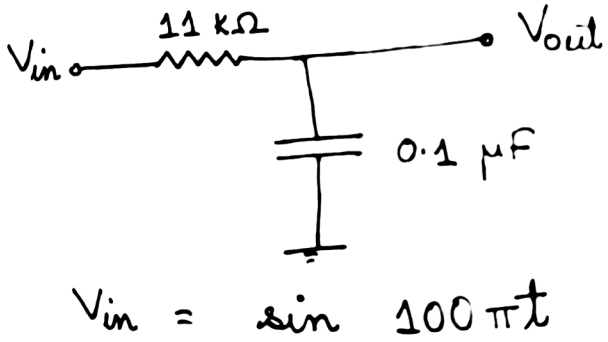
1. i) Define the following terms: (3)
   a) Filter
   b) Frequency Response of a Filter
   c) Cutoff Frequency of a Filter

   ii) Sketch the Frequency Response of an ideal Low Pass Filter. How does it differ from that of a practical one? (3)

   iii) Obtain an expression for the output voltage of the filter and calculate the time constant of the given filter circuit. (4 + 4)



   iv) Calculate the cut-off frequency of the filter, and the gain of the circuit at the input signal frequency. (6)



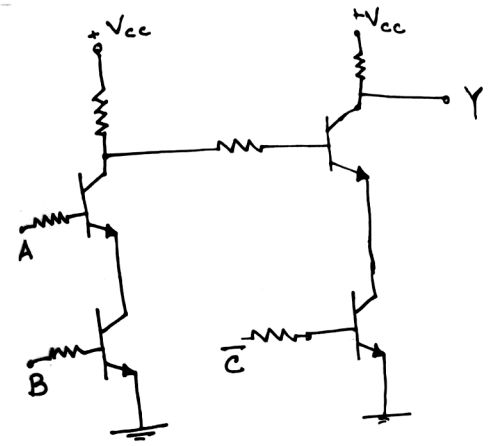
[Turn over

Module 2: CO2: Answer any three questions

2. i) Use RTL to implement the Boolean function

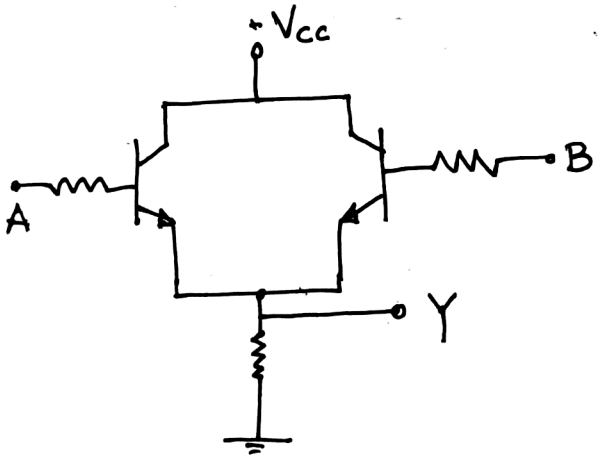
$Y = (AB)' + (CD)'$ (8)

ii) Derive a simplified Boolean expression for the output Y of the circuit below. (6)

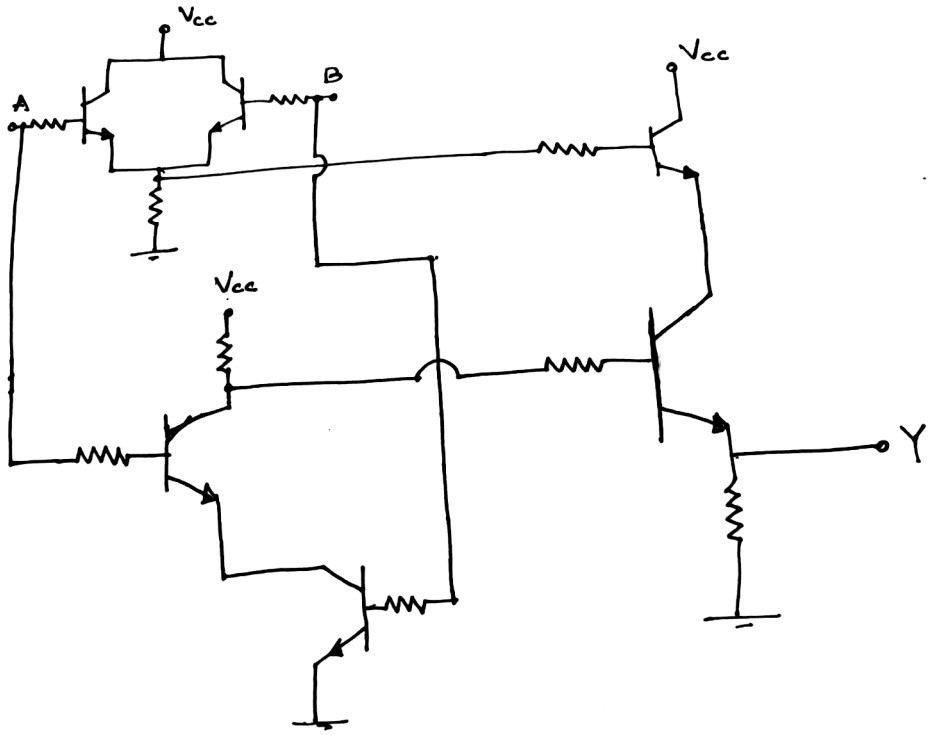


iii) With the help of a circuit diagram explain how a 3 input AND gate can be implemented using RTL. Explain the output when any one of the inputs is at logic 0. (6)

3. i) A and B are binary input signals. Explain the output Y for the different logical combinations of A and B. (4)



ii) Explain the RTL circuit given below. Construct the Truth Table for the circuit and specify the Boolean function that is being implemented here. (10)



iii) What is RTL? Implement the Universal Logic Gates using RTL and explain the circuits. (6)

4. i) Design Full- Adder circuit using CMOS logic.

ii) Describe the operation of complementary Switch in CMOS logic.

iii) Design 8X1 multiplexer using complementary switch.

iv) Implement the function $y = \overline{AB + C(A+B)}$ using CMOS logic.

v) Implement XOR gate using CMOS complementary switch.

6+6+4+2+2

5 i) Design a circuit to implement a current source independent of the load impedance. (5)

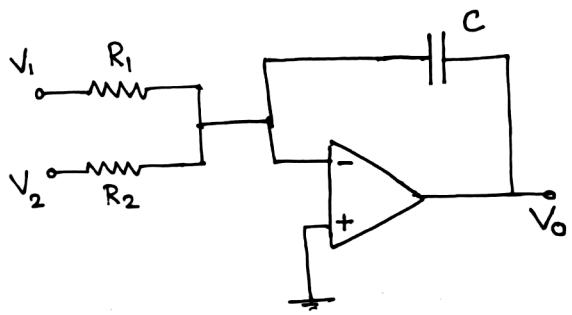
ii) With the help of a circuit diagram, discuss how to use OPAMP(s) to obtain the function

$f = 3V_1 + 2 \sin wt - 2V_3$ (8)

iii) Describe the operation of the given circuit and obtain the output voltage (expression) for it when

$V_1 = 10 \cos 2t$ $V_2 = t$

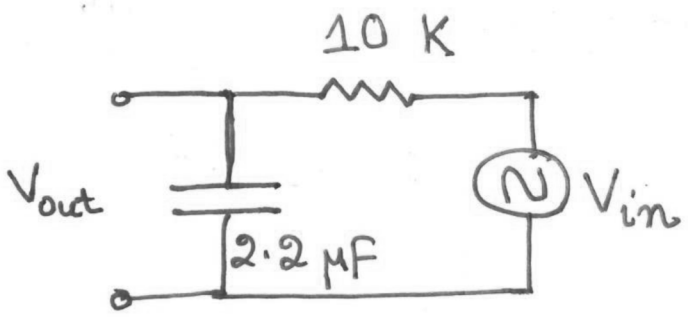
$R_1 = 2\ M\Omega$ $R_2 = 200\ k\Omega$ $C = 10\ \mu F$ (7)



6. i) Explain how a combination of resistors and capacitors can act as a low pass filter. (3)

ii) Explain the working principle of a passive High Pass Filter and derive an expression for the gain of the filter. (6)

iii) Which kind of filter is implemented by the following circuit? Determine the impedances of both the resistor and the capacitor at the cut-off frequency of the circuit. (6)

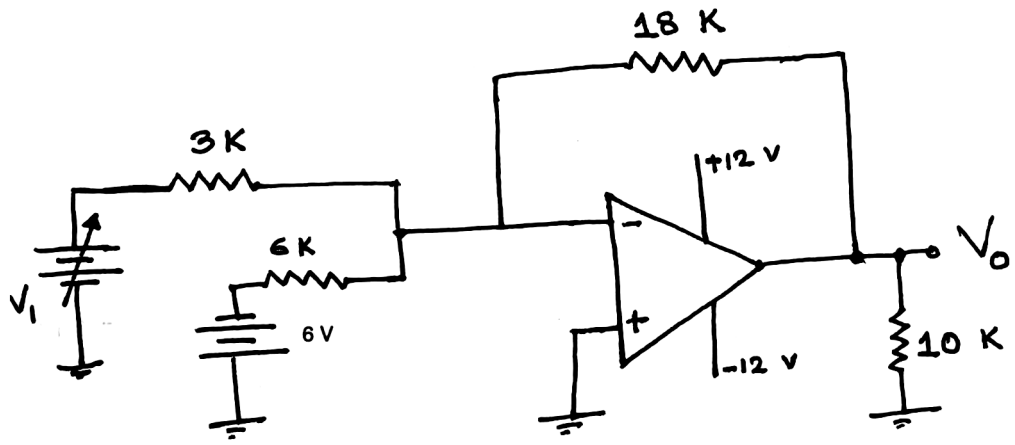


iv) With the help of a detailed circuit diagram and necessary equations, explain how a High Pass Filter can be implemented using an OpAmp. (5)

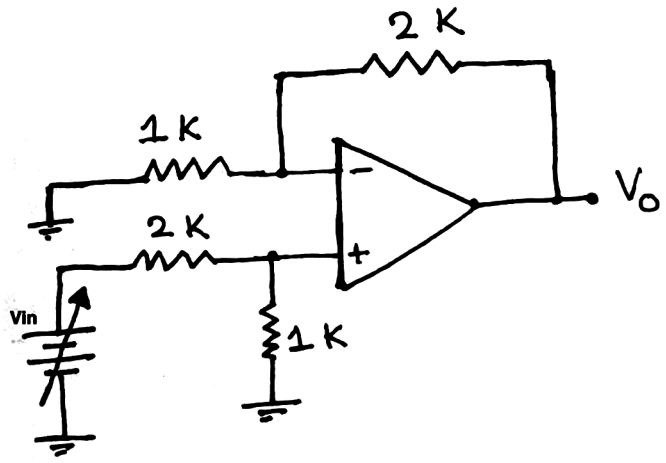
7. i) With the help of a circuit diagram and relevant expressions, describe the construction and working principle of a Difference Amplifier using OpAmps. (6)

ii) Determine the range of input voltage(V1) for which the OpAmp output will not be in saturation. Consider the saturation voltages of the OpAmp as (+12 V, -12 V)

(5)



ii) Explain the working principle of the circuit below and derive an expression for the output voltage Vo. (5)



iv) State a few characteristics of an ideal OpAmp. (4)

Module 3: CO3: Answer any one questions from Module 3

8. a

Find out H(Z) using impulse invariance method at 5 Hz sampling frequency from H(s) as given below :

$$H(s) = \frac{2}{(s+1)(s+2)}$$

b) Write the comparison between Impulse invariance and the Bilinear transformation method

c)

The system transfer function of analog filter is given by,

$$H(s) = \frac{s+0.1}{(s+0.1)^2+16}$$

Obtain the system transfer function of digital filter using BLT which is resonant at $\omega_r = \frac{\pi}{2}$.

d)

Using bilinear transformation, design a butterworth filter which satisfies the following conditions :

$0.8 \leq |H(e^{j\omega})| \leq 1$ $\quad 0 \leq \omega \leq 0.2\pi$

$|H(e^{j\omega})| \leq 0.2$ $\quad 0.6\pi \leq \omega \leq \pi$

6+2+6+6

9.

a.

A digital low pass IIR filter is to be designed with butter- worth approximation using bilinear transformation technique. Find the order of filter to meet the following specifications.

(i) Passband magnitude is constant within 1 dB for frequencies below 0.2π.

(ii) Stopband attenuation is greater than 15 dB for frequencies between 0.3π to π.

b. **Discuss the design of the FIR filter using the window method.**

c.

Design a linear phase FIR low pass filter of order seven with cut-off frequency 1 rad/sec using rectangular window.

6+7+7