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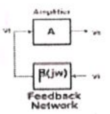
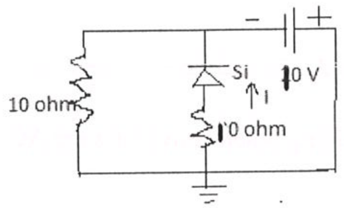
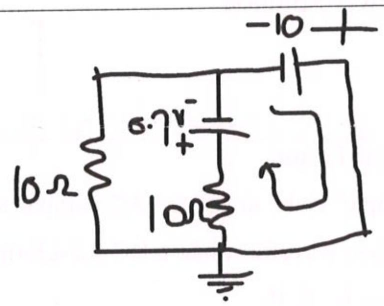
Maharashtra Institute of Technology, Aurangabad
(An Autonomous Institute)
Department of Electrical Engineering

END SEMESTER EXAMINATION
Academic Year 2022-23 Semester-I
Model Answers

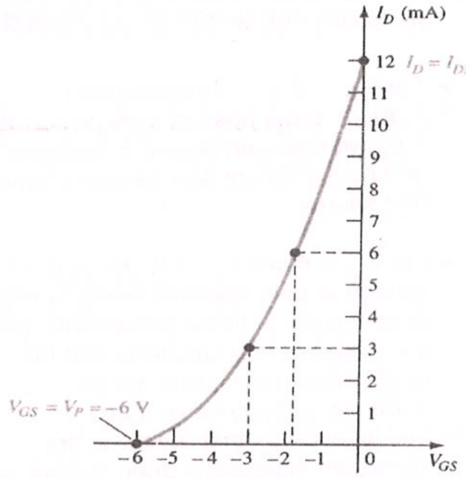
Class: SY EE **Date: / /2023**
Course: Analog Electronics **Time: 2 hr**
Max Marks: 50

Q. 1	**Solve/Answer the following questions**	
	Answer/Solution	Stepwise Marking Scheme
a)	Ripple Factor: 'Ripple' is the unwanted AC component remaining when converting the AC voltage waveform into a DC waveform. Value is =0.48	1 1
b)	The two breakdown mechanisms are Zener breakdown and Avalanche breakdown. Zener BD: The Zener breakdown occurs when the high electric field is applied across the PN junction diode. This results in the flow of electrons across the PN-junction. The connection is not destroyed It occurs because of the high electric field The junction gets back to the normal position after the voltage is removed Avalanche BD: The Avalanche breakdown happens when a high reverse bias voltage increases the electric field, which further expands up the depletion region. Connection is destroyed. It occurs because of the collision of free electrons The junction is destroyed permanently	1 1

c)	**Barkhausen Conditions For Oscillation:** It asserts that if $\mathbf{A}$ is the gain of the amplifying element in the circuit and $\beta(j\omega)$ is the feedback path transfer function, so $\beta\mathbf{A}$ is the loop gain around the circuit's feedback loop, the circuit will maintain steady-state oscillations only at frequencies for which: 1. The loop gain is equal to one in absolute magnitude, which means that $\lvert\beta A\rvert = 1$ 2. The phase shift through the loop is either zero or an integer multiple of 2π: $\angle\beta A = 2\pi n, \quad n = 0, 1, 2, \ldots$  Barkhausen's criteria is a necessary but not sufficient condition for oscillation: certain circuits meet the requirement but do not oscillate.	
d)	  $10 - 10 \times I - 0.7 = 0$ $I = \frac{10 - 0.7}{10} = 0.465A =$ $I = 465 mA$	1 1
e)	Av= -(Rf/Ri) = - (10K ohm/1K ohm) Av=-10	1 1
f)	It is the maximum rate of change of the output voltage in response to a step input voltage. $Slew Rate = \frac{\Delta V_{out}}{\Delta t}$ CMRR The ability of amplifier to reject the common-mode signals (unwanted signals) while amplifying the differential signal (desired signal). $CMRR = \frac{A_{ol}}{A_{cm}}$ $\qquad$ $CMRR = 20 \log \left(\frac{A_{ol}}{A_{cm}}\right)$	1 1
g)	Power Amplifier Class A Class B Class C	1

<table>
<tr><td></td><td>Class AB
Class D
Complimentary Symmentry Push pull amplifier</td><td>1</td></tr>
<tr><td>h)</td><td>Types of Active filters
High Pass Filter
Low Pass Filter
Band Pass Filter
Band Stop Filter
Band Reject Filter</td><td>1

1</td></tr>
<tr><td>Q. 2</td><td>Solve/Answer Any one</td><td></td></tr>
<tr><td>a)</td><td>



By shorthand method,

@ $V_{GS} = \frac{V_p}{2} = -6/2 = -3V$

$I_D = \frac{I_{DSS}}{4} = 12mA/4 = 3mA$

@ $I_D = \frac{I_{DSS}}{2} = 12mA/2 = 6mA$

$V_{GS} \cong 0.3V_p = 0.3(-6V) = -1.8V$

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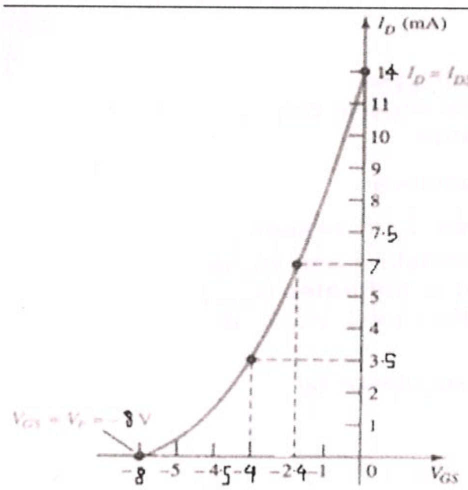

By shorthand method,

@ $V_{GS} = \frac{V_p}{2} = -8/2 = -4V$

$I_D = \frac{I_{DSS}}{4} = 14mA/4 = 3.5mA$

@ $I_D = \frac{I_{DSS}}{2} = 14mA/2 = 7mA$

$V_{GS} \cong 0.3V_p = 0.3(-8V) = -2.4V$

Or

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1
1
1</td></tr>
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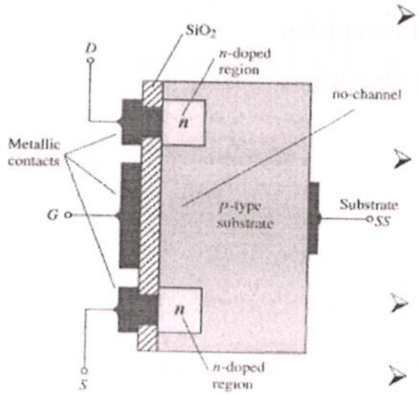
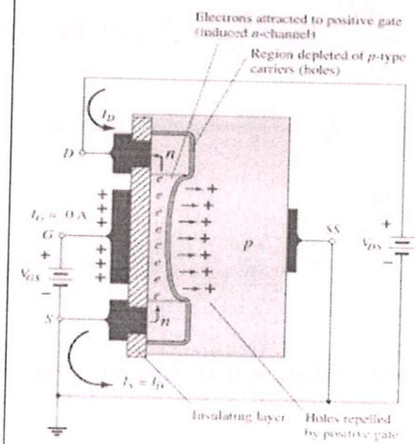
b)

Enhancement-Type MOSFET Construction



- The Drain (D) and Source (S) connect to the to n-doped regions. 1
- The Gate (G) connects to the p-doped substrate via a thin insulating layer of SiO2 1
- **There is no channel**
- The n-doped material lies on a p-doped substrate that may have an additional terminal connection 1



- For $V_{GS} = 0, I_D = 0$(no channel)
- For V_{DS} some positive voltage and V_{GS} = 0, two reversed biased n-junctions and no significant flow between drain and source. 1
- For $V_{GS} > 0$ and $V_{GS} > 0$, the positive voltage at gate pressure holes to enter deeper regions of the p-substrate, and the electrons in p-substrate and the electrons in p-substrate will be attracted to the positive gate. 1
- The level of V_{GS} that results in the significant increase in drain current in called:
  THRESHOLD VOLTAGE (Vt)
- For $V_{GS} < V_T$, $I_D = 0ma$ 1

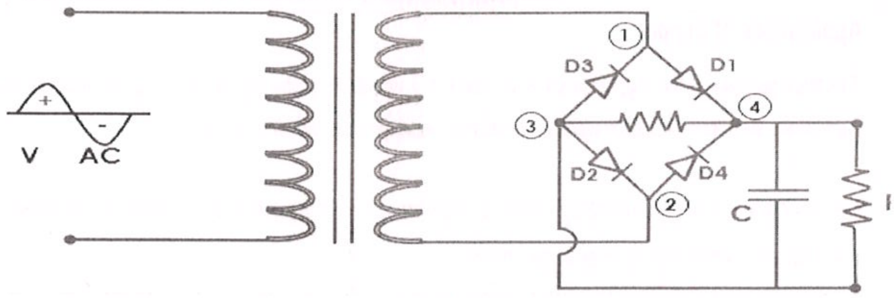
Note:
The enhancement-type MOSFET operates only in the enhancement mode

- V_{GS} is always positive 1
- As V_{GS} increases, I_D increases
- As V_{GS} is kept constant and V_{DS} is increased, then I_D saturates (I_{DSS}) and the saturation level, V_{DSsat} is reached. 1
- V_{DSsat} can be calculated by

$$V_{Dsat} = V_{GS} - V_T$$

Q3 a)

Waveforms of Full Wave Bridge Rectifier



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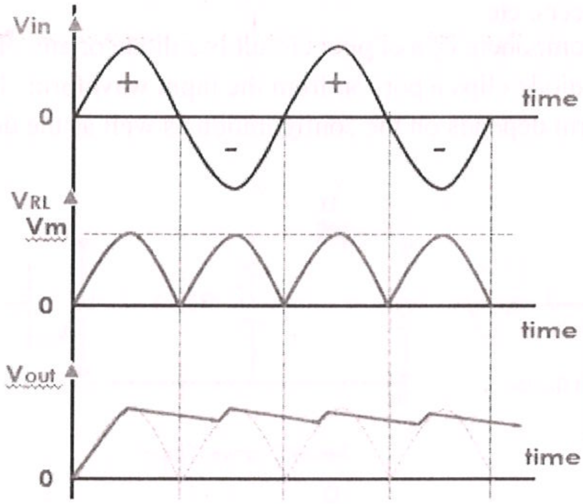
Working of Bridge rectifier

we place a capacitor across the load. The working of the capacitive filter circuit is to short the ripples and block the DC component so that it flows through another path, and that is through the load. During the half-wave, the diodes D1 and D2 conduct. It charges the capacitor immediately to the maximum value of the input voltage. When the rectified pulsating voltage starts decreasing and less than the capacitor voltage, the capacitor starts discharging and supplies current to the load. 1



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This discharging is slower when compared to the charging of the capacitor, and it does not get enough time to discharge entirely, and the charging starts again in the next pulse of the rectified voltage waveform. 1

Or

b)

Common Emitter configuration of transistor used as an amplifier because its voltage gain is greater than other configurations i. e. greater than 500. 2

4

S. No.	Characteristic	Common base	Common emitter	Common collector
1.	Input resistance	Low (about 100 Ω)	Low (about 750 Ω)	Very high (about 750 kΩ)
2.	Output resistance	Very high (about 450 kΩ)	High (about 45 kΩ)	Low (about 50 Ω)
3.	Voltage gain	about 150	about 500	less than 1
4.	Applications	For high frequency applications	For audio frequency applications	For impedance matching
5.	Current gain	No (less than 1)	High (β)	Appreciable

2

Diagrams of each configurations

Q. 4

a)

Applications of Clipper

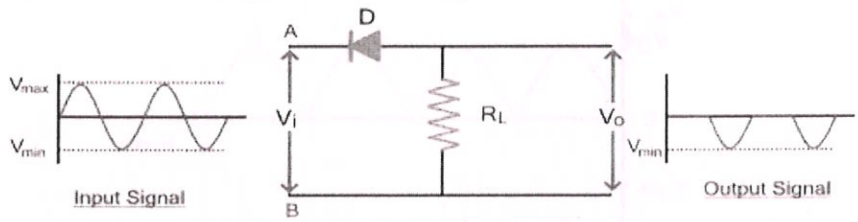
The main purpose of the clipper circuit is to modify the waveform of the signal which can be used in several applications such as in protection against overvoltage, noise removal, transmission, etc. 1

- The clipper circuit offer overvoltage protection therefore, it is used in power supplies for limiting the voltage.
- They are used for filtering noise in transmitters.
- They are used in transmitters and receivers of television.
- They are used for modifying or generating new waveforms such as square, triangular, etc.

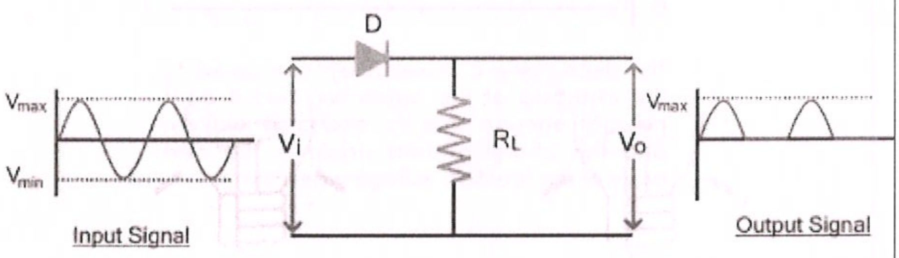
Clipper Circuit

Clipper circuits are the electronic circuits that clip off or remove a portion of an AC signal, without causing any distortion to the remaining part of the waveform. These are also known as clippers, clipping circuits, limiters, slicers, etc 1

The main component of a clipper circuit is a diode or any other type of diode. The diode clips a portion from the input waveform. The shape of the waveform depends on the configuration as well as the design of the circuit. 1



Series Positive Clipper 1

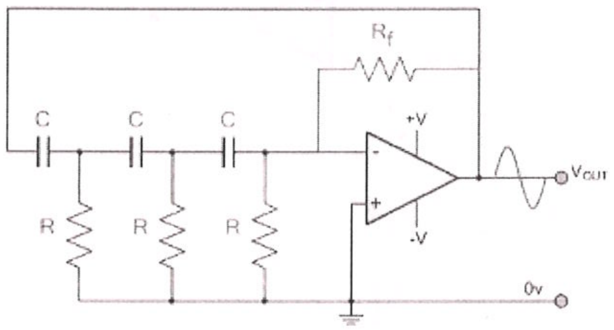


Series Negative Clipper 1

The input signal Vi is applied at the input side while the output is taken at the load resistor. During the positive half cycle of the input, the voltage at point A is positive than point B. So the diode is in reverse bias and there is no current conduction. The input signal cannot pass, thus there is no voltage drop at the Rl. Therefore, there the positive half cycle does not appear at the output as shown in the figure. 1 1

During the negative half-cycle, the voltage at point A is negative than point B. The diode becomes forward bias and the signal pass through it. The signal appears across the Rl. Therefore, the negative half cycle passes through the circuit and appears at the output. 1

As illustrated in the given figure, it shows how it clips the positive half and allows the negative half of the input waveform. 1

b)	Phase lead $$f_{out} = \frac{1}{2\pi RC\sqrt{2N}}$$  An RC phase shift oscillator, just as its name suggests, takes advantage of the phase shift that occurs in an RC circuit during discharge. These circuits typically rely on an op-amp wired up with feedback, similar to a comparator. Thermal noise in the circuit kicks off the initial rise in the output voltage thanks to feedback in the circuit. As the circuit output rises, successive RC stages in the circuit will charge and discharge and there will be a phase shift in their output voltages. This produces an oscillation due to charging/discharging in successive RC networks. The circuit diagram below shows two typical configurations for RC phase shift oscillator circuits with 3 RC networks and an op-amp. Note that an RC phase shift oscillator could have any number of RC networks in the feedback loop. These circuits are typically set up so that all the resistors and capacitors have equal values, which simplifies an analysis of this type of circuit. The RC networks in an RC phase shift oscillator are constructed such that the sum of phase shifts across these networks equals 180°, giving a total phase shift of 360° between the differential input and op-amp output (180° for the RC networks plus 180° for the inverted output).	1 2 1 1 1 1 1
Q5	Applications of Op-amp: Active filters, oscillators, comparators, voltage regulators, instrumentation and control systems, pulse generators, square wave generators etc. A voltage to current converter (also known as a V to I converter) is an electronic circuit that takes voltage as the input and produces current as the output. Voltage to Current converter: An op-amp is implemented to simply convert the voltage signal to corresponding current signal. The Op-amp used for this purpose is IC LM741. This Op-amp is designed to hold the precise amount of current by applying the voltage which is essential to sustain that current through out the circuit.	1 1

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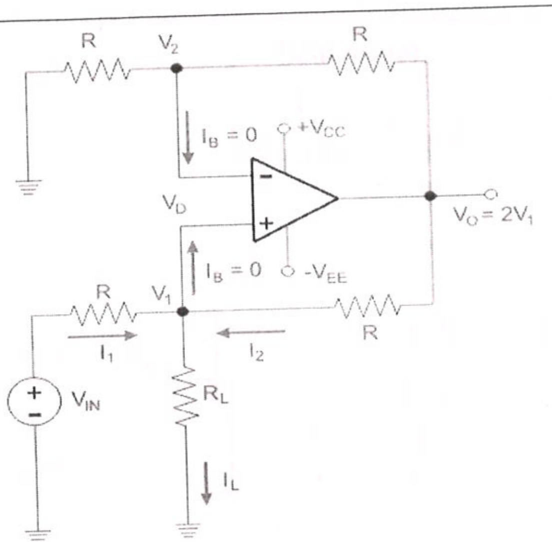

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This V to I converter is also known as Howland Current Converter. Here, one end of the load is always grounded. For the circuit analysis, we have to first determine the voltage, VIN and then the relationship or the connection between the input voltage and load current can be achieved. 1

For that, we apply Kirchhoff's current law at the node V1

$$I_1 + I_2 = I_L$$

$$\frac{V_{IN} - V_1}{R} + \frac{V_0 - V_1}{R} = I_L$$ 1

$$V_{IN} + V_0 - 2V_1 = I_L R$$

$$V_1 = \frac{V_{IN} + V_0 - I_L}{2}$$

For a non-inverting amplifier, gain is 1

$$A = 1 + \frac{R_F}{R_1}$$

Here, the resistor, $R_F = R = R_1$

So, $A = 1 + \frac{R}{R} = 2$

Hence the voltage in the output will be

$$V_0 = 2V_1 = V_{IN} + V_0 - I_L R$$

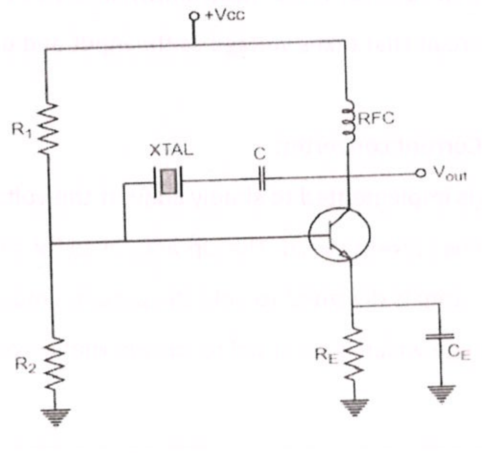
$$0 = V_{IN} - I_L R$$

$$\therefore V_{IN} = I_L R$$

$$I_L = \frac{V_{IN}}{R}$$

Thus, we can conclude from the above equation that the current IL is related to the voltage, VIN and the resistor, R.

Q6 The following circuit diagram shows the arrangement of a transistor pierce crystal oscillator.



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	The range of crystal oscillator is ranging from 1 Mhz to upto few megha Hz.	
	A crystal oscillator circuit can be constructed in a number of ways like a Crystal controlled tuned collector oscillator, a Colpitts crystal oscillator, a Clap crystal oscillator etc. But the transistor pierce crystal oscillator is the most commonly used one. This is the circuit which is normally referred as a crystal oscillator circuit.	1 1
	In this circuit, the crystal is connected as a series element in the feedback path from collector to the base. The resistors R1, R2 and RE provide a voltage-divider stabilized d.c. bias circuit. The capacitor CE provides a.c. bypass of the emitter resistor and RFC (radio frequency choke) coil provides for d.c. bias while decoupling any a.c. signal on the power lines from affecting the output signal. The coupling capacitor C has negligible impedance at the circuit operating frequency. But it blocks any d.c. between collector and base.	1 1 1
	The circuit frequency of oscillation is set by the series resonant frequency of the crystal and its value is given by the relation, $f_o = \frac{1}{2\pi\sqrt{L.C}}$ It may be noted that the changes in supply voltage, transistor device parameters etc. have no effect on the circuit operating frequency, which is held stabilized by the crystal.	1

Paper Setter Signature