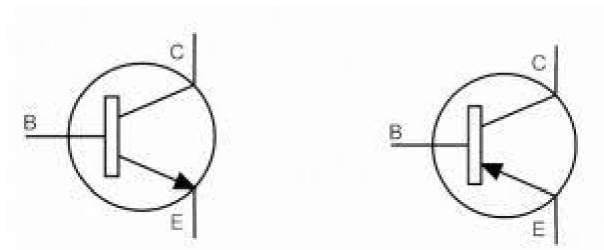
SUMMER– 19 EXAMINATION

Subject Name: Electronic Devices & Circuits **Model Answer** Subject Code: 17319

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constantvalues may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answers	Marking Scheme
1	**A**	**Attempt any SIX:**	**12- Total Marks**
	(a)	Name two types of BJT &draw their symbols.	2M
	Ans:	**Two types of BJT:** • **NPN** • **PNP**  n-p-n transistor p-n-p transistor	1M for types 1M for symbols
	(b)	Define Q-point	2M
	Ans:	**Q-point:** For proper operation of transistor, in any application, we set fixed levels of certain voltages and currents in a transistor. These values of currents and voltages define the	2M for correct definition

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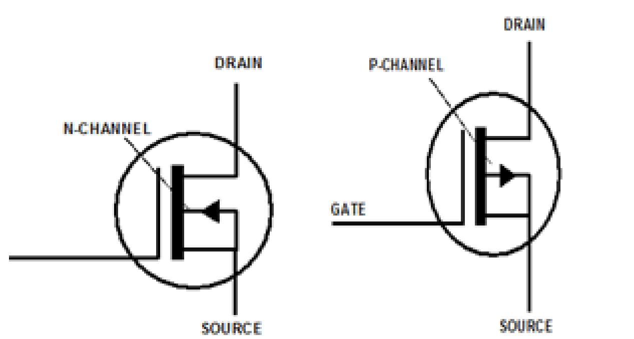
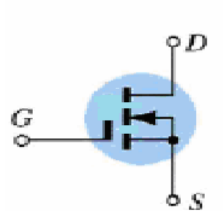
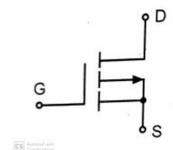
		point, at which transistor operates. This point is called operating point. It is also known as quiescent point or Q point.	
	(c)	State the need and types of amplifier coupling.	2M
	Ans:	Need of amplifier coupling: 1.When ever large amplifier with very good impedance matching is required, a signal stage amplifier circuit will not able to amplify the signal to a large extent. 2.Thus, a number of stages are required for amplification, for this output of the first stage is connected to the input of the second stage, this is called as cascade system or multi-stage system. 3.The connection of output first stage to the input second stage is called coupling. 4.In case of a multistage system, the very good coupling is very essential, or else there will be a large number of losses at the output. Types of amplifier coupling: 1.R-C coupled amplifier 2.Transformer coupled amplifier 3.Direct coupled amplifier 4. Inductance (LC) coupling	1M for need 1M for types
	(d)	Draw symbol for n-channel and p-channel MOSFET.	2M
	Ans:	**Symbol n-channel and p-channel MOSFET:**  N-channel Depletion MOSFET P-channel Depletion MOSFET (OR)	1M for n channel symbol 1M for p channel symbol

		  N-channel Enhancement -MOSFET P-channel Enhancement -MOSFET	
	(e)	State the necessity of tuned amplifier.	2M
	Ans:	**Necessity of tuned amplifier:** 1. Selection of the desired radio frequency signal. 2. Amplification of the selected signal to a selected voltage level.	1M for each point
	(f)	List applications of power amplifier.	2M
	Ans:	**Below are the applications of power amplifiers across different sectors:** 1.**Consumer Electronics:** Audio power amplifiers are used in almost all consumer electronic devices ranging from microwave ovens, headphone drivers, televisions, mobile phones and Home theatre systems to theatrical and concert reinforcement systems. **2.Industrial:** Switching type power amplifiers are used for controlling most of the industrial actuator systems like servos and DC motors. **3.Wireless Communication:** High power amplifiers are important in transmission of cellular or FM broadcasting signals to users. Higher power levels made possible because of power amplifiers increases data transfer rates and usability. They are also used in satellite communication equipment.	1M each for any 2 correct applications
	(g)	Sketch p-channel JFET construction.	2M

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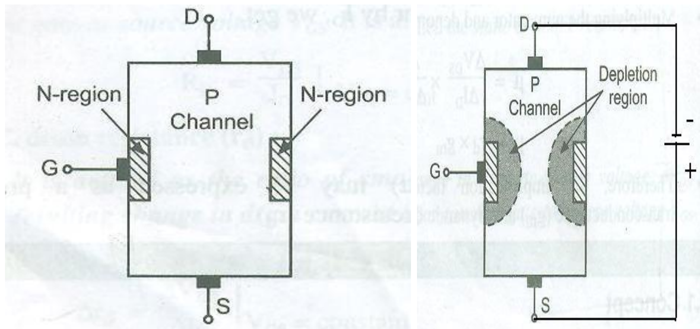
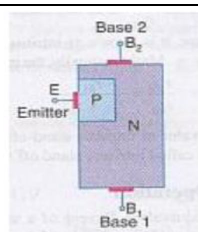
Ans: **p- channel JFET constructional diagram:** (2M for correct diagram)



(h) State the working principle of UJT (2M)

Ans: (2M for correct answer)



(a) Construction

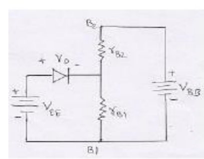


Figure shows the equivalent circuit of a unijunction transistor with voltage source V_{EE} connected across emitter and base 1 and V_{BB} connected across base 1 and base 2. Hence the Emitter diode is reversed biased by a voltage drop across the r_{B1} and its own barrier potential V_D. Thus total reverse bias voltage across a diode is equal to sum of ηV_{BB} and V_D.

As long as the V_{EE} is below the total reverse bias voltage across the diode, it remains reverse biased and there is no emitter current.

However if the V_{EE} voltage reaches or exceeds the value equal to ($\eta V_{BB} + V_D$),the diode conducts V_{EE}, which causes the diode to conduct ,is called peak point voltage.

$$V_P = \eta V_{BB} + V_D$$

When the emitter current begins to flow ,the UJT is said to be fired, triggered or turned on.

B Attempt any TWO: **8- Total Marks**

(a) Compare between CE, CB &CC configuration. (Any four points) (4M)

Ans: (1M each for any four correct)

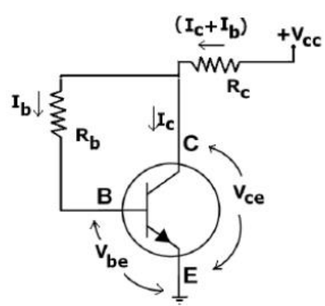
Characteristics	CE	CB	CC

				Marks
1.Input resistance	Moderate	low	Very high	comparison points
2.output resistance	Moderate	Very high	low	
3.voltage gain	highest	high	Equal to one	
4.current gain	$\beta = \frac{IC}{IB}$	$\alpha = \frac{IC}{IE}$	$\gamma = \frac{IE}{IB}$	
5.Applications	AF Applications	HF Applications	Impedance matching	

(b) Draw the circuit diagram of based biased with emitter feedback. How stability point is obtained? — 4M

Ans: **Circuit diagram of based biased with emitter feedback**

2M for circuit diagram



2M for stability point

Stability Point:

		To find S: $$S = \frac{(1+\beta)}{(1-\beta)\frac{\partial I_B}{\partial I_C}}$$ $\frac{\partial I_B}{\partial I_C}$ is obtained by diff. I_B WRT I_S $$I_B = \frac{V_{CC} - I_C R_C - V_{BE}}{R_C + R_B}$$ $$\frac{\partial I_B}{\partial I_C} = \frac{-R_C}{R_C+R_B}$$ $$S = \frac{(1+\beta)}{(1-\beta)\frac{-R_C}{R_C+R_B}}$$ $$= \frac{(1+\beta)}{(1+\beta)\frac{R_C}{R_C+R_B}}$$ $$S = \frac{(1+\beta)(R_C+R_B)}{R_C + R_B + \beta R_C}$$ $$\boxed{S = \frac{(1+\beta)(R_C+R_B)}{R_B + (\beta+1)R_C}}$$	
	(c)	State the need of regulation. Explain the concept of load & line regulation.	4M
	Ans:	**Need of Regulation:** The major disadvantage of a power supply is that the output voltage changes with the variations in the input voltage or the DC output voltage of the rectifier also increase similarly. In many electronic applications, it is desired that the output voltage, should remain constant regardless of the variations in the input voltage or load. In order to get ensure this ;a voltage stabilizing device called voltage regulator is used. **Load Regulation:** The load regulation indicates the change in output voltage that will occur per unit change in load current. Mathematically	2M for need of regulation

		$$Load\ Regulation = \frac{V_{NL} - V_{FL}}{\Delta I_L}$$ The load regulation of voltage regulator is expressed in terms of µv/µA. Where, V_{NL} *is no load output voltage* V_{FL} *is full load voltage* ΔI_L *is change in laod current* **Line Regulation:** The line regulation rating of a voltage regulator indicates the change in output voltage that will occur per unit change in the input voltage. $$Line\ regulation = \frac{\Delta V_L}{\Delta V_S}$$ Where, ΔV_L is the change in output voltage in mV or µV ΔV_S is the change in input voltage in volts.	1M each for load and line regulation

Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any FOUR:**	**16- Total Marks**
	(a)	State the need of biasing and describe the concept of DC load line	4M
	Ans:	**Need of Biasing for Transistor**: The transistor should be biased in the active region if it is to be used for amplification and in saturation and cut off if it is used as a switch. 2. The Q point should be adjusted approximately at the center of the load line for voltage amplifier application. 3. The value of stability factor (S) should be as small as possible.	2M for need of biasing

4. Q point should be stabilized by introducing a negative feedback in the biasing circuit.

5. The Q-point should not be affected due to temperature changes or device to device variation.

6. Bypass capacitor should be included to avoid reduction in voltage gain due to negative feedback.

7. Transistor should be biased in the linear region of the transfer characteristics.

Concept of DC load line:

2M for concept of DC load line (diagram optional)

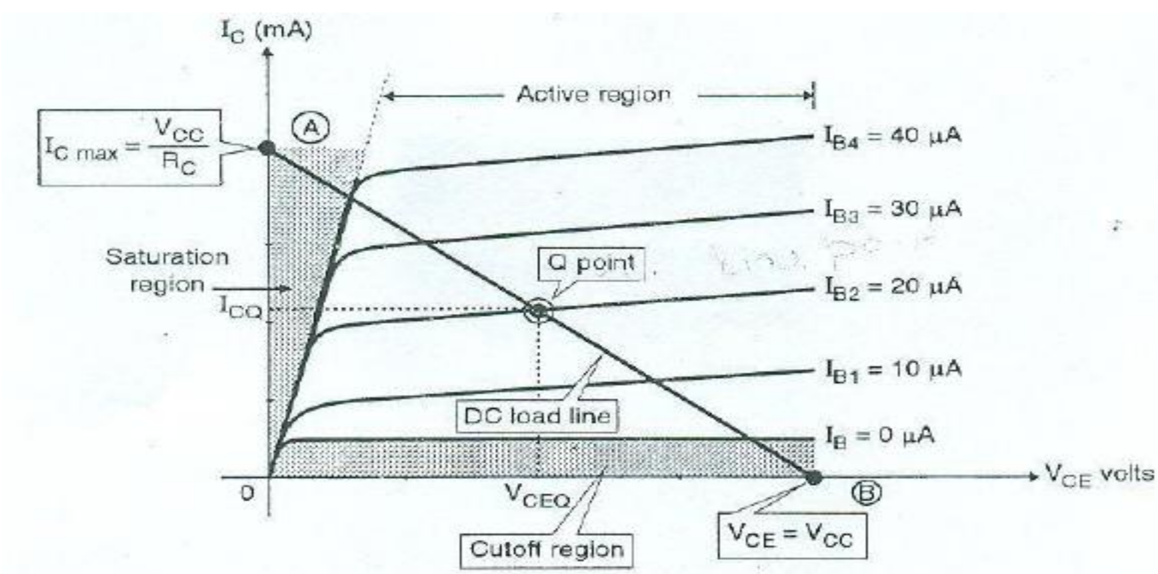
The DC word indicates that this line is drawn under the dc operating conditions without any ac signal at the input.

And the word load line is used because the slope of this line is -1/Rc is the load resistance.

Operating point is the point on the load line which represents the dc current through a transistor (I_{CQ}) and the voltage across it (V_{CEQ}) When no ac signal is applied.

The dc load line is a set of infinite number of such operating points and the user or designer can choose any point on the dc load as the operating point.

The position of operating point on the load line is dependent on the application of the transistor.



	(b)	Define the following terms:	4M

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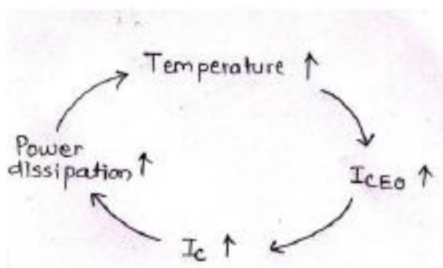
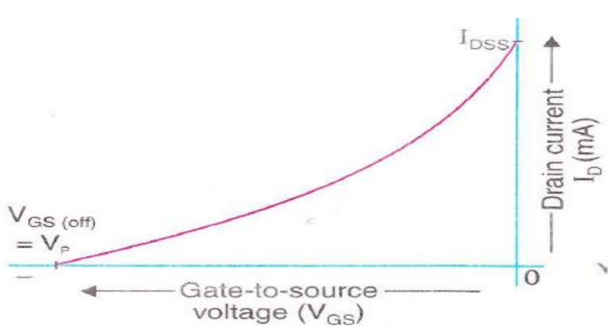
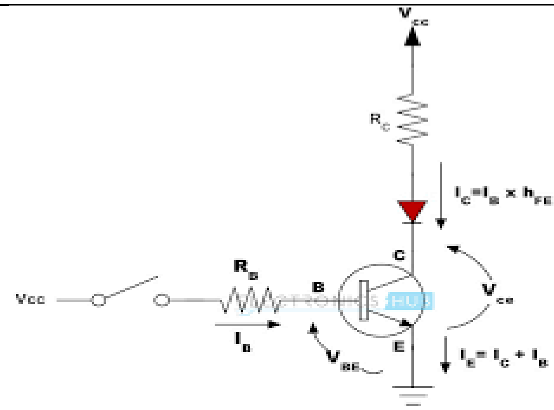
		(i) Stabilization (ii) Thermal runaway	
	Ans :	**Stabilization:** The process of making operating point independent of temperature changes or variation in transistor parameter is known as stabilization. The maintenance of the operating point stable is called the stabilization. **Thermal runaway:**  1.The reverse saturation current in semiconductor devices changes with temperature. The reverse saturation current approximately doubles for every 10 degree rise in temperature. 2.As the leakage current of transistor increases, collector current increases. 3. The increase in power dissipation at collector base junction. 4.This in turn increases the collector base junction causing the collector current current to further increase. 5.This process becomes cumulative. and it is possible that the ratings of the transistor are exceeded. If it happens, the device gets burnt out. This process is known as “Thermal Runaway”.	2M for stabilization 2M for Thermal runaway
	(c)	Draw the transfer characteristics for N-channel JFET.	4M
	Ans :	**Transfer characteristics for N-channel JFET:**  	2M for characteristic 2M for label

	(d)	Draw the circuit of using transistor as a switch & explain its working.	4M
	Ans :	 a) When both junctions are forward bias it works in saturation region & act as closed switch. b) When both junctions are reverse biased it works in cutoff region & act as open switch. c) If input is not given to base ,transistor remains off. diode will be off. I_C=0,Acts as open switch. d) when input is applied to base above 0.7V ,transistor becomes ON, Diode is ON. I_C starts flowing ,Transistor acts as close switch.	2M for diagram 2M for explanation
	(e)	Compare between positive and negative feedback. (four points)	4M
	Ans :	(see table below)	1M each for any four correct comparison points

Sr No.	Parameter	Positive Feedback	Negative Feedback
1	Overall Phase shift	0 degree or 360 degree	180 degree
2	Input voltage	Increases	Decreases
3	Output voltage	Increases	Decreases
4	Feedback signal & Input signal	Are in phase	Are out of phase
5	Voltage Gain	Increases	Decreases
6	Noise	Increases	Decreases
7	Bandwidth	Decreases	Increases

			8	Applications	Oscillators, Schmitt triggers	Amplifier	

	8	Applications	Oscillators, Schmitt triggers	Amplifier

	(f)	List the ICs used for positive and negative voltage regulation with two example each.	4M
	Ans :	IC 78xx (7805,7806, 7808,,7812,7815,7818)-Positive Voltage Regulator. IC 79xx (7905, 7906,7908,7912, 7915, 7918) - Negative Voltage Regulator Example: 7805= +5v 7905= -5v 7806= +6v 7906= -6v 7808= +8v 7908= -8v 7812= +12v 7912= -12v 7815= +15v 7915= -15v 7818= +18v 7918= -18v	2M for correct IC Number and 2M for example (Two examples each for positive and negative voltage regulator)

Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any FOUR:**	**16- Total Marks**
	(a)	**In CE configuration if β = 90, leakage current I_{CEO}= 40μA, base current is 0.4mA, determine I_C and I_E**	4M
	Ans:	**Given:** β = 90 I_{CEO}= 40µA I_B = 0.4mA **Required :**	**Each formula : 2M**

		I_C = ? and I_E = ? **Solution:** $I_C = \beta I_B + I_{CEO}$ $= 90 \times 0.4\times10^{-3} + 40 \times 10^{-6}$ **I_C = 36.04 mA** $I_E = I_C + I_B$ = 36.04 mA + 0.4mA **I_E = 36.44 mA**	**Each ans : 2M**
	(b)	Compare FET and BJT. (four points)	4M
	Ans:	(see table below)	**Any four points: 4M**

Sr. no	FET	BJT
1.	It is unipolar device i.e. current in the device is carried either by electrons or holes	It is bipolar device i.e. current in the device is carried either by both electrons & holes
2.	It is a voltage controlled device i.e. voltage at the gate (or drain) terminal controls amount of current flowing through the device.	It is a current controlled device i.e. the base current controls the amount of collector current.
3.	It has a negative temperature co-efficient at high current levels. It means that current decreases as temperature increases.	It has a positive temperature co-efficient at high current levels. It means that current increases as temperature increases.
4.	It has relatively lower gain bandwidth product as compared to BJT.	It has relatively higher gain bandwidth product as compared to FET.
5.	It is less noisy.	It is comparatively more noisy.
6.	It is relatively immune to radiation.	It is susceptible to radiation

	(c)	Draw the circuit and explain the operation of UJT relaxation oscillator.	4M

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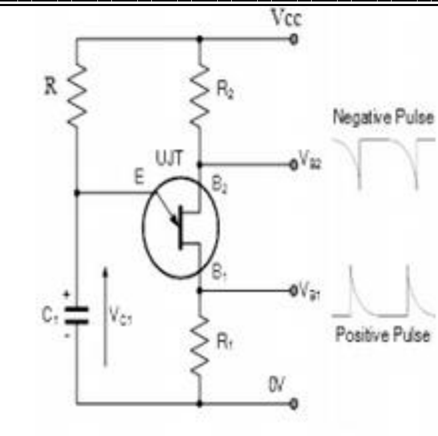
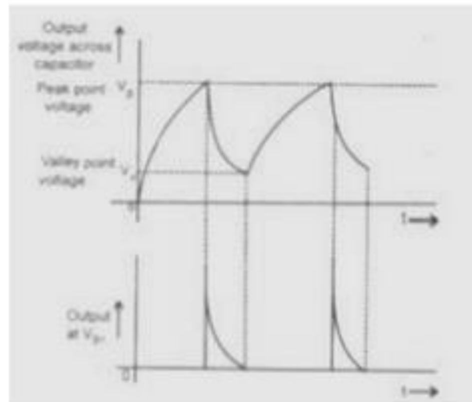
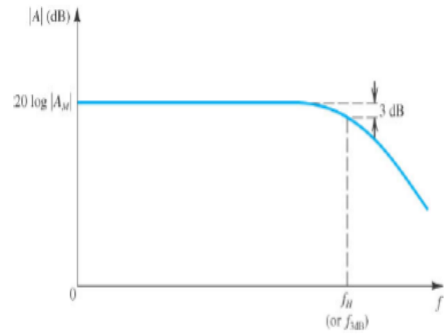
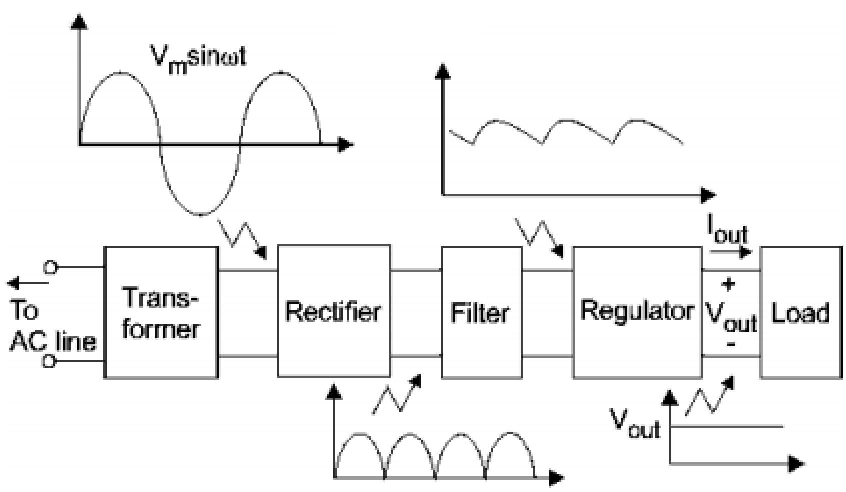
	Ans:	 **Working:** When the supply voltage (V_{CC}) is switched ON, the capacitor charges through resistor (R), till the capacitor voltage reaches the voltage level (V_P) which is called as peak point voltage. At this voltage the UJT turns ON. As a result of this, the capacitor (C) discharges rapidly through resistor (R1). When that capacitor voltage drops to level Vv (called valley- point voltage) the uni- junction transistor switches OFF allowing the capacitor (C) to charge again. In this way because of the charging and discharging of capacitor the exponential sweep voltage will be obtained at the emitter terminal of UJT. The voltage developed at base 1(VB1) terminal is in the form of narrow pulses commonly known as trigger pulses. The sweep period depends upon time constant (R.C) and the sweep frequency can be varied by changing value of either resistance (R) or capacitor (C). Due to this fact, the resistor R is shown as a variable resistor. The sweep period is given by the relation T= R.C. loge (1/1-η) $T = 2.3\ R.C.\ \log_{10}(1/1-\eta)$	**Circuit diagram : 1M** **Working: 2M** **Waveform : 1m**
	(d)	Draw the frequency response of DC amplifier. Comment on it.	4M
	Ans:	frequency response:	**Response : 2M**

		 **Comment :** The gain remains constant at its midband value A_M down to zero frequency (DC). Direct-coupled amplifiers do not suffer gain reduction at low frequencies as compared to the capacitively coupled amplifiers that use bypass capacitors. However, gain falls off at the high frequency end due to the internal capacitances of the transistor.	**Comment : 2M**
	(e)	Draw the block diagram of DC regulated power supply and explain the function of each.	4M
	Ans:	 1. A step down transformer 2. A rectifier 3. A filter 4. A regulator Operation of Regulated Power Supply:- Step Down Transformer:-	**Block diagram : 1M** **Waveforms for each block: 1M** **Explanation: 2M**

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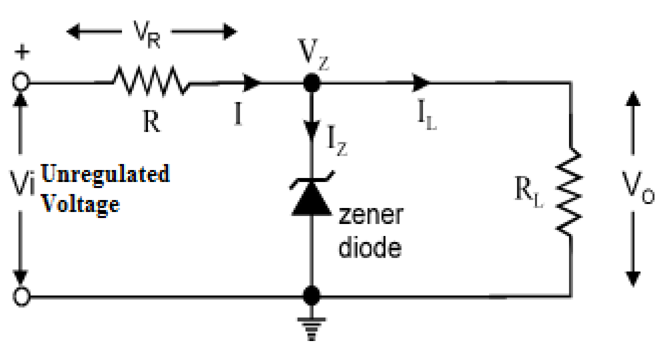
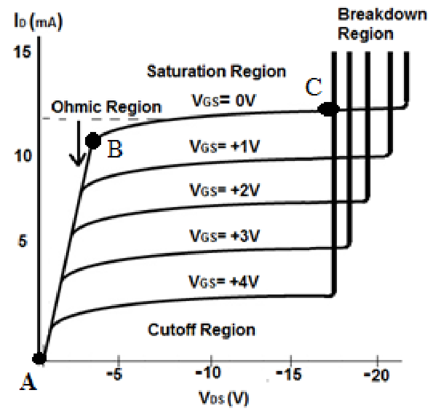
		A step down transformer will step down the voltage from the ac mains to the required voltage level. The turn's ratio of the transformer is so adjusted such as to obtain the required voltage value. The output of the transformer is given as an input to the rectifier circuit. Rectifier:- Rectifier is an electronic circuit consisting of diodes which carries out the rectification process. The input to a rectifier is ac whereas its output is unidirectional pulsating dc. Usually a full wave rectifier or a bridge rectifier is used to rectify both the half cycles of the ac supply (full wave rectification). Filter :- The rectified voltage from the rectifier is a pulsating dc voltage having very high ripple content. Hence a filter is used. Regulator: This is the last block in a regulated DC power supply. The output voltage or current will change or fluctuate when there is change in the input from ac mains or due to change in load current at the output of the regulated power supply or due to other factors like temperature changes. This problem can be eliminated by using a regulator. A regulator will maintain the output constant even when changes at the input or any other changes occur.	
	(f)	Draw the circuit of Zener diode as a voltage regulator and explain its working.	4M
	Ans:	 **Working**	**Circuit diagram : 2M**

		• For proper operation, the input voltage Vi must be greater than the Zener voltage Vz. This ensures that the Zener diode operates in the reverse breakdown condition. The unregulated input voltage Vi is applied to the Zener diode. • From fig, output voltage is equal to zener voltage and load voltage. • Suppose this input voltage exceeds the Zener voltage. This voltage operates the Zener diode in reverse breakdown region and maintains a constant voltage, i.e. Vz = Vo --------- (1) • The input current is given by, $I_S = (Vi – Vz) / Rs$ ---------- (2) • We know that the input current I_S the sum of Zener current Iz and load current I_L. Therefore, $I_S = Iz + I_L$ ------------ (3) or $Iz = I_s - I_L$ • As input voltage Vi increases , then input current Is increases from equation no. (2), then Iz current increases from equation no. (3), hence zener voltage remains Vz constant (according to reverse bias of zener diode characteristics). • Since zener voltage is equal to output voltage from equation no. (1). Therefore output voltage Vo remains constant. • Thus, a Zener diode acts as a voltage regulator and the fixed voltage is maintained across the load resistor RL.	**Working : 2M**

Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any FOUR:**	**12- Total Marks**
	(a)	Draw the drain characteristics of p-channel FET and explain.	4M
	Ans:	Drain characteristics:-	Characeristics-2M



As V_{DS} is increased from zero as shown , I_D will increased proportionally through the p channel. In this region the channel resistance is constants because the depletion region is not large enough to have significant effect. This is called the “Ohmic region” because V_{DS} & I_D are related by ohm’s law.

As point B, the curve level off & I_D becomes essentially constants.

As V_{DS} increases from point B to C the reverse bias voltage from gate to drain (V_{GD}) produces a depletion region (i.e. channel resistance). It is proportional to the increase in the V_{DS} so the current I_D practically constant at I_{DSS}. The value of V_{DS} at which I_D becomes essentially constant is the pinch off voltage (V_P).

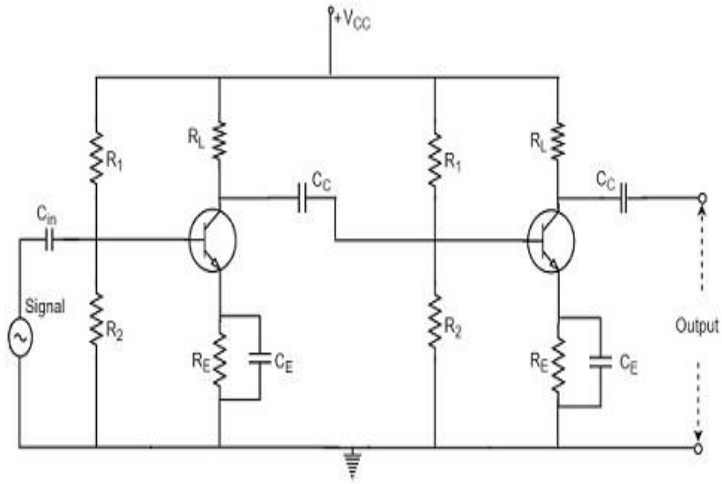
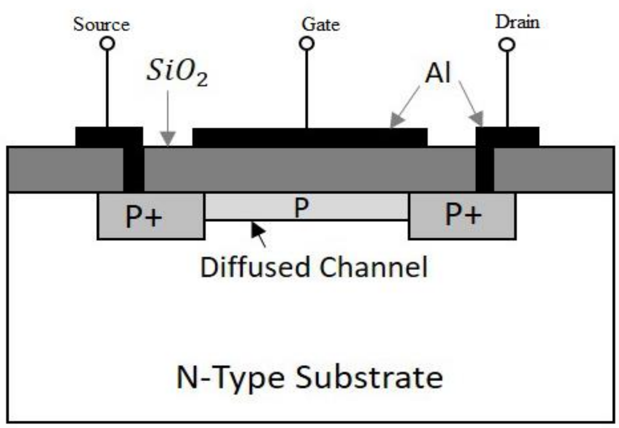
Breakdown occurs at point C. when I_D begins to increase very rapidly with any further increase in V_{DS}. So JFET’s are always operated below breakdown & within constant current region,

As V_{GS} is set increasing, more positive value by adjusting V_{GG}. I_D decreases as the magnitude of V_{GS} is increased because of narrowing width of channel.

The maximum value of V_{GS} at which drain current reaches to zero due to overlapping both the depletion layer. (i.e. channel width zero) is called cutoff voltage or V_{GS}(off).

Explaination-2M

	(b)	Draw the multistage amplifier circuit diagram using RC coupling. State its advantages.	4M

	Ans:	 **Advantages:** 1. It has a wide frequency response. 2. For coupling the resistor and the capacitor are used and which are not expensive so the cost is low. 3. The circuit is very compact and extremely light. 4. It offers a constant gain over a wide frequency band. 5. It is high fidelity amplifier. 6. It provides less frequency distortion.	Diagram-2M Advantages-2M(any two)
	(c)	Draw the construction of p-channel D-MOSFET and state its working principle.	4M
	Ans:	**Construction of p-channel D-MOSFET:**  **Working principle:**	Diagram-2M

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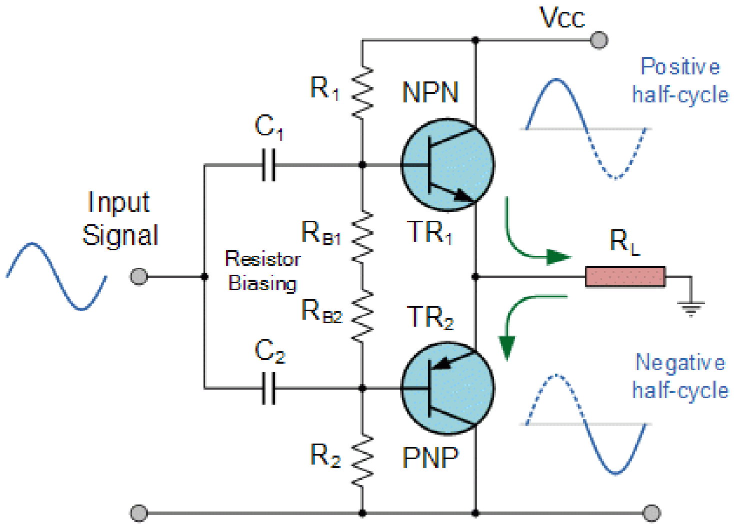
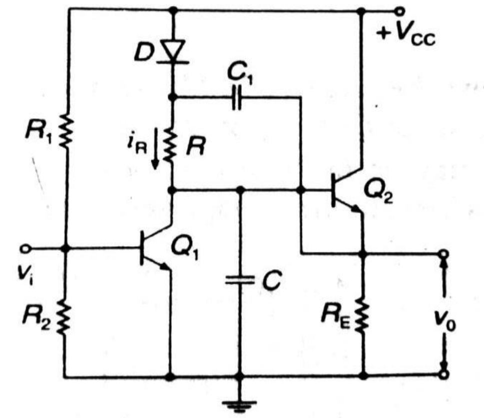
		The gate to source voltage is set to zero volts by the direct connection from one terminal to the other & voltage V_{DS} is applied across the drain to source terminals. This result the flow of current is positively charged holes. When gate is negative with respect to source then the electrons present under the oxide layer are pushed downward into the substrate with a repulsive force and draws additional holes from the N type substrate. Thus drain current (I_D) increases as increase in negative value. For positive voltage at gate, the gate will tend to repel holes towards N type substrate and attract electrons from the substrate toward insulated layer. Recombination occurs between electron & holes that will reduce the number of free carriers in the channel for conduction. So drain current reduces. The value of voltage of VGS at which drain current nearly becomes zero is called cut off voltage.	Working Principle-2M
	(d)	Draw the circuit diagram of complementary symmetry Class B push-pull amplifier and describe its working.	4M
	Ans:	Diagram of complementary symmetry Class B push-pull amplifier:  Working: The above circuit employs a NPN transistor and a PNP transistor connected in push pull configuration. When the input signal is applied, during the positive half cycle of the input signal, the NPN transistor conducts and the PNP transistor cuts off. During the negative half cycle, the NPN transistor cuts off and the PNP transistor conducts.	Diagram-2M Working-2M

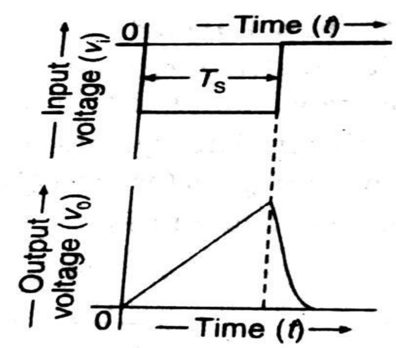
		In this way, the NPN transistor amplifies during positive half cycle of the input, while PNP transistor amplifies during negative half cycle of the input. As the transistors are both complement to each other, act symmetrically while being connected in push pull configuration of class B, this circuit is termed as Complementary symmetry push pull class B amplifier.	
	(e)	Compare between class A and class B amplifier on the basis of (i) Efficiency (ii) Power (iii) Position of Q- point (iv) O/P distortion	4M
	Ans:	(see table below)	4M(1M for each point)
	(f)	Draw the circuit diagram of Bootstrap's time base generator and explain its working.	4M
	Ans:	Circuit Diagram	Diagram-2M

Parameter	Class A	Class B
Efficiency	lowest efficiency 25% to 50%	Above 78.5%
Power	less	More than class A
Position of Q point	Q point is at the centre of load line.	On X axis
O/P disortion	No distortion	More than class A



Waveform:

Working-2M
Waveform
(optional)



Here transistor Q_1 acts as a switch and transistor Q_2 acts as an emitter follower (i.e. a unit gain amplifier).

Circuit Operation:

Initially transistor Q_1 is ON and Q_2 is OFF. Therefore capacitor C_1 is charged to V_{CC} through the diode forward resistance (R_F). At this instance output voltage is zero.
When negative pulse is applied to the base of transistor Q1, it turns OFF. Since transistor Q_2 is an emitter follower, therefore the output voltage V0 is same as base voltage of transistor Q_2.
When Q_1 turns OFF, the capacitor C_1 starts charging capacitor C through resistor (R). As a result of these both the base voltage of Q_2 and output voltage begins to increase from zero.
As the output voltage increases diode D becomes reverse biased, because of the fact that the output voltage is coupled through the capacitor (C_1) to the diode.
Since the value of capacitor (C_1) is much larger than that of capacitor (C), the voltage across capacitor (C_1) practically remains constant.
Thus voltage drop across resistor (R) and hence current (I_R) remains constant, means capacitor C is charged with constant current.

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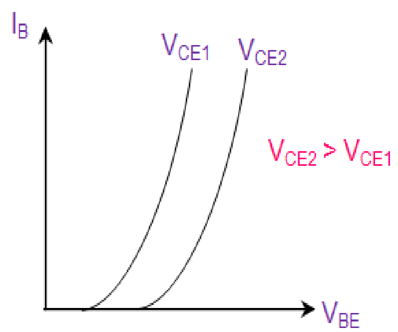
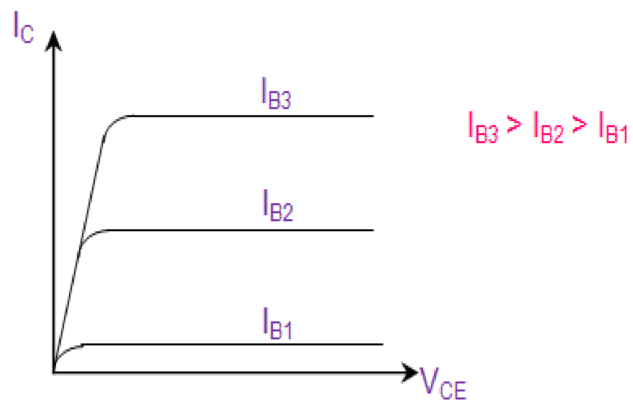
		This causes voltage across capacitor C (and hence the output voltage) to increase linearly with time. The circuit pulls itself up by its own bootstrap and hence it is known as bootstrap sweep circuit.	

Q. No.	Sub Q. N.	Answers	Marking Scheme
5		**Attempt any FOUR:**	**16- Total Marks**
	(a)	Draw the input and output characteristics of CE configuration.	4M
	Ans:	**Input characteristics of CE configuration:**  **Output characteristics of CE configuration:**	input characteristics-2M output characteristics-2M



(b) An RC phase shaft oscillator has R= 4.7kΩ, C = 0.01 µI, R_1 = 1kΩ and R_F = 22kΩ — **4M**

(i) Determine whether the oscillations will be sustained.
(ii) What will be the frequency of oscillations?

Ans: i) The operational amplifier gain (A_V) must be equal to 29 in order to sustain oscillations. — **2M**

$$A_V = \frac{R_F}{R} = \frac{22}{4.7} = 4.68$$

Since operation amplifier gain is less than 29 the RC phase shift oscillator will not sustain oscillations.

Note: Any other method can be considered for calculating sustained oscillations

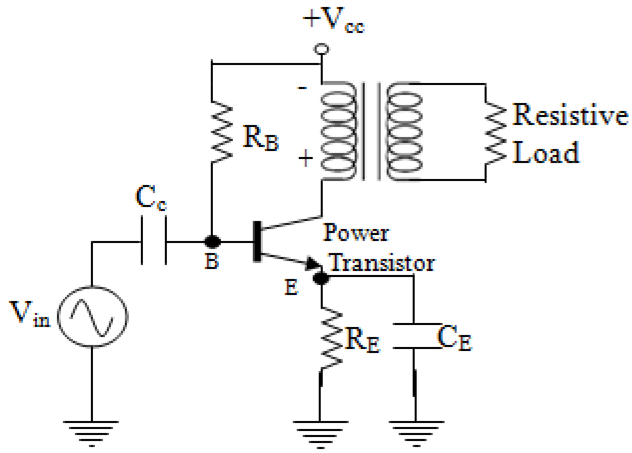
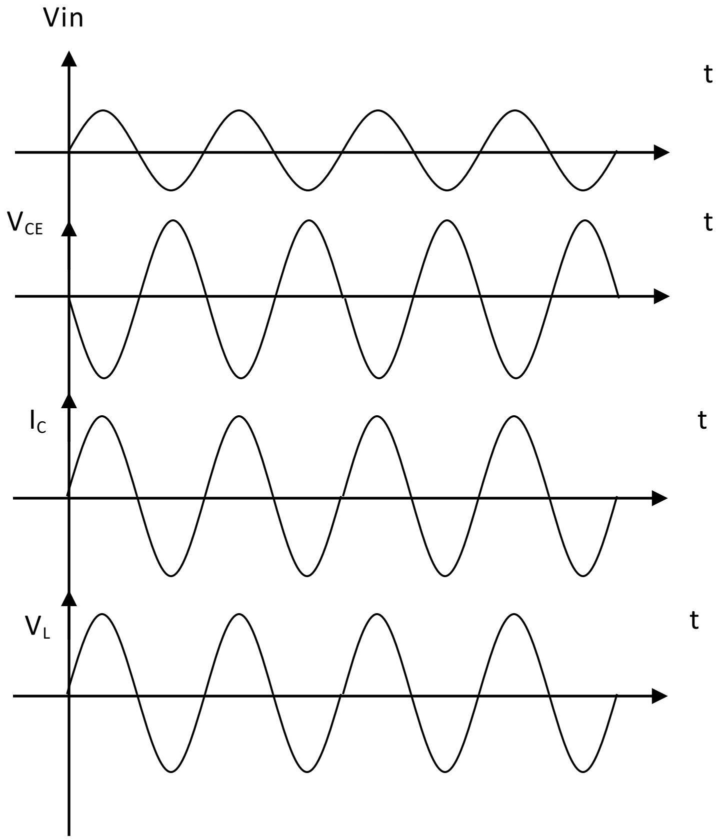
ii) frequency of oscillations: — **2M**

$$f = \frac{1}{2\pi RC\sqrt{6}}$$

$$f = \frac{1}{2\pi * 4.7 * 10^3 * 0.01 * 10^{-6} * \sqrt{6}}$$

=1.38kHz

(c) Draw the single stage class A power amplifier circuit diagram and draw the input and output waveforms. — **4M**

	Ans:	**Circuit diagram:-**  **Input / Output waveforms:-** 	**Circuit Diagram-2M** **Input waveform-1M** **Output(VL) waveform-1M** **(V_{CE} and I_C waveform is optional)**
	(d)	State and explain the working principle of FET amplifier and list its applications.	4M

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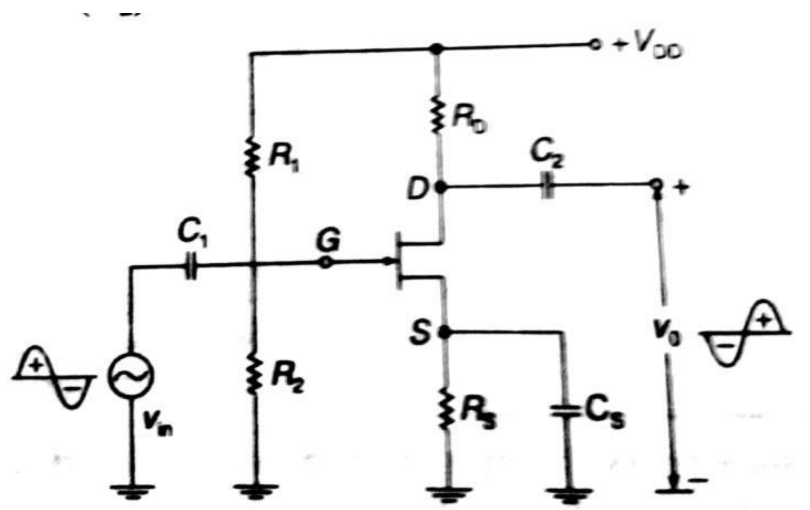
	Ans:	**Note: Any other configuration explanation also can be considered.**  **Operation of FET amplifier:** When small a.c. signal is applied to the gate, it produces variation in the gate to source voltage. This results in variation in the drain current. As the gate to source voltage increases, the drain current also increases. As the result of this, the voltage drop across resistor (RD) also increases. This causes the drain voltage to decrease. It means positive half cycle of the input voltage produces the negative half cycle of the output voltage. (ie.) the output voltage is 180° out of phase with the input voltage. **Application:** Buffer amplifier Low noise amplifier Cascade amplifier Chopper amplifier	Diagram-1.5M Working principle-1.5M Application-1M(Any two)
	(e)	State the basic principle of piezoelectric crystal and draw the circuit diagram of crystal oscillator.	4M
	Ans:	**Basic Principle:**	**Basic principle-2M**

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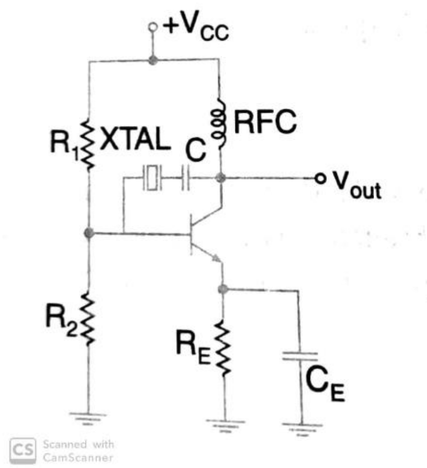
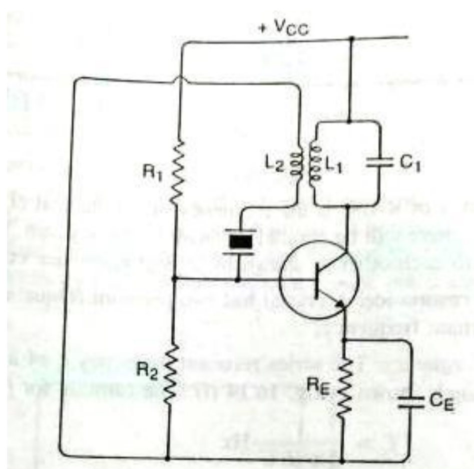
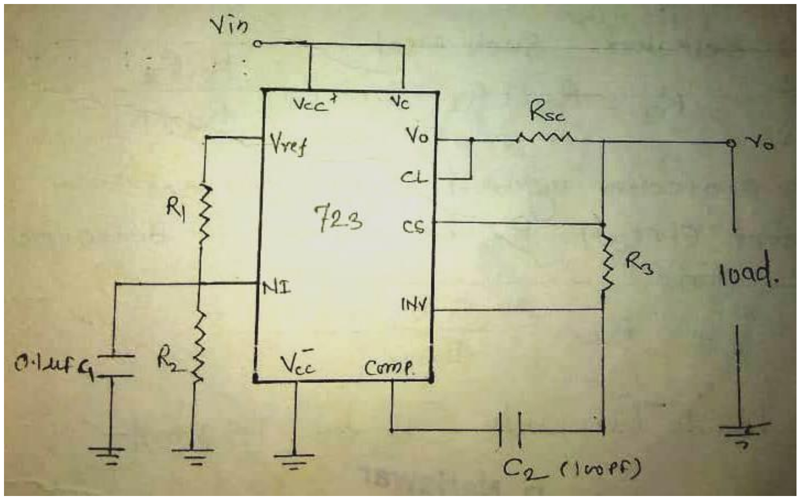
		The main principle of a piezoelectric crystal is that a mechanical force, when applied on the crystal, it vibrates and produces electric charges on the crystal surface. When ac voltage is applied across crystal, it vibrates at the frequency of the applied voltage.  (OR) 	**Diagram-2M**
	(f)	Explain the use of IC LM723 as a voltage regulator.	4M
	Ans:	The LM723 is the adjustable voltage regulator IC. It can be used as both positive and negative voltage regulator. It has an ability to provide up to 150 mA of current to the	

		load. The input voltage ranges from 9.5 to 40V and it can regulate voltage from 2V to 37V. i) **LM 723 can be used as low voltage regulator:**  This circuit is basically used to obtained 2v to 7 v. In order to achieve this (Vo<Vref) a potential divider is required to be connected between Vref pin and ground. Therefore the voltage at the non inverting terminal of the error amplifier due to R1 R2 divider is- VNI= $\mathrm{Vref}\frac{R2}{R1}$ The difference between VNI and the output voltage Vo which is directly fed back to the Inverting terminal is amplified by the error amplifier. The output of the error amplifier drives the pass transistor so as to minimize the difference between the non inverting and inverting input of error amplifier. Therefore Vo=Vref$\frac{R2}{R1+R2}$ ii) **LM 723 can be used as high voltage regulator:**	Any one 4M (either low voltage regulator or high voltage regulator)

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		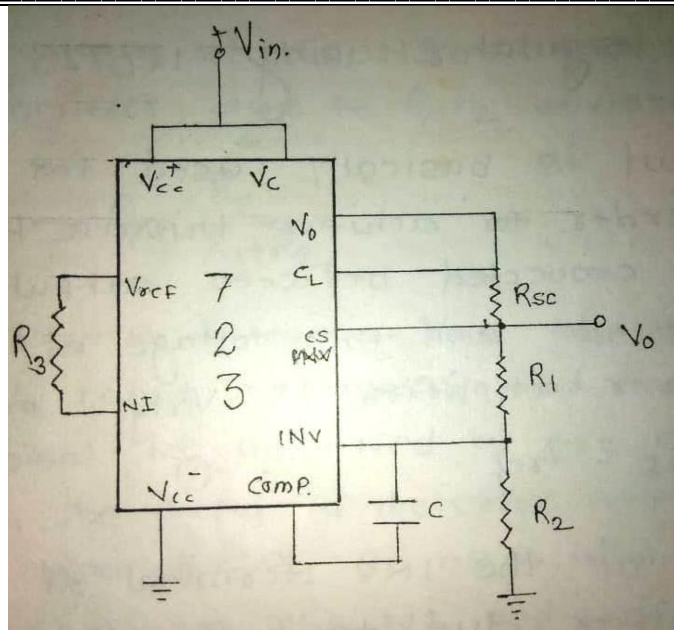 This circuit is basically used for 7v to 35v. in order to achieve this, a potential divider is connected between output terminal Vo and ground. The voltage at non inverting terminal of the error amplifier is Vref Therefore VNI=Vref---------(1) The voltage at the inverting terminal of the error amplifier due to R1R2 divider is- VINV=Vout $\left(\frac{R2}{R1+R2}\right)$---------(2) The difference of error amplifier is- $$\mathrm{Vref} - \mathrm{Vout}\left(\frac{R2}{R1+R2}\right) = 0$$ $$\mathrm{Vref} = \mathrm{Vout}\left(\frac{R2}{R1+R2}\right)$$ $$\mathrm{Vout} = \mathrm{Vref}\left(1+\frac{R1}{R2}\right)$$	

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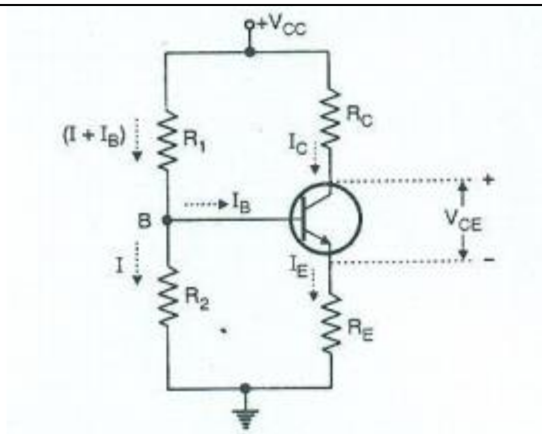
		Note: Other method for regulator also can be consider.	

Q. No.	Sub Q. N.	Answers	Marking Scheme
6		**Attempt any FOUR:**	**16- Total Mar**
	(a)	Draw the circuit of voltage divider for BJT &explain its working.	4M
	Ans:	 Working : - Figure shows the circuit of a voltage divider bias. The name voltage divider is derived from the fact that resistors R_1 and R_2 form a potential divider across the supply V_{CC}. By suitably selecting this voltage divider network, the operating point of the transistor can be made almost independent of current gain β . To set the operating point Q, first determine the base current. To get more accurate value of base current, Thevenin's Theorem is used. Now applying the Thevenin's theorem, we get the voltage,	**Circuit diagra : 2M** **Working: 2M**

$$V_{TH} = \left(\frac{R_2}{R_1 + R_2}\right) . V_{CC}$$

And the equivalent resistance.

$$R_{TH} = R_1 || R_2 = \frac{R_1 . R_2}{R_1 + R_2}$$

Applying KVL to the base emitter loop of this circuit,

$$V_{TH} = I_B R_{TH} + V_{BE} + I_E R_E$$

$$I_B = \frac{V_{TH} - V_{BE}}{R_{TH} + (\beta + 1) R_E} \quad (I_E = (\beta + 1) I_B)$$

$$I_B = \frac{V_{TH}}{R_{TH} + \beta R_E} \quad (V_{TH} >> V_{BE}, (\beta + 1) = \beta)$$

$$I_C = \beta I_B$$

$$I_C = \frac{V_{TH}}{R_E + R_{TH} / \beta}$$

$$I_C = V_{TH}/R_E \quad (R_E >> R_{TH}/ \beta)$$

Applying KVL to the output section, we get

$$V_{CC} = I_C R_C + V_{CE} + I_E R_E$$

$$V_{CE} = V_{CC} - I_C (R_C + R_E)$$

(b)	Draw the transistorized series voltage regulator circuit and explain its working.	4M

Ans:

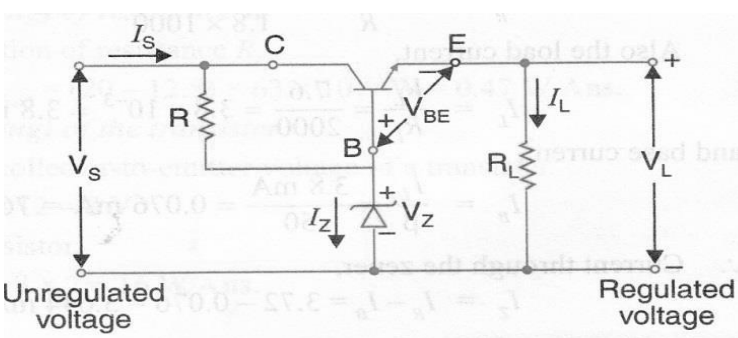


Diagram : 2M

Explanation :

- In this circuit transistor acts as a control element. This transistor is connected in series with the load hence the circuit is called as Series Voltage Regulator. Other components in the circuit are Zener diode (V_Z), and resistor R.

Explanation : 2M

- Zener diode V_Z is operated in breakdown region and provides constant voltage V_Z.
- As V_Z & V_{BE} of the transistor are constant, output voltage across R_L will also be constant. To find output voltage V_O,

Applying KVL to o/p loop of the circuit

$$V_{BE} + I_L R_L - V_Z = 0$$

Therefore, $V_O = I_L R_L = V_Z - V_{BE}$

$$V_O = V_Z - V_{BE}$$

- If output voltage increases then V_{BE} decreases. Due to reduction in V_{BE}, I_B decreases and I_C decreases. This will increase the collector to emitter voltage across the transistor and V_O will be regulated this is because

$$V_O = Vin - V_{CE}$$

- If the output voltage decreases, then exactly opposite action will take place and the output voltage is regulated.

	(c)	State and explain Barkhausen's criteria of oscillators.	4M

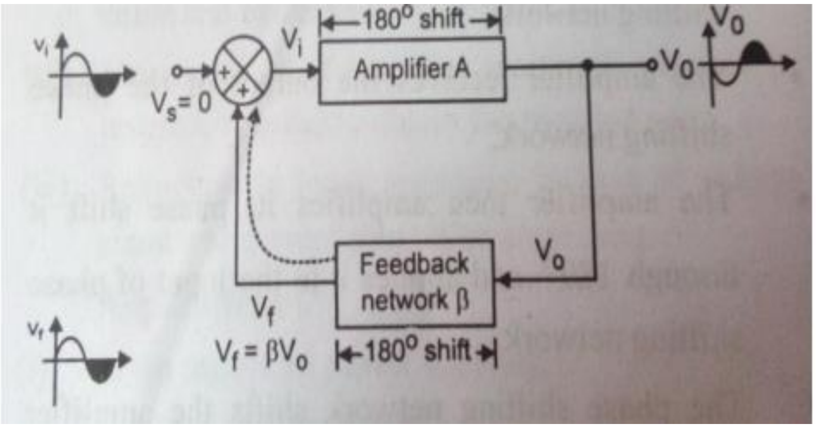
Ans:

Statement : 1

Statement of Barkhausen's criteria:

To produce sustained oscillations, an oscillator circuit must satisfy

- $A_v \beta \geq 1$
- Phase shift between the input and output signals must be equal to 360° or 0°



- In oscillator positive feedback is used.

Voltage gain of feedback amplifier is,

Explanation:3 (diagram optional)

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$$Avf = \frac{Av}{1 - Av\beta}$$

Where, Av = open loop gain

β= feedback factor

If Avβ = 1

Then 1- Avβ = 0

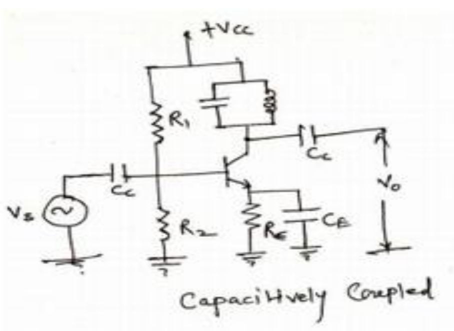
And will increase to infinity but in actual practice output of feedback amplifier cannot be infinite, therefore 1-Avβ=0 represents, output voltage whose frequency is completely different from the input signal.

- The amplifier reverses the phase of an input signal at its output (means it gives 180° phase shift) in order to provide positive feedback, the feedback network must provide a phase shift of 180°. So that total phase shift of 360° or 0° at the amplifier input.
- The above two condition for positive feedback i.e. Avβ=1 and net phase shift around loop equal to 360° or 0° are called Barkhausen Criterion of Oscillation.

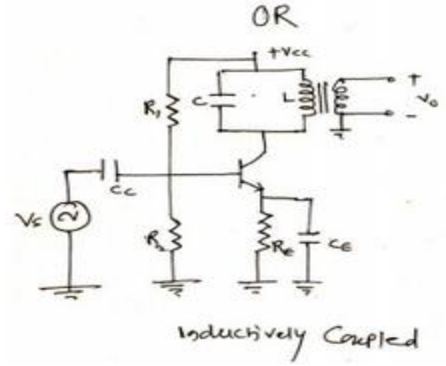
(d) Draw the circuit of single tuned amplifier and state its operating principle. 4M

Ans:

Any Circuit diagram : 2M

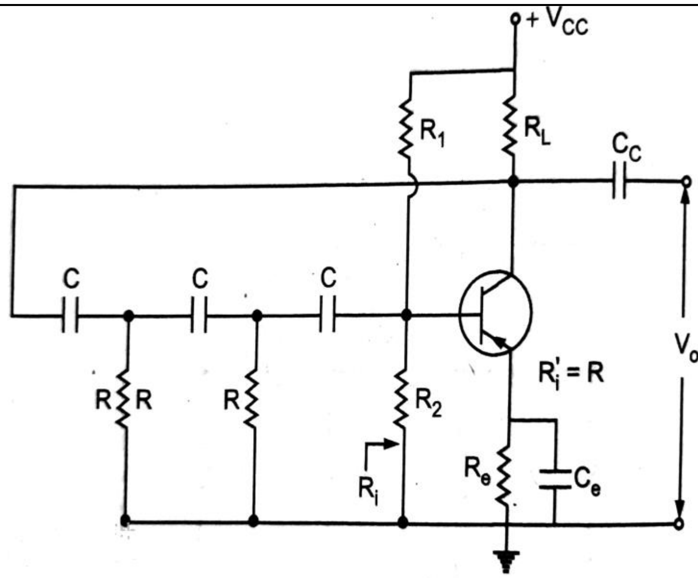


OR

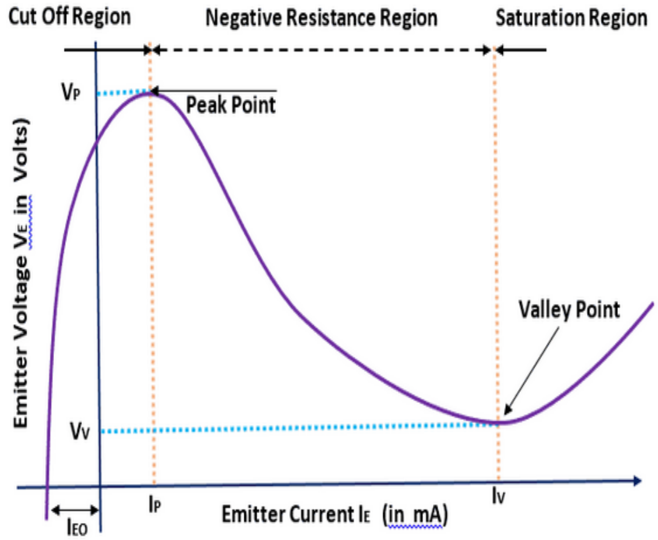


Operating Principle:

Operating Principle : 2M

		The working of tuned voltage amplifier may be understood by considering a radio frequency signal, to be amplified applied at the input of the amplifier. The resonant frequency of the tuned circuit is made equal to the frequency of the input signal by changing the value of capacitor (C) and inductor (L). When the frequency of the tuned circuit becomes equal to that of the input signal a large signal appears across the output terminals. If the input signal is a complex wave (i.e. it contains many frequency components.) in that case the frequency with input frequency equal to the resonant frequency will be amplified. And all the other frequencies will be rejected by the tuned circuit.	
	(e)	Draw the labeled circuit of RC phase shift oscillator. State the formula for frequency of oscillator.	4M
	Ans:	 Frequency of oscillation is given by, $f = \frac{1}{2\pi(\sqrt{6})CR}$	**Circuit diagram : 3M** **Formula :1M**
	(f)	Draw the characteristics of UJT and state its working principle.	4M

Ans:



The characteristics of Unijunction Transistor (UJT) can be explained by three parameters:

- Cutoff Region
- Negative Resistance Region
- Saturation Region

Characteristic : 1M

Cutoff Region

The region, to the left of peak- point, is called cut-off-point region. In the region, the emitter voltage is below the peak –point voltage (Vp). And the emitter current is approximately zero. The UJT is in its OFF position in this region.

working principle : 3M

Negative Resistance Region

The region, between the peak point and valley point, is called negative resistance region. In this region, the emitter voltage decreases from V_p to V_v and the emitter current increases from I_p to I_v. The increase in emitter current is due to the decrease in resistance.

Saturation Region

The region, beyond the valley point, is called saturation point. In this region, the device is in its ON position. The emitter voltage V_E remains almost constant with the increasing emitter current.
