WINTER – 19EXAMINATION

Subject Name:Applied Electronics **Model Answer**Subject Code: 22329

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.	Answer	Marking Scheme
Q.1		**Attempt any FIVE of the following:**	**10-Total Marks**
	a)	**List the types of coupling used in BJT amplifier.**	**2M**
	Ans:	Types of coupling used in BJT amplifier: i. Resistance capacitance (RC)coupling ii. Impedance coupling iii. Transformer coupling iv. Direct coupling	**Each ½ M**
	b)	**Compare small signal amplifier with power amplifier(any four)**	**2M**
	Ans:	(see table below)	**Any four points: each ½ M**

Sr.No	Parameters	Small signal Amplifiers	Power Amplifiers
1	Amplification quantity	It increases voltage into high resistance load. Hence small signal amplifiers are also called as voltage amplifiers.	It increases power into low resistance load. Hence these amplifiers are also called as large signal amplifiers.
2	Current Gain(β)	High(typically 100)	Low(5 to 20)
3	Input Resistance(R_i)	Quite low	Very large
4	Output	High	low

	Impedance(R_o)		
5	Physical size	Small	Large in size
6	Coupling	R-C coupling	Transformer coupling
7	Power output	low	High

c) **State four advantages of negative feedback used in feedback amplifier.** **2M**

Ans: **Advantages of negative feedback: (Any Four)** **Each ½ M**

i. Distortion decreases
ii. Noise in output decreases
iii. Stability of gain of amplifier improves
iv. It is used as an amplifier.
v. Operating point is stabilized.
vi. Input resistance increases in certain configuration and output resistance decreases in certain configurations.
vii. Bandwidth is increased

d) **State Barkhausen criteria of oscillation.** **2M**

Ans: Where, A_V = gain of an amplifier without feedback also called open loop gain **1M**

βA_V = product of feedback fraction and open loop gain. It is called loop gain.

The Barkhausen criterion for the generation of sustained oscillations. for positive feedback are:

1. $\beta A = 1$ **1M**
2. Total phase shift should be 360° or 0°

e) **Differentiate positive feedback and negative feedback (four points)** **2M**

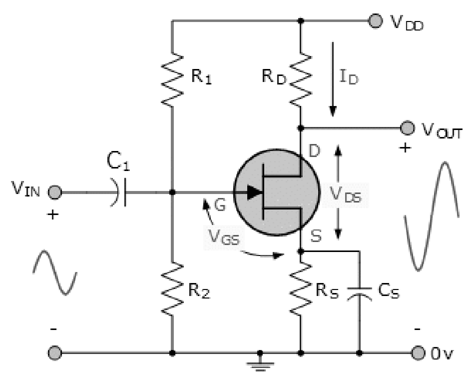
Ans: **Any Four points Each ½ M**

Sr. No.	Parameter	Positive feedback	Negative feedback
1	Feedback signal	In phase with the input signal.	180 ° out of phase with the input signal.
2	Net input signal	Increases	Decreases
3	Gain	Increases	Decreases
4	Noise Increases	Increases	Decreases
5	Stability	Poor	Improved
6	Input impedance	decreases	increases
7	Output impedance	increases	decreases
8	Uses	Oscillators, Schmitt trigger	Amplifiers, bootstrapping

	f)	**State the need of tuned amplifier in electronic circuits.(four points)**	**2M**
	Ans:	**(Note:Any two points can be given full marks)** **Need of tuned amplifier:** i. Selects the desired radio frequency signal. ii. Amplifies the selected high or radiosignal to a suitable voltage level. iii. As a filter.	**2M**
	g)	**List the uses of heat sink (four points)**	**2M**
	Ans:	**Uses of heat sink:** i. It is used to avoid thermal runaway in electronic circuits. ii. Use to transfer heat generated by a mechanical or an electronic device to the surroundings. iii. Use to optimize the heat exchange between component and surrounding by maximizing the contact surface between heat sink and air. iv. Used to dissipate the amount of heat generated.	**Each point ½ M**

Q.2		**Attempt any THREE of the following:**	**12-Total Marks**
	a)	**Explain the working principle of FET amplifier and list its two applications.**	**4M**

Ans: **Circuit diagram:** — **Circuit diagram: 1 ½M**



Explanation: — **1 ½M**

i. When small a.c. signal is applied to the gate, it produces variation in the gate to source voltage. This produces variation in the drain current. As the gate to source voltage increases, the drain current also increases. As the result of this voltage drop across R_D also increases. This causes the drain voltage to decreases.

ii. As the input voltage rises, gate to source voltage becomes less negative, it will increase the channel width and increase the level of drain current I_D.

iii. As the input voltage falls, it will decrease the channel width and decrease the level of drain current I_D.Thus I_D varies sinusoidally above its Q point value.

iv. The drain to source voltage V_{DS} is given by $V_{DS} = V_{DD} – I_D R_D$

v. Therefore as I_D increases the voltage drop $I_D R_D$ will also increase and voltage V_{DS} will decrease.

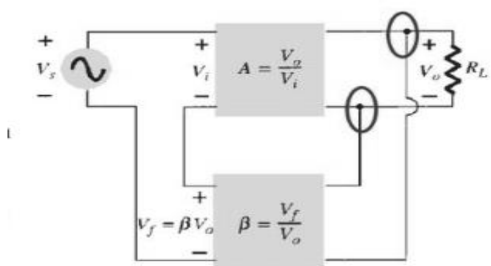
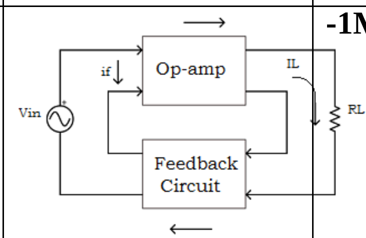
vi. If ΔI_D is large for a small value of ΔV_{GS}; the ΔV_{DS} will also be large and we get amplification. Thus the AC output voltage V_{DS} is 180° out of phase with AC input voltage.

Applications: (Any 2) — **1M (1/2 M each)**

i. Low noise amplifier
ii. Buffer amplifier
iii. Cascade amplifier
iv. Analog switch
v. Multiplexer
vi. Chopper
vii. Current limiter

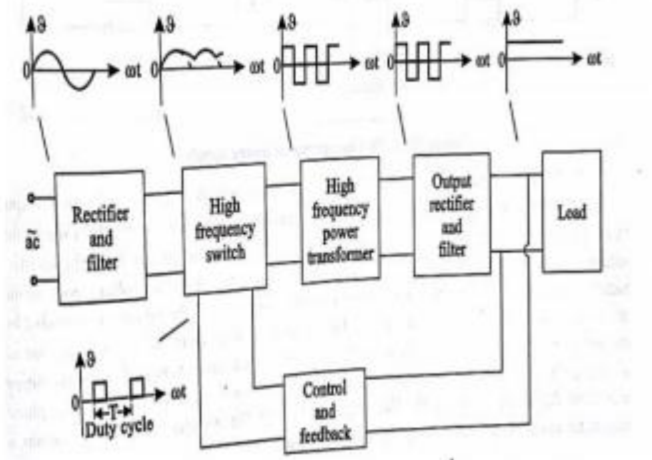
b) Compare the performance of voltage series and current series type of negative feedback amplifiers.(four points) — **4M**

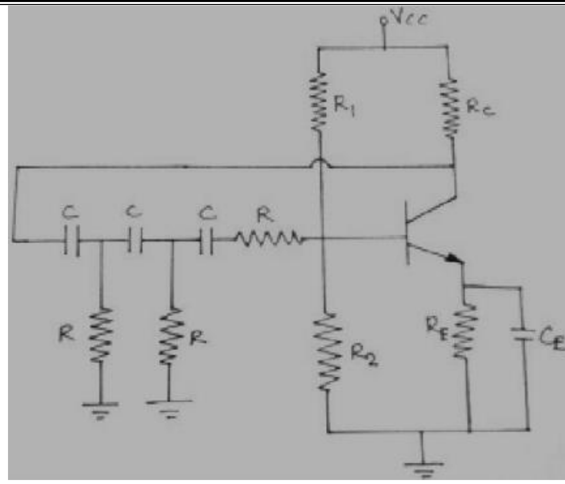
Ans: **Any four point Each point -1M**

Sr.No	Parameters	voltage series negative feedback amplifiers	current series type of negative feedback amplifiers
1	**Block diagram**		
2	**Gain**	Decreases	Decreases
3	**Output resistance**	Decrease $Z_{if}=\frac{ZI}{1+\beta A}$	Increase $Z_{if}=Z_i(1+\beta A)$
4	**Input resistance**	Increases $Z_{if}=Z_i(1+\beta A)$	Increase $Z_{if}=Z_i(1+\beta A)$
5	**Disortion**	Decrease	Decrease

c) Draw the block diagram of SMPS and state its working principle. — **4M**

Ans: **Diagram:** — **2M**

		 **Working principle:-** **Rectifier and filter**:- It converts the ac supply voltage to a pulsating dc, which is then filtered out to reduce the amount of ripple content. It uses the power diodes in a bridge configuration to obtain the pulsating dc and the capacitor is used as a filter element. **High-frequency switching:-** It uses either MOSFETs or BJTs to convert the dc voltage to high frequency ac square wave. This high-frequency ac square wave ranges from 20 kHz to 100 kHz. Since the power transistors are not operated in their active region, their operation results in low power dissipation. Thus, it is a two stage conversion. i.e. the input ac supply voltage is first rectified to dc and then the high-frequency switching section changes it back to ac. **High frequency power transformer**:-It isolates the circuit and steps-up or steps-down the voltage to the desired voltage level. The output of the transformer is the input of the second rectifier section, called the output rectifier section. **Output rectifier**: - This rectifier section is different from the first block of the rectifier in that the frequency of the voltage is very high. Therefore, the bridge configuration of this rectifier uses a high frequency diode such as a Schottky diode and the output ripple is naturally filtered because of the number of overlaps between each individual output pulse. Since the ripple is very small in the output voltage of the rectifier, a small capacitance value is required in the filter section. **Control and feedback**:- It provides a pulse width modulation(PWM) output signal. The PWM controller provides a duty-cycle that varies pulse by pulse to provide an accurate dc output voltage.	**2M**
	d)	**Design a RC phase shift oscillator to generate the frequency of 500KHz.Assume suitable values for $R_1=R_2=R_3=R$ and $C_1=C_2=C_3=C$ .Justifyyour answer.**	**4M**
	Ans:	**RC Phase shift oscillator:**	**Circuit diagram 1M**



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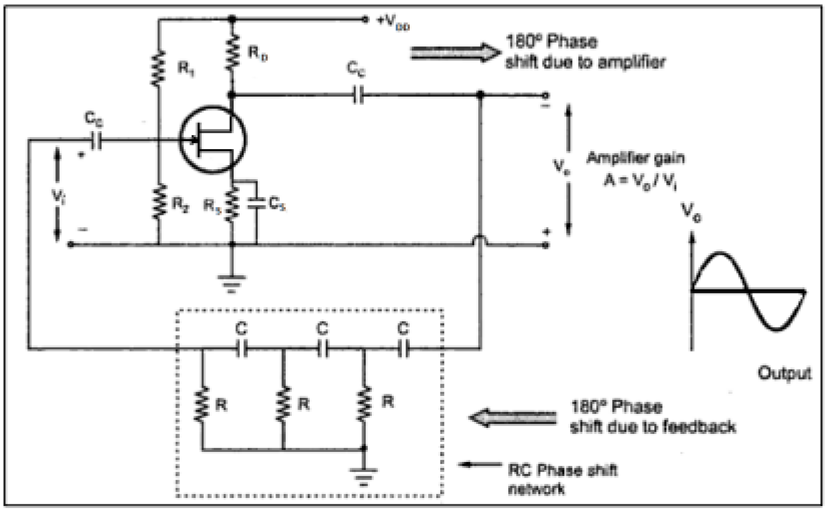


Assume the values of R and C:

(NOTE:STUDENT CAN ASSUME ANY VALUES OF R AND CALCULATE "C"<u>OR</u>ASSUME ANY VALUES "C " AND CALCULATE " R")

Assume

R1=R2=R3=R=10KΩ

Given :

$f = 500KHz$

Assume $R = 10K\Omega$

$C = ?$

Solution :

Formula of frequency of RC phase shift oscillator is

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

$$500k = \frac{1}{2\pi\, 10\times10^3\, C\sqrt{6}}$$

$$C = \frac{1}{2\pi\times10\times10^3\times500\times10^3\sqrt{6}}$$

$$= \frac{1}{7.695\times10^{10}}$$

$$= 1.299\times10^{-11}$$

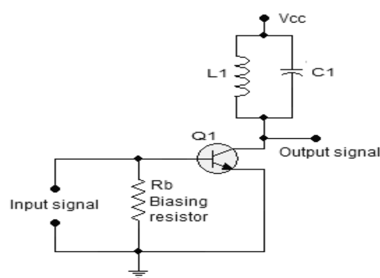
$$C = 12.99pF$$

Similarly students can calculate R assuming C

This oscillator is used to generate low frequency signal.

Calculation 2M

Justification 1M

Q.3		Attempt any THREE of the following:	12-Total Marks
	a)	**Classify the power amplifiers on the basis of operation and input/output waveforms.**	4M
	Ans:	Depending upon the operation and input/output waveforms power amplifiers are classified into following type. 1) Class A amplifier. 2) Class B amplifier. 3) Class C amplifier. 4) Class AB amplifier. 5) Class D amplifier.	Any 4 types 1M each
	b)	**Describe the operation of class-C type of power amplifier with the help of neat sketch.**	4M
	Ans:	**Circuit diagram:**  **Operation:** • Class C power amplifier is a type of amplifier where the transistor conducts for less than one half cycle of the input signal. Less than one half cycles means the conduction angle is less than 180° and its typical value is 80° to 120°. • Biasing resistor R_b pulls the base of Q_1 further downwards and the Q-point will be set below the cut-off point in the DC load line. As a result the transistor will start conducting only after the input signal amplitude has risen above the base emitter voltage (Vbe~0.7V) plus the downward bias voltage caused by R_b. That is the reason why the major portion of the input signal is absent in the output signal. • Inductor L_1 and capacitor C_1 forms a tank circuit which is used in the extraction of the required signal from the pulsed output of the transistor. • Values of L1 and C_1 are so selected that the resonant circuit oscillates in the frequency of the input signal. Since the resonant circuit oscillates in one frequency (generally the carrier frequency) all other frequencies are attenuated.	2M 2M
	c)	**Justify the need of current time base generator to obtain the specified sawtooth waveform with one example.**	4M
	Ans:	**Justification:-** • Current Time base generator is a circuit where the output current is a linear function of time over a specified time interval. • Time base circuits are used by radar systems to determine range to a target, by comparing the current location along the time base to the time of arrival of radio	Justification 2M, Waveform

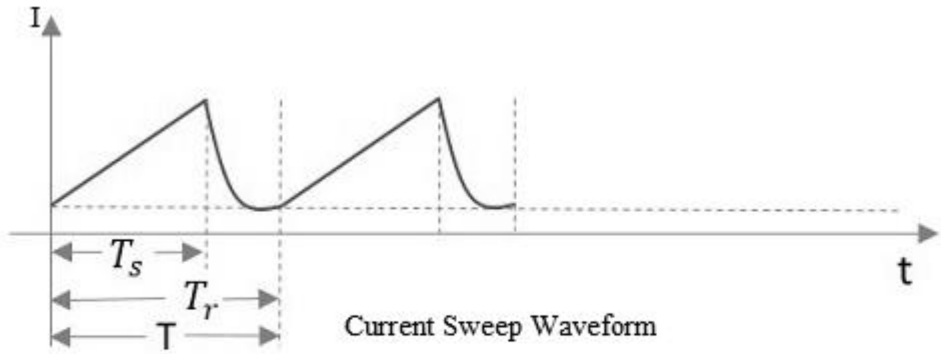
echoes.

- Current Time base generators produce very high frequency sawtooth waves specifically designed to deflect the beam in cathode ray tube (CRT) smoothly across the face of the tube and then return it to its starting position.
- To display the variations of a signal with respect to time on an oscilloscope, a voltage/current that varies linearly with time, has to be applied to the deflection plates. This makes the signal to sweep the beam horizontally

1M,

Example 1M

Waveform:



Current Sweep Waveform

Example:

- A cathode ray tube (CRT) consists of three primary parts, the electron gun that provides a stream of accelerated electrons, the phosphor-covered screen that lights up when the electrons hit it, and the deflection plates that use magnetic or electric fields to deflect the electrons in-flight and allows them to be directed around the screen.
- It is the ability for the electron stream to be rapidly moved using the deflection plates that allow the CRT to be used to display very rapid signals.
- To display such a signal on an oscilloscope for examination, it is desirable to have the electron beam sweep across the screen so that the electron beam cycles at the same frequency as the carrier, or some multiple of that base frequency.
- This is the purpose of the current time base generator, which is attached to one of the set of deflection plates, normally the X axis, while the amplified output of the radio signal is sent to the other axis, normally Y. The result is a visual re-creation of the original waveform.

OR

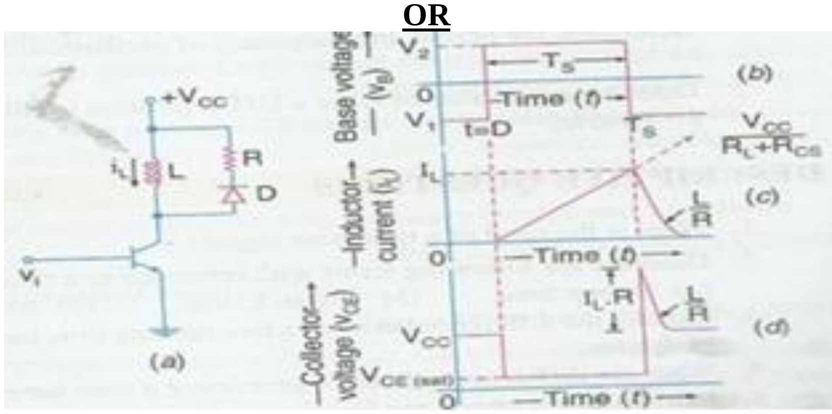
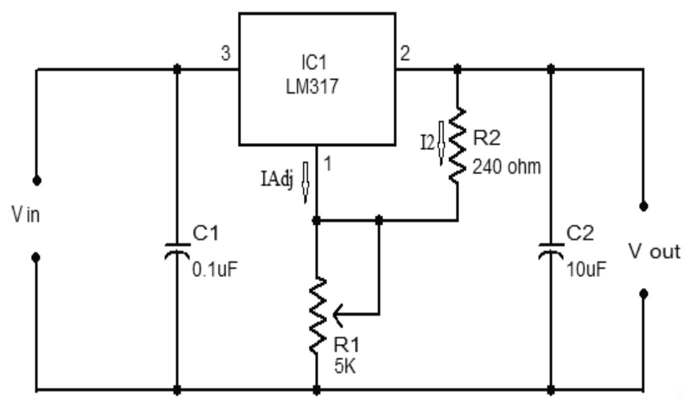


Fig: A current time base circuit.

- Above Fig. shows a simple circuit of a current time base generator.
- Here an inductor (L) in series with a transistor is connected across the V_{CC} supply.
- The transistor operates as a switch in the circuit.
- The gating waveform at the base operates between two levels. $V_1$and V_2 as shown.
- The lower level (V_1) keeps the transistor in cut-off, while the upper level drives the transistor into saturation.
- When the transistor switch is turned ON, then neglecting the effect of small saturation resistance (R_{cs}), the current through and inductor (i_L) increases linearly with the time.
- The diode D does not conduct during the sweep, because it is reverse biased.

d) **Design a voltage regulator using IC LM317, draw the circuit diagram and state the output voltage equation.** **4M**

Ans: **Circuit diagram:-** **2M**



- IC LM317 is adjustable three terminal positive voltage regulator, available with output voltage of 1.2v to 37v and output current from 0.1A to 18.12 A.
- Three terminals of adjustable voltage regulators are V_{in}, V_{out}, and adjustment, above fig shows connection diagram of LM 317 regulator. It requires only two external resistors to set the output voltage.
- LM 317 develops a nominal 1.25v referred to as the reference voltage. V_{ref} between output and adjustment terminals. This voltage is impressed across R_2, since the voltage is constant; the current I_2 is also constant for given value of R_2. In addition to I_2, current I_{Adj} from the adjustment terminal also flows through the output resistor R_1.
- LM317 is designed such as I_{ADJ}-100μA-

The output voltage Vo is $V_0=R_2.I_2 + R_1(I_{ADJ} + I_2)$---(1) **Design-1M**

$$I2 = \frac{Vref}{R2}$$

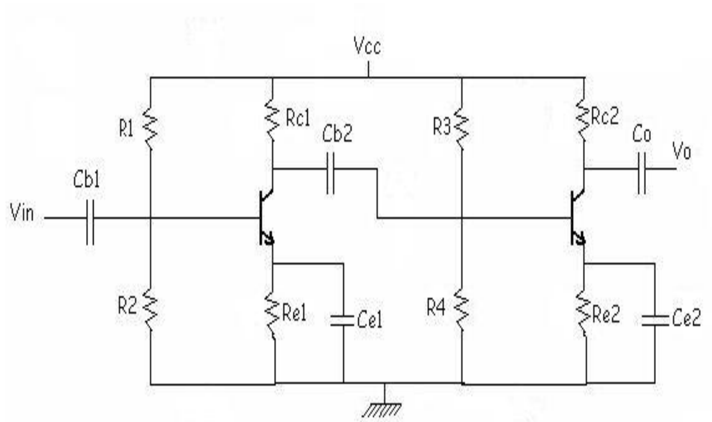
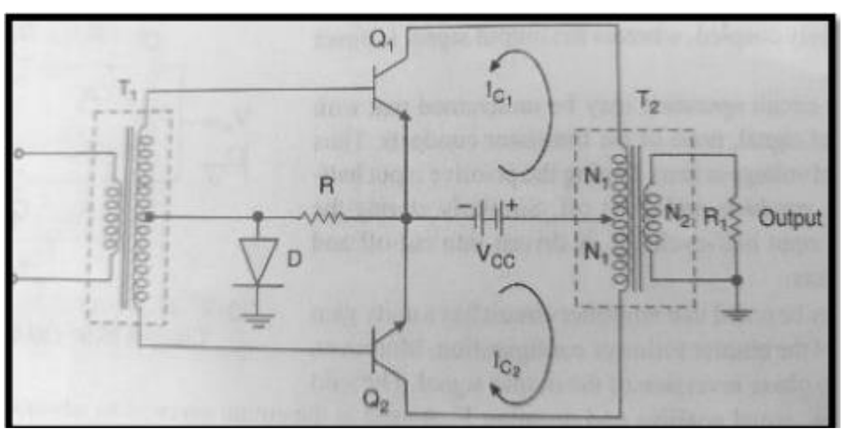
Substitute I2 in equation (1)

$V_0=R_2.\frac{Vref}{R2}+R_1(I_{ADJ} + \frac{Vref}{R2})$

$V_0=R_2.\frac{Vref}{R2}+R_1.I_{ADJ} + R1.\frac{Vref}{R2})$

$V_0=V_{ref}(1+\frac{R1}{R2})+R_1.I_{ADJ}$

Where V_{ref}=1.25v.

		However the current IADJ is very small and constant. Therefore the voltage drop across R2 due to IADJ is also very small and can be neglected. Therefore **$V_0=1.25.(1+\frac{R1}{R2})$** The output is a function of R_1 for a given value of R_2 and can be varied by adjusting the value of R_1. The resistor R_2 usually is 240 ohm. Normally no capacitor is needed unless the LM317 is situated far from the power supply filter capacitor.	**Output equation- 1M**
Q.4		**Attempt any THREE of the following :**	**12-Total Marks**
	a)	**Draw the two stage BJT amplifier. State the formula for overall gain of this amplifier.**	**4M**
	Ans:	**Diagram:**  Let Av_1-Voltage gain of first amplifier Av_2-voltage gain of second amplifier **Overall voltage gain, $Av = Av_1 * Av_2$**	**3M** **Formula 1M**
	b)	**Draw the circuit diagram of class AB power amplifier and describe its working.**	**4M**
	Ans:	**Circuit diagram:**  **Circuit Description**: The circuit consists of two center-tapped transformers T_1 and T_2, two identical transistors Q_1 and Q_2 , Resistor R and diode D. The DC voltage developed across the diode D is connected to the bases of both the transistors through the secondary winding	**2M**

of the input transformer. This voltage acts as DC bias for the transistors because it is equal to cut-in voltage and they will conduct for complete half cycleperiod of the input to eliminate the cross-over distortion.

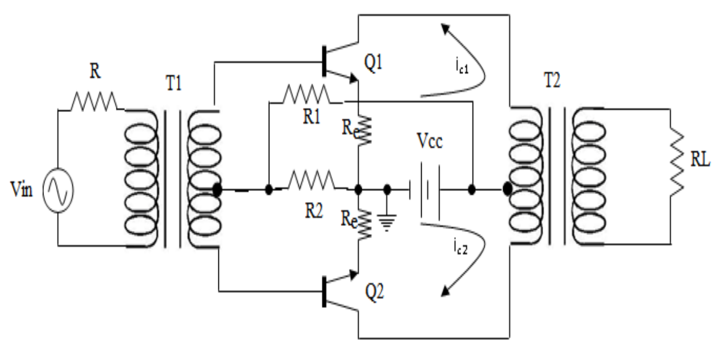
WORKING:

- **i.** When there is no a.c. input signal is applied both the transistors Q_1& Q_2 are cut off. Hence no current is drawn from VCC.
- **ii.** DURING POSITIVE HALF CYCLE:
  - The base of the transistor Q_1 is positive and that of Q_2 is negative.
- **iii.** As a result of this Q_1 conducts, while the transistor Q_2 is OFF. ¬ DURING DURING NEGATIVE HALF CYCLE:
  - The base of the transistor Q_2 is positive and that of Q_1 is negative.
  - As a result of this Q_2 conducts, while the transistor Q_1 is OFF.
- **iv.** Thus at any instant any one transistor in the circuit is conducting. Then the output transformer joins these two halves & produces a full sine wave in the load resistor.

2M

OR

Circuit diagram:-



Circuit operation:-

- Resistor R_1, R_2 are chosen to provide biasing to the transistors Q_1, Q_2, input transformer T_1 provides phase splitting function in which two voltages are out of phase with each other. V_{CC} is tied to the transistor collectors through the centre tapped output transformer T_2. R_e is stabilized resistor.
- When positive half cycle of the input signal is applied, the base of Q_1 becomes positive and base of Q_2 negative. Therefore Q_1 is ON and Q_2 is OFF. As transistors Q_1 and Q_2 are biased just above cut off. Therefore as positive input cross zero, collector current ic_1 starts flowing through Q_1, through transformer T_2 as shown and $ic_2 = 0$. A positive sinusoidal voltage will appear across load.
- When negative half cycle is applied across input the base of Q_1 becomes negative while the base of Q_2 is positive. Therefore Q_1 is off and Q_2 conduct, as soon as input cross zero, negative sinusoidal voltage will appear across load.

c)	**With the help of neat circuit diagram, explain the operation of voltage shunt type feedback amplifier.**	**4M**
Ans:	**Diagram:**	**2M**

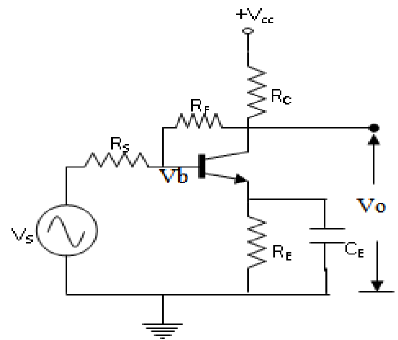


Fig. shows common emitter transistor amplifier with a feedback resistor R_F connected between its output and input terminals. This is collector to base biasing when the input signal is applied to the input then amplified output V_O is produced with 180^0 phase shift (out of phase with input) with the input.

Hence the feedback current is given by –

$$I_F = \frac{V_b - V_o}{R_F}$$

$\because V_b << V_o$

$$\therefore I_f = -\frac{V_O}{R_F}$$

Thus if we reduce the output voltage to zero then feedback voltage will reduce to zero, therefore it is voltage feedback. As $I_S = I_f + I_i$ it is shunt type therefore it voltage shunt negative feedback amplifier.

Explanation 2M

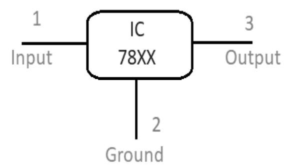
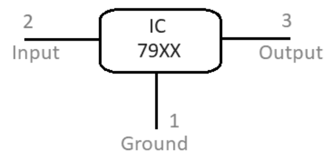
d) Compare between RC phase shift oscillator and crystal oscillator. **4M**

Ans: (Note: Any other relevant point also can be considered.) **Any 4 points 1M each point**

Sr. No.	RC phase shift oscillator	Crystal oscillator
1	This oscillator is used for low frequency range.	Quartz crystal is mainly used in radio-frequency (RF) oscillators
2	Used resistor and capacitor network to decide frequency of oscillator.	Crystal decides the frequency of oscillator.
3	RC phase shift oscillators are comparatively less stable.	crystal oscillators are highly stable
4	RC network is used as feedback network.	Crystal is connected in feedback.

e) Compare the fixed voltage regulators using 78XX and 79XX.(any four points) **4M**

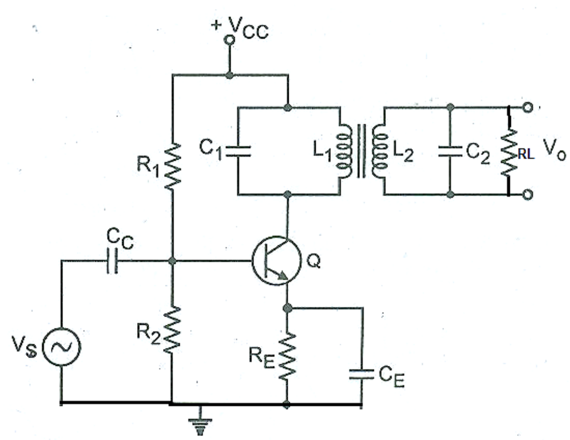
Ans: (Note: Any other relevant point also can be considered.) **1M each**

Sr. No.	78xx	79xx
1	It produces positive fixed DC voltage values,	It produces negative fixed DC voltage values
2	IC 78xx (7805, 7806, 7808, 7812, 7815, 7818,7824)- Positive Voltage Regulator.	IC 79xx (7905, 7906,7908,7912, 7915) - Negative Voltage Regulator
3	Output current is 1A	Output current is 1.5A
4	 OR 1-Input 2-Ground 3-Output	 OR 1-Ground 2-Input 3-Output

point

Q.5		**Attempt any TWO of the following**	**12 Total Marks**
	(a)	**Describe the operation of double tuned amplifier with the help of neat circuit diagram and mention its applications.**	**6M**

Ans: **Circuit diagram:** **2M**



Operation: **2M**

- The signal to be amplified is applied at the input terminal through the coupling capacitor C_C
- The resonant frequency of the tuned circuit L_1 C_1 is made equal to that of tuned circuit L_2 C_2
- Under these conditions the tuned circuit offers avery high impedance to the input signal. As a result of this, a large output appears across the tuned circuit L_1C_1which is inductively coupled to the L_2C_2 tuned circuit.

Applications:(any two) **1M each**

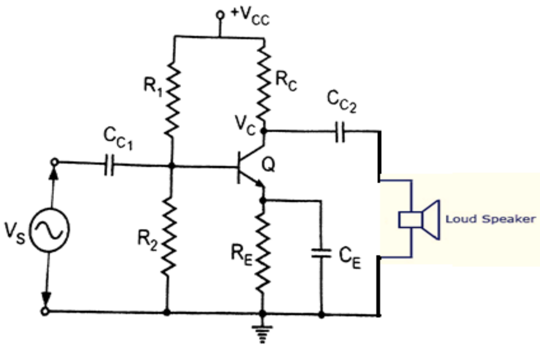
(i) Radio and T .V broadcasting as tuning circuit.

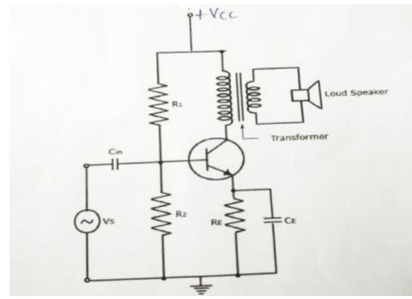
(ii) Wireless communication system.

(b) **Sketch the labeled diagram of class A and class B types of power amplifier. Also draw the input and output waveforms. State one application of each.** **6M**

Ans:

CLASS A POWER AMPLIFIER CIRCUIT DIAGRAM: **Diagram 1 ½ M**





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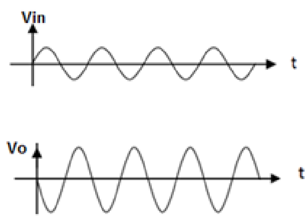
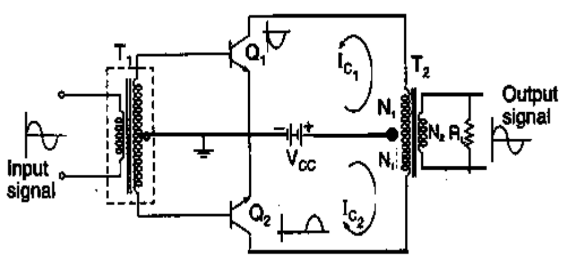
CLASS A POWER AMPLIFIER I/P &O/P WAVEFORMS: **Waveform 1M**

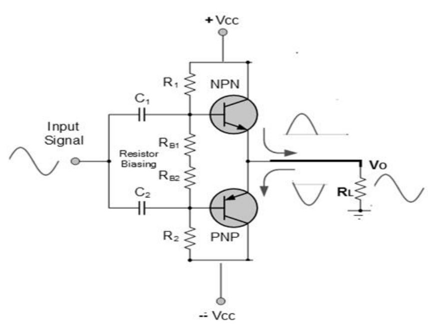


CLASS A POWER AMPLIFIER APPLICATION:

1. High gain voltage amplifiers
2. RF& IF amplifiers in Radio & T.V.
3. Audio amplifiers

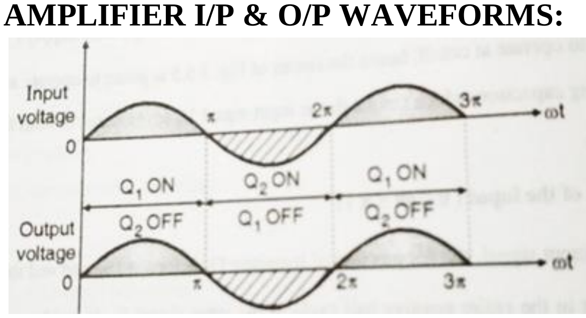
CLASS B POWER AMPLIFIER CIRCUITRAM: **Diagram 1 ½ M**





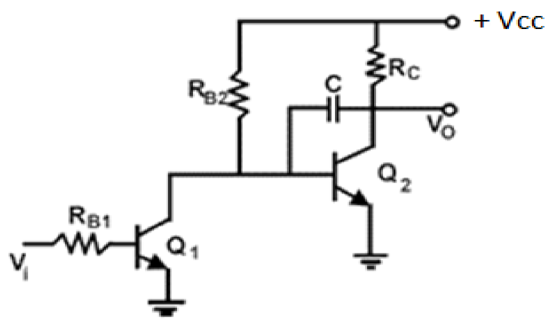
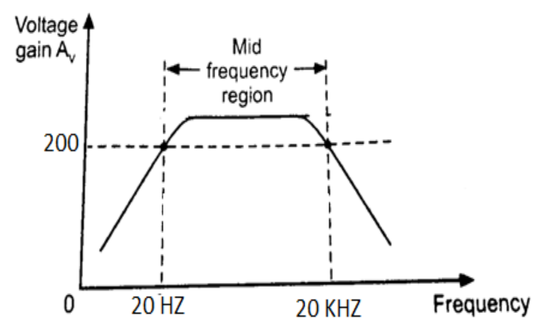
class B push pull power amplifiercomplementary symmetry class B push pull power amplifier

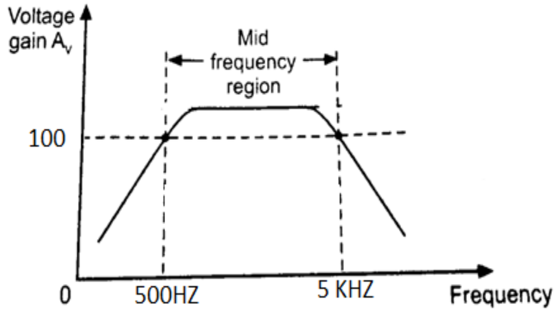
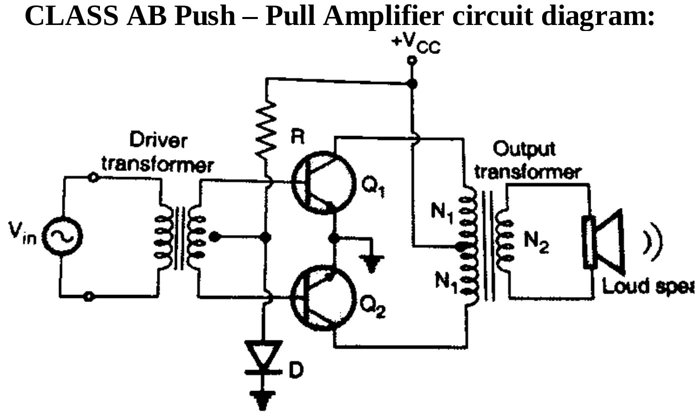
CLASS B POWER AMPLIFIER I/P & O/P WAVEFORMS: **Waveform 1M**



CLASS B POWER AMPLIFIER APPLICATION(Any 2): **½ M**

1. Final stages of the amplifier circuits.

		2. In public address systems (PA system) 3. In tape recorders and music system 4. In T.V receivers	
	(c)	**Draw the neat labelled diagram of miller sweep generator and mention its two applications.**	**6M**
	Ans:	**Circuit Diagram:**  **Applications (Any Two):** • In Television (TV) • In CRO • To convert step waveform into ramp waveform.	**4M** **1M each**
Q.6		**Attempt any TWO of the following:**	**12Total Marks**
	(a)	**For a BJT ac amplifier, with a midband voltage gain of 200, if the cutoff frequencies are f_1=20Hz and f_2=20KHz.Draw the frequency response for amplifier. Draw the frequency response in case of mid gain of 100 and f_1=500Hz to f_2=5KHz.**	**6M**
	Ans:	**(i) Frequency response for amplifier with mid-band voltage gain of 200, if the cutoff frequencies are f_1=20Hz and f_2= 20KHz.**  **(ii) Frequency response for amplifier with mid-band voltage gain of 100, if the cutoff frequencies are f_1=500Hz and f_2= 5KHz.**	**3M** **3M**

			
	(b)	**Draw a class AB push pull amplifier and comment on its usefulness in the output stage as compared to other power amplifiers and the relationship between maximum transistor power dissipation w.r.t the supply voltage.**	6M
	Ans:	**CLASS AB Push – Pull Amplifier circuit diagram:**  **Usefulness as compared to other power amplifiers:** 1. Efficiency more than Class A power amplifier **2.** Cross over distortion is eliminated as compared to Class B power amplifier. **Relationship between maximum transistor power dissipation w.r.t the supply voltage:** $P_D = Pi_{(DC)} - Po_{(A.C.)}$ $= \frac{2VCC*Im}{\pi} - \frac{Vm*Im}{2}$	3M 2M 1M
	(c)	**Comment on the effect of negative feedback on the gain, input and output resistance of the feedback amplifiers.Describe the gain bandwidth product term used in this context and its importance.**	6M
	Ans:	**Effect of negative feedback:** 1. Gain decreases with negative feedback. 2. Input resistance increases with negative feedback. 3. Output resistance decreases with negative feedback. **Explanation of significance of Gain bandwidth product** • Bandwidth measure at 3db voltage gain. As Gain and bandwidth product is always constant, and it is unity gain bandwidth. • The gain decreases with negative feedback bandwidth increases which means it is stable output on more range of frequency.	3M Explanation 3M