JEPPIAAR
ENGINEERING COLLEGE

JEPPIAAR NAGAR, CHENNAI - 600119

Department of Electronics & Communication Engineering

QUESTION BANK

EC3353 ELECTRONIC DEVICES AND CIRCUITS

III Semester ECE (Regulation 2021)

BATCH 2023-2027

JEPPIAAR ENGINEERING COLLEGE		
Vision of the Institute	To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class University	
Mission of the Institute	**M1**	To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking
	M2	To participate in the production, development and dissemination of knowledge and interact with national and international communities.
	M3	To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society
	M4	To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation's economy
DEPARTMENT: ELECTRONICS AND COMMUNICATION ENGINEERING		
Vision of the Department	To become a centre of excellence to provide quality education and produce creative engineers in the field of Electronics and Communication Engineering to excel at international level.	
Mission of the Department	**M1**	Inculcate creative thinking and zeal for research to excel in teaching-learning process
	M2	Create and disseminate technical knowledge in collaboration with industries
	M3	Provide ethical and value based education by promoting activities for the betterment of the society
	M4	Encourage higher studies, employability skills, entrepreneurship and research to produce efficient professionals thereby adding value to the nation's economy

PROGRAM OUTCOMES (PO)	**PO 1**	**Engineering knowledge**: **Apply** the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
	PO 2	**Problem analysis**: **Identify, formulate, review** research literature, and **analyze** complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
	PO 3	**Design/development of solutions**: **Design solutions** for complex engineering problems and **design** system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
	PO 4	**Conduct investigations of complex problems**: **Use** research-based knowledge and research methods including **design** of experiments, **analysis** and **interpretation** of data, and **synthesis** of the information to provide valid conclusions.
	PO 5	**Modern tool usage**: **Create**, **select**, and **apply** appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
	PO 6	**The engineer and society**: **Apply** reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
	PO 7	**Environment and sustainability**: **Understand** the impact of the professional engineering solutions in societal and environmental contexts, and **demonstrate** the knowledge of, and need for sustainable development.
	PO 8	**Ethics**: **Apply** ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
	PO 9	**Individual and team work**: **Function effectively** as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
	PO 10	**Communication**: **Communicate effectively** on complex engineering activities with the engineering community and with society at large, such as, being able **to comprehend** and **write** effective reports and **design** documentation, **make** effective presentations, and **give** and **receive** clear instructions.
	PO 11	**Project management and finance**: **Demonstrate** knowledge and understanding of the engineering and management principles and **apply** these to one's own work, as a member and leader in a team, to **manage** projects and in multidisciplinary environments.
	PO 12	**Life-long learning**: **Recognize** the need for, and have the preparation and ability to **engage** in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)	**PEO I**	Produce technically competent graduates with a solid foundation in the field of Electronics and Communication Engineering with the ability to analyze, design, develop, and implement electronic systems.
	PEO II	Motivate the students for choosing the successful career choices in both public and private sectors by imparting professional development activities.
	PEO III	Inculcate the ethical values, effective communication skills and develop the ability to integrate engineering skills to broader social needs to the students.
	PEO IV	Impart professional competence, desire for lifelong learning and leadership skills in the field of Electronics and Communication Engineering.
PROGRAM SPECIFIC OUTCOMES (PSOs)	**PSO 1**	Design, develop and analyze electronic systems through application of relevant electronics, mathematics and engineering principles.
	PSO 2	Design, develop and analyze communication systems through application of fundamentals from communication principles, signal processing, and RF System Design & Electromagnetics.
	PSO 3	Adapt to emerging electronics and communication technologies and develop innovative solutions for existing and newer problems.

UNIT I – SEMICONDUCTOR DEVICES

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier- Zener as regulator.

PART-A

1 **What is meant by N-type and P-type semiconductor?**
When a small amount of impurity (eg. Antimony, Arsenic) is added to a pure semiconductor crystal the resulting extrinsic semiconductor is N-type semiconductor. If trivalent impurity(eg.Indium, Gallium) is added to a pure semiconductor then the resulting extrinsic semiconductor is known as P-type semiconductor.

2 **What is a PN junction diode?**
A PN junction diode is a two terminal device consisting of a PN junction formed either of Germanium or Silicon crystal. A PN junction is formed by diffusing P type material to one half side and N type material to other half side.

3 **What is doping? (Dec/Jan 2016)**
The process of adding impurity to pure semiconductor is known as doping. As a result of it the characteristics of semiconductor is changed and hence the conductivity increases.

4 **State mass action law.(Nov/Dec 2016)**
Mass action law states that in a semiconductor the product of the number of holes and the number of electrons is constant and is independent of the amount of donor and acceptor impurity doping.
$np = n_i^2$ where n= free electron concentration, p= hole concentration; n_i = intrinsic concentration

5 **Define the term the drift current. (Dec/Jan 2016)**
If a steady electric field is applied across a semiconductor it causes the free electrons to move towards the positive terminal and the holes move towards the negative terminal of the battery. This combined effect causes a current flow in the semiconductor. The current produced in this manner is known as drift current. Drift current density due to electrons, $J_n = q\, n\, \mu_n E$, Drift current density due to holes, $J_p = q\, p\mu_p E$; where J_n= Drift current density due to electrons, J_p= Drift current density due to holes, q=Charge of the carrier, μ_n = Mobility of electrons, μ_p = Mobility of holes, E = Applied electric field strength.

6 **Define the term diffusion current. (Dec/Jan 2016) / (May/June 2016)**
In a semiconductor it is possible to have a non-uniform distribution of carriers. A concentration gradient exists, if the number of either holes or electrons is greater in one region as compared to the rest of the region. The holes and electrons then tend to move from a region of higher concentration to lower concentration region. This process is known as diffusion and the electric current produced due this process is known as diffusion current.

7 **What is Depletion region in a PN junction diode?**
In a PN junction diode, the holes and the electrons combine to form electron-hole pair, leaving the uncovered acceptor and donor ions at the vicinity of the junction. The region where the charge carriers are depleted and has only immobile charges which are electrically charged is known as depletion region or space charge region.

8 **Define barrier potential.(Nov/Dec 2016)**
Potential barrier is defined as an electric potential that is established across the junction, during the initial diffusion of charge carriers at the junction, which restricts further movement of charge carriers across the junction.

9 **Explain the terms knee voltage and breakdown voltage.**

Knee voltage: The forward voltage at which the current through the PN junction starts increasing rapidly is known as knee voltage. It is also called as cut-in voltage or threshold voltage.

Breakdown voltage: It is the reverse voltage of a PN junction diode at which the junction break down when the sudden rise in reverse current.

10 **Write down and explain junction diode equation**.

The equation which explains the forward and reverse characteristics of a semiconductor diode is known diode equation. The diode current is given by $I = I_o (e^{v/\eta V_T} -1)$ Where I_o = reverse saturation current , η = 1 for Ge diodes,2 for silicon diodes, V- External voltage V_T = volt equivalent of temperature. = T/11,600

11 **Define and explain peak inverse voltage (PIV)(April/May 2017)**

Peak inverse voltage is the maximum reverse voltage that can be applied to the PN junction without damage ~~to the~~ junction. If the reverse voltage across the junction exceeds to its peak inverse voltage, the junction may be destroyed due to excessive heat.

12 **Differentiate drift and diffusion current (Nov/Dec'14)**

Drift current	Diffusion current
1. Developed due to potential gradient	Developed due to concentration gradient
2. Phenomenon found both in semiconductors and metals.	Only in semiconductors
3. $J_n = q\, n\, \mu_n E$ and $J_p = q\, p\, \mu_p E$	$J_n= q\, D_n d_n /dx$ and $J_p= q\, D_p d_p /dx$

13 **Define the term diffusion capacitance or storage capacitance. (May 2015) (Nov 2014)(Nov 2017)(May 2018) (April/May 2019), (Nov 2020)**

The diffusion capacitance effect is found when the diode is forward biased and it is defined as the rate of change of injected charge with voltage and given by $C_D = \tau I / \eta V_T$ where I = diode current , V_T = volt equivalent temperature.V_T = T /11,600 ,η = constant η = 1 for Ge diodes 2 for silicon diodes τ = mean life time.

14 **Define Storage time. (May/June 2016)**

The time required for excess minority carriers stored in a forward-biased pn junction to be removed after the junction is switched to reverse bias is called storage time of pn diode**.**

15 **Consider a silicon pn junction at T=300K so that n_i=$1.515 \times 10^{10} cm^{-3}$. The n type doping is $1 \times 10^{16} cm^{-3}$ and a forward bias of 0.60 V is applied to the pn junction. Calculate the minority hole concentration at the edges of the space charge region.(April/May 2015)(Nov 2014)**

The minority hole concentration can be calculated from the formula $np = n_i^2$

To find p: p=22.952×10^3

16 **Find the voltage at which the reverse current in a germanium PN junction diode attains a value of 90% of its saturation value at room temperature.(April/May 2017)**

We Know that $I = I_0(e^{V/V_T} - 1)$,$-0.90 I_0 = I_0(e^{V/V_T} - 1)$

$$V_T = \frac{T}{11,600} = 26mv$$

$$-0.90 = (e^{V/V_T} - 1)$$

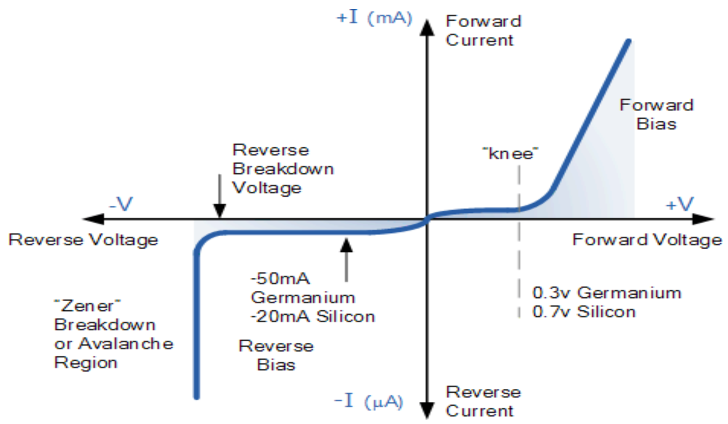
$$-0.90 = (e^{V/26mv} - 1)$$

$$V = - 0.06v$$

17 **Why the depletion layer is very thin in Zener diode? (Nov 2019)**

Zener diode is a heavily doped piece of semiconductor device. If in a diode, the extrinsic side has more doping, it will create less space for depletion region. So the depletion layer is very thin in Zener diode.

18 **Sketch the forward bias characteristics of the PN junction diode.(April/May 2015).**



19 **Write down the current diode equation? (April/May 2018)**

$$I = I_0 \left(e^{V/V_T} - 1 \right)$$

Where: I = the net current flowing through the diode;I_0 = "dark saturation current;
V =applied voltage across the terminals of the diode;q = absolute value of electron charge;k = Boltzmann's constant; and T = absolute temperature (K).

20 **State the relationship between diffusion Capacitance and diode current in a PN diode? (April/May 2018)**

Diffusion capacitance exists in during forward bias.
$C_D = \frac{dq}{dv}$ dq represents the change in number of minority carriers stored outside the depletion region, dv is applied voltage. $I = \frac{Q}{v}$ and $I = I_0 \left(e^{V/V_T} - 1 \right)$ relation between Cd and diode current is given as $C_D = \frac{cI_0}{yV_T}$

21 **Calculate the diffusion capacitance for a silicon diode with a 15 mA forward current, if the charge carrier transit time is 70nsec. (Nov 2015) (May 2019)**

For T = 25^{0}C = 298 K;V_T = T /11,600 = 25.7mV

η= 2 for silicon diode; I = 15mA; τ= 70 nsec. τ

$$C_d = \frac{\tau I}{\eta V_T} = \frac{70 \times 10^{-9} \times 15 \times 10^{-3}}{2 \times 25.7 \times 10^{-3}} = 20.428\ nF$$

22 **What is a rectifier and list its types? (May 2015) (Nov 2014) (Nov 2019)**

A rectifier is a circuit that is used for converting AC supply into unidirectional DC supply. **Half-wave rectifier**: The half wave rectifier is a type of rectifier which converts half of the AC input signal (positive half cycle) into pulsating DC output signal and the remaining half signal (negative half cycle) is blocked or lost. In half wave rectifier circuit, we use only a single diode. **Full-wave rectifier**: The full wave rectifier is a type of rectifier which converts the full AC input signal (positive half cycle and negative half cycle) to pulsating DC output.

23 **State few applications of Zener diode. (Dec 2016)**

i)A Zener diode can be applied in a voltage regulator circuit to regulate the voltage applied to a load, such as in a linear regulator. (ii) A Zener diode can be applied to a circuit with a resistor to act as a voltage shifter. (iii) Zener diode can be used as a waveform Clipper to reshape a signal and also to prevent voltage spikes from affecting circuits that are connected to the power supply

24 **Define: Ripple factor & transformer utilization factor.**

Ripple factor: Ripple Factor is the ratio of rms value of ac component present in the rectified output to the average value of rectified output. It is a dimensionless quantity and denoted by γ. Its value is always less than unity

$$\textbf{Ripple Factor}, \gamma = \frac{\sqrt{(Irms)^2 - (Idc)^2}}{Idc}$$

$$= \frac{\sqrt{(Vrms)^2 - (Vdc)^2}}{Vdc}$$

Tansformer Utilization Factor: It is the ratio of power delivered to the load to the volt ampere rating of transformer.

T.U.F = DC Power Output / Effective VA rating of transformer

25 **State two disadvantages of half wave rectifier. (Nov 2018)**

- They only allow a half-cycle through per sinewave, and the other half-cycleis wasted. This leads to power loss.
- The output current we obtain is not purely DC, and it still contains a lot of ripple (i.e. it has a high ripple factor)

26 **What is meant by biasing a transistor?(Nov 2014)**

Transistor biasing is the process of maintaining proper flow of zero signal collector current and collector-emitter voltage during the passage of signal. Biasing keeps emitter-base junction forward biased and collector-base junction reverse biased during the passage of signal.

27 **What is thermal runaway?(Nov 2017) (Nov 2019)**

The reverse saturation current in a semiconductor doubles for every 100 C rise in temperature. As temperature increases the leakage current increases and the collector current also increases. The increase in collector produces an increase in power dissipation at the collector - base junction. This in turn further increase the temperature of the collector-base junction causing the collector current to further increase. This process may become cumulative and it is possible for the transistor to burn out. This process is known as Thermal runaway. It can be avoided using a stabilization or heat sink with the transistor.

28 **Calculate I_C and I_E for a transistor that has α_{dc} = 0.99 and I_B = 150 µA. Determine the value of β_{dc} for the transistor. (Nov 2015)**

$\alpha_{dc}=\frac{I_C}{I_E}$; $I_C = \alpha_{dc} I_E$

$I_E = I_B + I_C$; $I_B = I_E - \alpha_{dc}I_E$;

$I_B = (1 - \alpha_{dc}) I_E \Rightarrow I_E = \frac{I_B}{1-\alpha_{dc}} = \frac{150\ \mu A}{1-0.99}$ = 15mA $I_C = \alpha_{dc}$

I_E = 0.99×15 mA = 14.85 mA

$\beta_{dc} = \frac{\alpha}{1-\alpha} = \frac{0.99}{1-0.99} = 99$

29 **28. State Two application of UJT. (Nov 2018)**

The UJT is used in:

- Phase control circuit.
- Timing circuit

30 **Compare BJT and JFET. (May 2015)(May 2010 /Nov 2014)(May 2018) (May 2019)**

BJT	JFET
Low input impedance	High input impedance
High Output impedance	Low output impedance
Bipolar device	Unipolar device
Noise is more	Less noise
Cheaper	Costlier
Gain is more	Gain is less
Current controlled device	Voltage controlled device

31 **Define transconductance of JFET or MOSFET.(Nov /Dec 2017)**
Transconductance (gm) is defined as the ratio of small change in drain current (ΔId) to the corresponding change to gate source (ΔV_{gs}) at constant drain to source voltage (V_{ds}).
$g_m = \frac{\Delta I_d}{\Delta V_{gs}}$ at constant V_{ds}

32 **What is MOSFET? (May 2013)**
The MOSFET is an abbreviation of Metal Oxide Semiconductor Field Effect Transistor. It is a three terminal semiconductor device similar to a FET with gate insulated from the channel. Therefore it is also known as insulated Gate (IGFET)

33 **When VGS of a JFET changes from -3.1V to -3V, the drain current changed from 1mA to 1.3mA. Find the value of transconductance. (Nov 2018)**
gm = dI / dE =(1.3-1)/0.1 =0.3/0.1 =3

34 **How a FET is used as a voltage variable resistor?(Nov 2019)**
FET is a device that is usually operated in the constant current portion of its output characteristics. But if it is operated in the region prior to pinch-off, it will behave as a voltage variable resistor. Because in this region, the drain to source resistance can be controlled by varying the gate to source voltage.

35 **In a common base connection, current amplification factor is 0.9. If the emitter current is 1mA, find the value of base current. (Nov 2017)**

$\alpha = I_c / I_e$

$0.9 = Ic / 1x10^{-3}$

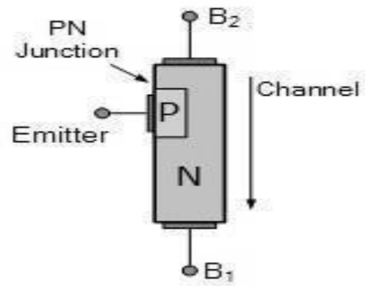
$I_c = 0.9mA$

$I_e = I_c + I_b$

$I_b = I_e – I_c = 1x10^{-3} – 0.9x10^{-3}$ I_b

$= 0.1mA$

36 **Draw the structure of UJT (Nov 17)**



37 **A transistor has a typical β of 100. If the collector current is 40mA. What is the value of emitter current?(May 2017)**

$\beta = Ic / Ib$

$100 = 40 \times 10^{-3} / Ib$

$Ib = 40 \times 10^{-3} / 100 = 0.4mA$

$Ie = Ic + Ib$

$= 40 \times 10^{-3} + 0.410^{-3} = 40.4mA$

38. Define PIV, what is the value of PIV for bridge wave rectifier? (NOV/DEC 2011)

PIV is the peak voltage across the diode in the reverse direction.

PIV for
HWR = E_{sm}
= πE_{DC} | I_{DC}
= 0 PIV for
FWR = 2E_{sm}
= πE_{DC} | I_{DC} =
0
PIV for bridge wave FWR = E_{sm}

39. **Define and explain peak inverse voltage (PIV)(Nov 2010)**

Peak inverse voltage is the maximum reverse voltage that can be applied to the PNjunction without damage to the junction. If the reverse voltage across the junctionexceeds to its peak inverse voltage, the junction may be destroyed due to excessive heat.

40. What is meant by transformer utilization factor?

It is the ratio of power delivered to the load to the volt ampere rating of transformer.

41. Mention some characteristics of LASER diode.

It is coherent i.e. there is no path difference between the waves comprising the beam.It is monochromatic i.e. it consists of one wavelength and hence one colour only.

It is collimated i.e. emitted light waves travel parallel to each other.

42. Mention some applications of LASER diode

Laser diodes used in variety of applications ranging from medical equipment used in surgery to consumer products like optical disk equipment, laser printers, hologram scanners, etc. Laser diodes emitting visible light are used as pointers. Those emitting visible and infrared light are used to measure the distance.

43. Define rectifier

A rectifier is an electrical device that converts alternating current to direct current. Typically this is done with a diode because they have the ability to conduct current oneway & block current from going in the other way.

44. What is a rectifier and list its types?

Rectifier is a circuit which converts a.c. to d.c. signal.

Half-wave rectifier: It is the simplest type of rectifier, which is made with just one diode.

Full-wave rectifier: This rectifier is essentially made of two half-wave rectifiers, and can be made with two diodes and an earthed centre tap on the transformer. The centre tap allows the circuit to be completed because current cannot flow through the other diode.

Bridge rectifier: A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full-wave rectification.

45. Define: Ripple factor.

It is the ratio of a.c voltage to d.c voltage or a.c. current to d.c. current

46. Define filter and its need. (NOV/DEC 2009)

A filter is a component that is used to reduce the ripple voltage. Generally the componentused is a capacitor.

47. How does the avalanche breakdown voltage vary with temperature?

In lightly doped diode an increase in temperature increases the probability of collision of electrons and thus increases the depletion width. Thus the electrons and holes needs ahigh voltage to cross the junction. Thus the avalanche voltage is increased with increased temperature.

48. How does the Zener breakdown voltage vary with temperature?

In heavily doped diodes, an increase in temperature increases the energies of valence electrons, and hence makes it easier for these electrons to escape from covalent bonds. Thus less voltage is sufficient to knock or pull these electrons from their position in the crystal and convert them in to conduction electrons. Thus Zener break down voltage decreases with temperature.

49. Mention the types of junction capacitance.

- Depletion layer capacitance or transition capacitance
- Diffusion capacitance

50. What is the total current at the junction of PN junction diode?

The total in the junction is due to the hole current entering the n material and theelectron current entering the p material. Total current is given by

$$I = I_{pn}(0) + I_{np}(0)$$

I – Total current

$I_{pn}(0)$ - hole current entering the n material

$I_{np}(0)$ - electron current entering the p material.

PART-B

1 **i)** With necessary diagrams, explain the forward and reverse characteristics of PN junction diode. **(Nov 2015)(May 2016) (May 2019) (Nov 2019) (Nov 2020)**

ii) Draw the circuit diagram of a half wave rectifier for producing a positive output voltage. Explain the circuit operation and sketch the waveforms. **(Nov 2015) (Nov 2019)**

2 **(i)** Discuss about drift and diffusion current of PN diode. **(May 2013)**

(ii) The reverse saturation current of a silicon PN diode is 10μA. Calculate the diode current for the forward bias voltage of 0.6V at 25^0C. **(May 2013)**

3 Explain the working of center tapped full wave rectifier (with and without filter) with neat diagrams and derive the necessary equations. **(May 2015)(Nov 2013)(May 2018)**

4 Discuss in detail about Zener shunt regulator. **(May 2015)(May 2013)(May 2017) (Nov 2018) (Nov 2020)**

5 Draw the circuit diagram of half wave rectifier and explain its operation with necessary waveform. Also derive the necessary equations. **(May 2012)(DEC 2016)**

6 With neat diagram, explain the operation of Zener diode and its forward and reverse characteristics. Also distinguish between Avalanche and Zener breakdowns. **(Nov 2015,2013,May 2016)**

7 Derive the expression for diffusion and transient capacitance of PN junction diode. **(Dec 2016)(May 2016)(May 2017) (Nov 2019)**

8 Compare half wave and full wave rectifier.
An a.c. supply of 230V is applied to a half-wave rectifier circuit through transformer of turns ration 5:1. Assume the diode is an ideal one. The load resistance is 300Ω.Find (a) dc output voltage (b) PIV (c) maximum and average values of power delivered to the load.

9 Draw the circuit diagram and explain the working of full wave bridge rectifier with output filter and derive the expression of average output current, efficiency and ripple factor.
Discuss its advantages over center tap full wave rectifier.**(May 2017)(Nov 2017) (Nov 2018) (Nov 2020)**

10 There is an application which needs the output voltage to be regulated. Choose an appropriate diode
/device, that would ensure this operation with appropriate circuit, describe how it regulates voltage. Consider a specific example, design the circuit with appropriate values of components involved . State the important constraints that need to be considered. (Nov 2017)

11 Brief about the breakdown Mechanisms in PN diodes (April/May 2019)

12 Explain the input and output characteristics of a CE transistor configuration. List out the comparisons between CE, CB and CC configurations.(Nov 2013) (Nov 2019) (Nov 2020)

13 Draw the basic construction and equivalent circuit of a UJT. Briefly explain the device operation. (May 2015)(Nov 2015)(May 2016) (Nov 2018)(Nov 2019)(Apr 2021)

14 Explain the construction and operation of NPN transistor with neat sketch. Also comment on the characteristics of NPN transistor.(Nov 2014)

15 For an n-channel Silicon JFET with a= 3*10-4 cm and Nd= 1015 electrons/cm-3. Find (a) Pinch-off
voltage and (b)channel half width for Vgs=0.5 Vp.(May 2016) (ii)Elaborately discuss the drain and transfer characteristics of depletion and enhancement MOSFET. (May 2016)(May 2018)

16 Brief about the operation of a N channel depletion type MOSFET with a neat diagram. (May 2019)

17 Explain how a potential barrier is developed at the PN junction (Dec/Jan 2016)

18 Describe the construction of PN junction diode. Explain the forward and reverse characteristic of PN junction diode and obtain its VI characteristic curve. Nov/Dec 2016)(April/May 2018)

19 With a neat circuit diagram explain the operation of Zener Voltage regulator. (June 2009)

UNIT –II AMPLIFIERS
PART-A

1 **Write the procedure to draw the a.c. equivalent of a network**.

- Setting all the dc sources to zero and replacing them by a short circuit equivalent.
- Replacing all capacitors by a short circuit.
- Removing all elements bypassed by the short circuit equivalents introduced by step 1&step 2.
- Redraw the n/w in a more convenient & logical form.

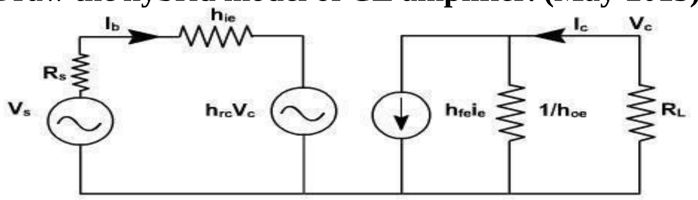
2 **Write short note on effects of coupling capacitor**.
Coupling capacitors are in series with the signal and are part of a high-pass filter network. They affect the low-frequency response of the amplifier. The coupling capacitor transmits a.c. signal but blocks d.c. This prevents d.c. interference between various stages and the shifting of operating point.

3 **What are amplifiers? Write its uses. (May 2015)**
An electronic device that is used to increase the magnitude of an electrical signal. Such a device used for the amplification of audio frequency signals in a radio. The amount of amplification provided by an amplifier is measured by its gain

4 **What are the high frequency effects?**

- The gain decreases at high frequencies due to internal feedback capacitance's. The highest frequency of operation of BJT will be limited by internal capacitance's of BJT.
- The on and off switching times of BJT will be high and speed will be limited due to internal charge storage effects.

5 **Draw the hybrid model of CE amplifier. (May 2015)**



h_{ie} = Input resistance with output shorted

h_{re}= Reverse voltage gain with input open
h_{fe} = Forward current gain with output shorted
h_{oe} = Output conductance with input open

6 **Write the hybrid equations of CE amplifier.**
In common emitter transistor configuration, the input signal is applied between the base and emitter terminals of the transistor and output appears between the collector and emitter terminals. The input voltage (V_b) and the output current(i_c) are given by the following equations

h_i = Input resistance, h_r = Reverse voltage gain
h_f = Forward current gain, h_o = Output conductance

$$V_b = h_{ie} i_b + h_{re} V_c$$

$$I_c = h_{fe} i_b + h_{oe} V_c$$

7 **What is meant by hybrid parameters?(May 2011)(Nov 2014) (Nov 2018)**
Hybrid parameters are also known as h parameters. They use Z parameters, Y parameters, voltage ratio, and current ratios to represent the relationship between voltage and current in a two port network.
H parameters are useful in describing the input-output characteristics of circuits where it is hard to measure Z or Y parameters (such as a transistor). H parameters encapsulate all the important linear characteristics of the circuit, so they are very useful for simulation purposes. The relationship between voltages and current in h parameters can be represented as:

$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$

8. **What is meant by hybrid parameters?(May 2011)(Nov 2014) (Nov 2018)**
Hybrid parameters are also known as h parameters. They use Z parameters, Y parameters, voltage ratio, and current ratios to represent the relationship between voltage and current in a two port network.
H parameters are useful in describing the input-output characteristics of circuits where it is hard to measure Z or Y parameters (such as a transistor). H parameters encapsulate all the important linear characteristics of the circuit, so they are very useful for simulation purposes. The relationship between voltages and current in h parameters can be represented as:

$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$

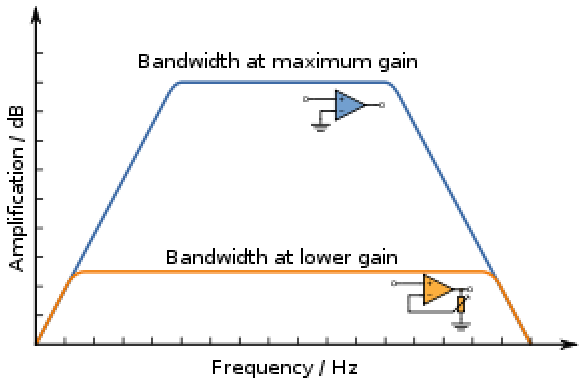
9. **Give the condition for approximate analysis of small signal model.**
The small signal model is dependent on the DC bias currents and voltages in the circuit (the Q point). Any nonlinear component whose characteristics are given by a continuous, single-valued, smooth (differentiable) curve can be approximated by a linear small-signal model.

10. **A common emitter amplifier has an input resistance 2.5K and voltage gain of 200. If the input signal voltage is 5mV. Find the base current of the amplifier. (May 2017,May 2019)**
$Vs = I_b \times Rs$
$I_b = Vs / Rs$
$= 5 \times 10^{-3} / 2.5 \times 10^{3}$
$I_b = 2\mu A$

11. **What are 3 dB frequencies?**
3dB is equivalent to 0.707 times the peak value, also known as the half power point which would be half of the squared voltage or the voltage divided by the square root of 2 (1/sqrt(2)) or 0.707).The frequency at which we have 70.7% of fall from the maximum gain is called 3db frequency.

12 **What is meant by gain bandwidth product?**

The gain–bandwidth product (designated as GBWP, GBW, GBP, or GB) for an amplifier is theproduct of the amplifier's bandwidth and the gain at which the bandwidth is measured

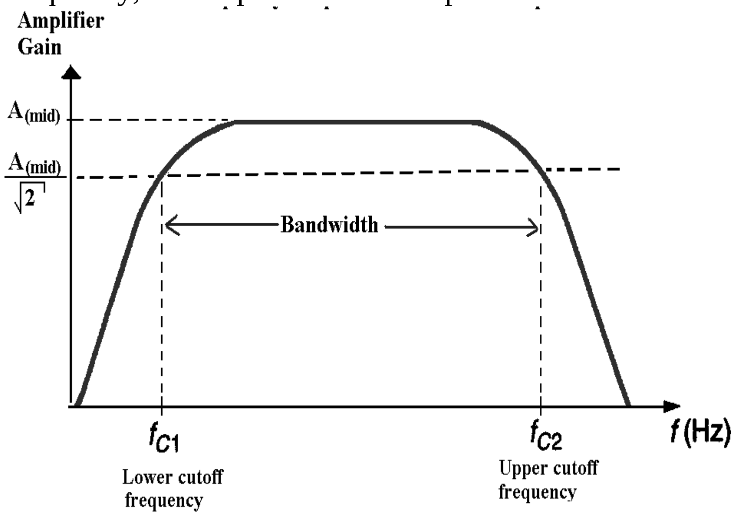


13 **Give the significance of coupling and bypass capacitor on BW of amplifiers. (Nov 2015) (May 2019)(Nov 2019)**

The coupling capacitance has very high reactance at low frequency, therefore it will allow only a small part of signal from one stage and in addition to that the bypass capacitor cannot bypass the emitter resistor effectively. As a result of these factors the voltage gain rolls off at low frequency. At high frequency the reactance of coupling capacitor is very low, therefore it behaves like a short circuit. As a result of this the loading effect of the next stage increases which reduces the voltage gain. Hencethe voltage gain rolls off at high frequency

14 **Define frequency response. Draw its curve of an amplifier.**

Frequency response, of any circuit, represents the behavior of the circuit when different frequencies are fed to it. It is a measure of magnitude and phase of the output as a function of frequency, in comparison to the input.



15 **List out the application and characteristics of CE amplifier.**

- It is used as voltage amplifier, among the three basic transistor amplifiers.
- Characteristics of CE amplifier:
- It has good voltage gain with phase inversions. i.e. the output voltage is 180°out of phasewith input
- It also has good current, power gain and relatively high input and output impedance

16 **In an amplifier the maximum voltage gain is 2000, occurs at 2 KHz. It falls to 1414 at 10Hz and 50Hz.Find i) B.W ii) Lower and upper cut off frequency.**

i) $BW = 50\ Hz - 10\ Hz = 40\ Hz$

ii) $F1 = 10\ Hz$ & $F_2 = 50\ Hz$

17 **Define bandwidth.**

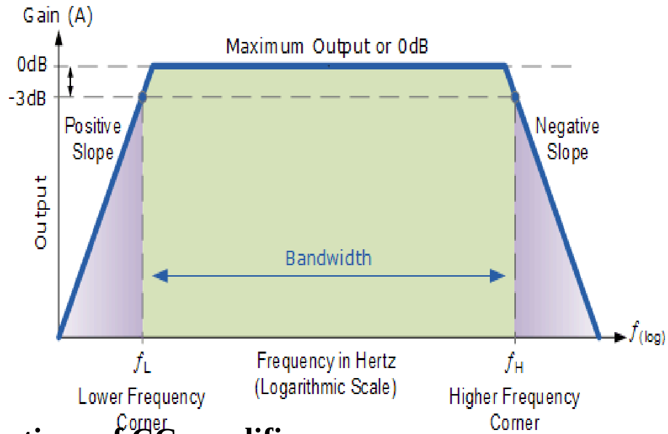
Bandwidth is the difference between the upper and lower frequencies in a continuous band of frequencies. It is typically measured in hertz

f_1=lower cutoff frequency, f_2=upper cutoff frequency.

$BW = f_2 - f_1$

18 **Define upper and lower cut off frequencies of an amplifier.**

The gain is constant over a frequency range. The frequencies at which the gain reduces to 70.7% of the maximum gain are known as upper cut off and lower cut off frequency



19 **Mention some applications of CC amplifier.**

- This amplifier is used as impedance matching circuit.
- It is used as a switching circuit.
- The high current gain combined with near unity voltage gain makes this circuit a great voltage buffer
- It is also used for circuit isolation

20 **State Millers theorem. (Dec 2016) (Nov 2019)**

Millers theorem states that the capacitor connected between the input and output can be split in to two networks such that one network appears as the mirror image of the other one.The impedance of such network can be taken by open circuiting or short circuiting the common connections exist between the twonetworks.

21 **State the reason for choosing 3 db point to determine the bandwidth.**

The reason for choosing 3 db point to determine the bandwidth is that, above this level, larger the frequency variation (i.e. output delivers the constant output below this level even for lower frequency variation), the gain variation is large i.e. the output is not constant. Thus 3 db point is selected as reference to find the bandwidth.

22 **What are 3 dB frequencies?**

- 3dB is equivalent to 0.707 times the peak value, also known as the half power point which would be half of the squared voltage or the voltage divided by the square root of 2 (1/sqrt(2)) or 0.707.)
- The frequency at which we have 70.7% of fall from the maximum gain is called 3db frequency.

23 **Draw the hybrid-π model of CE configuration. (Nov 2020)**

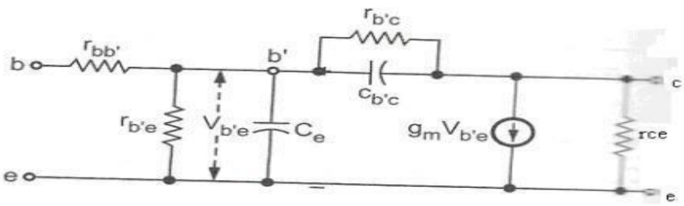


Fig. Hybrid - ∏ model for a transistor in CE configuration

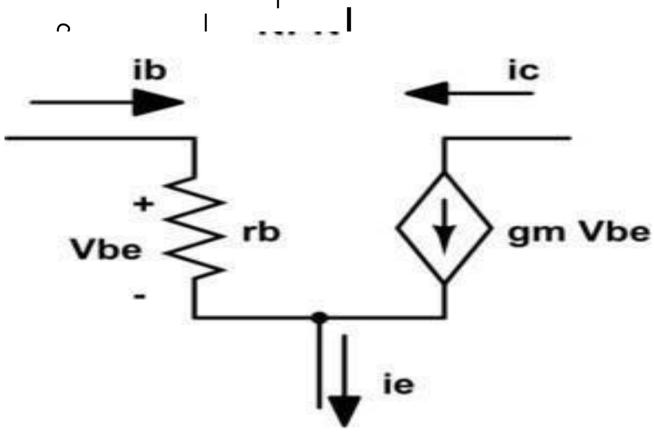
24 **Mention the condition for proper amplification of a signal. (Nov 2020)**

- Proper zero signal collector current.
- Minimum proper base-emitter voltage (VBE) at any instant.
- Minimum proper collector-emitter voltage (VCE) at any instant

25 **What is source follower? (May 2018)**

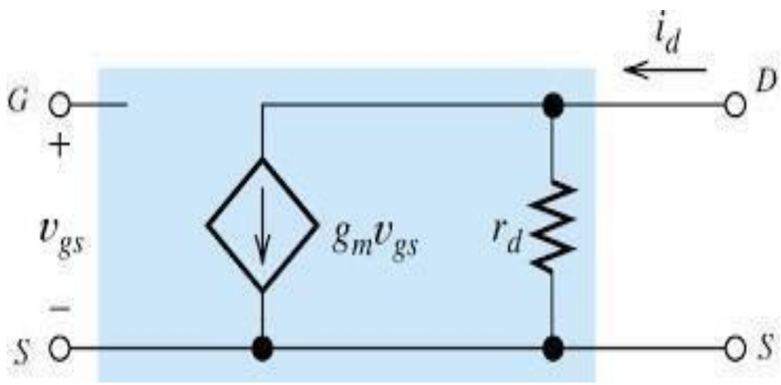
In electronics, a common-drain amplifier, also known as a source follower, is one of three basic single-stage field effect transistor (FET) amplifier topologies, typically used as a voltage buffer. In this the gate terminal of the transistor serves as the input, the source is the output, and the drain is common to both (input and output)

26 **Draw the small signal model of BJT (May 2016).**



27 **Draw the small signal equivalent circuit of a CSJFET. (Nov 2015)**

The relation of I_D by V_{GS}, is included as a current source g_mV_{GS}, connected from drain to source. The input impedance is represented by the open circuit at its input terminals, since gate current I_G is zero. The output impedance is represented by r_d from drain to source.



28 **Differentiate between power transistor and signal transistor. (May 2016)**

Power transistor	Signal transistor
Power transistor can conduct large amount of currents	Signal transistor can conduct small amount of currents
It has a vertical structure	It has a horizontal structure
Quasi saturation region is present	Quasi saturation region is Absent
There is a inclusion of drift layer	There is no drift layer

29 **What is thermal runaway?(Nov 2017) (Nov 2019)**

The reverse saturation current in a semiconductor doubles for every 100 C rise in temperature. As temperature increases the leakage current increases and the collector current also increases. The increase in collector produces an increase in power dissipation at the collector - base junction. This in turn further increase the temperature of the collector-base junction causing the collector current to further increase. This process may become cumulative and it is possible for the transistor to burn out. This process is known as Thermal runaway. It can be avoided using a stabilization or heat sink with the transistor.

30 **Which configuration is known as emitter follower and why it is named so?**

CC configuration is known as emitter follower, whatever may be the signal applied at the input, may produce same signal at the output. In other words, the gain of the circuit is unity. So that the common collector circuit is named as emitter follower.(Output follows the input)

PART-B

1 In a transistor amplifier using voltage divider bias, the operating point is chosen such that Ic = 2mA, Vce = 3V. If Rc =2.2k, Vcc = 9V and β = 50.Find the values of bias resistors and Re. Assume Vbe = 0.3V and current through the bias resistors is $10I_b$. **(Nov 2017)**

2 Enumerate the selection of Q point for transistor bias circuit and discuss the limitations on the output voltage swing. **(Nov 2019)**

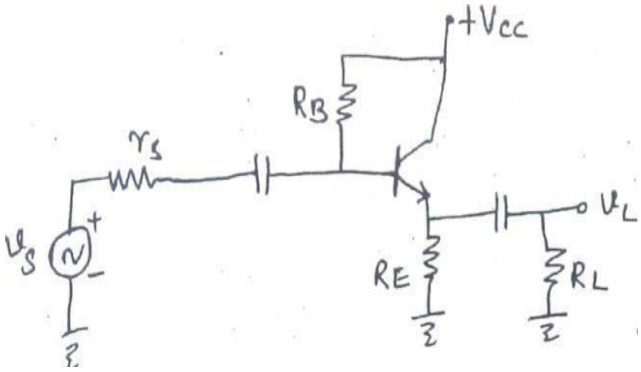
3 With a neat diagram explain any two biasing techniques used for biasing a transistor.**(Nov 2020**

4 Explain about CE amplifier and derive the expression for h parameters of the same. Also derive the expression for gain, input impedance and output impedance of CE amplifier. **(Nov 2013,Nov 2014,May 2015,Dec 2016,May 2018,May 2019,Nov 2020)**

5 The hybrid parameters of a transistor used as an amplifier in the CE configuration are h_{ie} = 800Ω, h_{fe}= 46, h_{oe} = 80 x 10^{-6} and h_{re}= 5.4x 10^{-4}. If R_L = 5K and R_s = 500Ω. Calculate Ai, Ri, Av, Pi

6 **(i)** Discuss the factors involved in the selection of I_C, R_C and R_E for a single stage common emitter BJT amplifier circuit, using voltage divider bias**. (Nov 2015)**

(ii) A CC amplifier shown in the below figure has V_{CC} = 15V, R_B = 75KΩ and R_E = 910Ω, β of the silicon transistor is 100 and the load resistor is 600Ω Find r_{in} and A_v. **(Nov 2015)**



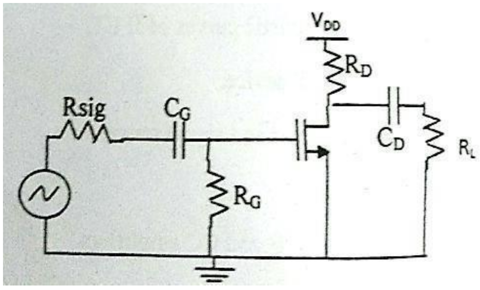
7 Explain about CB amplifier and derive the expression for h parameters of the same. Also derive the expression for gain, input impedance and output impedance of CB amplifier. **(Nov 2013,May 2016)**

8 Explain about CC amplifier and derive the expression for h parameters of the same. Also derive the expression for gain, input impedance and output impedance of CC amplifier.**(Nov 2019)**

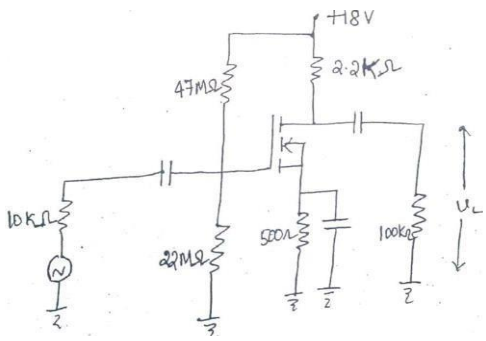
9 Explain about Common Drain MOSFET amplifier and derive the expression for gain, input impedance and output Impedance.**(DEC 2016,May 2017)**

10 i)Explain about the high frequency response of common source FET amplifier and derive the expression for lower cut off frequency and upper cut off frequency.**(Nov 2017,May 2019)**
ii)Compare the characteristics of CB, CE and CC amplifiers.

11 Determine the mid-band gain, upper cutoff frequency of a common source amplifier fed with the signal having internal resistance R_{sig} = 100 KΩ.The amplifier has R_g = 4.7 MΩ,g_m = 1 mA/V.R_D =R_L = 15 KΩ ,r_o= 150KΩ, C_{gs}= 1 pf and C_{gd} = 0.4 pf.(May 2016) (Nov 2020)

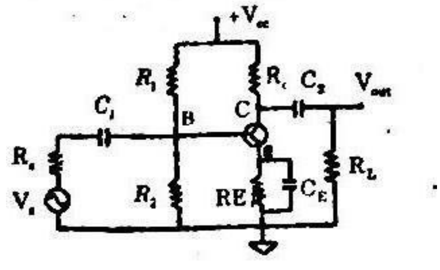


12 The MOSFET shown in the below figure has the following parameters. V_T = 2V, $\beta = 0.5\times10^3$, r_d = 75KΩ and it is biased at I_D = 1.93mA. Determine the input impedance and voltage gain. **(Nov 2015)**

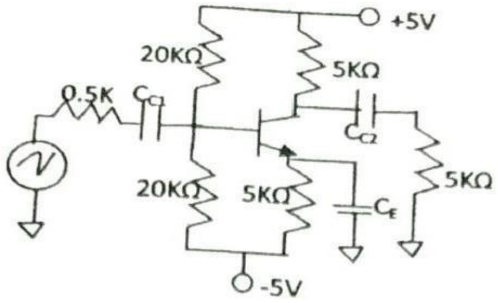


13 A common base transistor amplifier is driven by a voltage source V_S and internal resistance R_S = 1200Ω. The load impedance is a resistor R_L of 1000Ω. The 'h' parameters are given below: h_{ib} = 220Ω, h_{rb}= 3 x 10^{-4}, h_{fb}= -0.98, h_{ob} = 0.5 µA / V. Compute current gain, input impedance, voltage gain, output impedance and power gain. **(Nov 2012,Nov 2019)**

14 Evaluate the A_i ,A_v ,R_i,R_o ,A_{is},A_{vs} of a single stage CE amplifier with R_s=1 KΩ, R_1=22 KΩ, R_2 =10 KΩ, R_c=2 KΩ, R_L =2 KΩ,h_{fe}=150, h_{ie}=1.1 KΩ, h_{re}=2.5*10^(-4), h_{oe}=25 µA/V **(Nov 2016)**



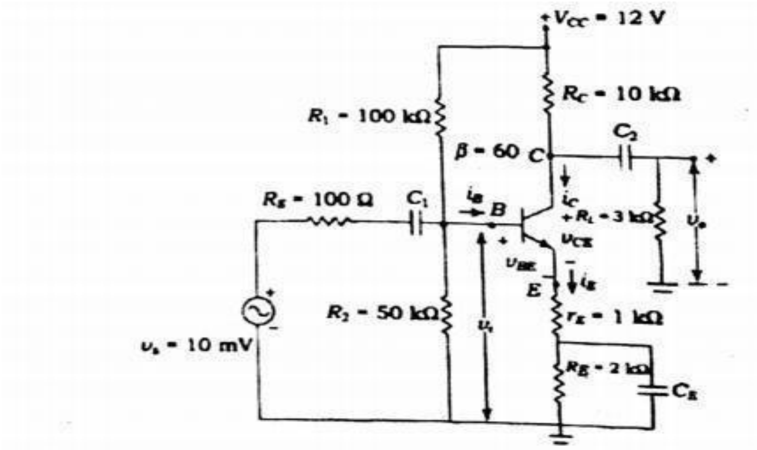
15 Determine the mid-band gain and bandwidth of a CE amplifier .Assume the lower cut-off frequency is 100 Hz. Let $h_{fe}=\beta=100, C_{be}=4$ pf, $C_{bc} = 0.2$ pf and $V_A=\infty$.**(May 2016)**



16 Explain the working of a common emitter amplifier**. (Nov 2017)**

17 Explain the mid-band analysis of single stage CE, CB and CC amplifiers**(May 2018)**

18 Explain the working of a n-channel depletion MOSFET. Discuss its transfer characteristics. **(Nov 2018)**



UNIT III – MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIERS

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – MOSFET input stages – tuned amplifiers – Gain and frequency response – Neutralization methods.

PART A

1 **What are the features of BiMOS cascode amplifier? (Apr 2017 , Dec 2019)**
BiCMOS is an evolved semiconductor technology that integrates two formerly separate semiconductor technologies, those of the bipolar junction transistor and the CMOS transistor, in a single integrated circuit device. It has following main features. (i) They provide infinite input impedance (ii) They provide large voltage gain due to larger trans conductance.

2 **What are the features of bipolar cascode configuration?**
The cascode is a two-stage amplifier that consists of a common-emitter stage feeding into a common-base stage. Compared to a single amplifier stage, this combination has the following main features higher input–output isolation, higher input impedance, high output impedance, and higher bandwidth.

3. **What are the applications of differential amplifier? (Nov 2011)**
1. In the medial electronics field
2. As a input stage in the measuring instruments
3. In analog computation
4. In linear integrated circuits.

4 **What is a differential amplifier? What are its advantages?**

It is an amplifier that has two inputs and produces an output signal that is a function of the difference between the two inputs.

Adavantages: It can compare any two signals and detect any difference.

It gives higher gain than two cascaded stages of ordinary direct coupling.It provides very uniform amplification of signal from dc up to very high frequencies.

5. **Define CMRR. What is its ideal value?What are the ways to improve it?(May 2016)(May 2017) (Nov 2020)**

The common mode rejection ratio (CMRR) is defined as the ratio of the differential voltage gain (A_d) to the common mode voltage gain (A_{cm}).Its ideal value is infinity. A typical CMRR is 80-100dB at low frequency.

$$\textbf{CMRR} = A_d/A_c$$

CMRR can be improved by using

(i) constant current bias circuit (ii) Current Mirror circuit

6 **Explain the need for constant current source for difference amplifier.**

The necessity for constant current source for differential amplifier is to increase the common mode rejection ratio without changing the quiescent current (operating point) and without lowering the forward current gain

7 **What is the input impedance of a differential amplifier with R_E at its emitter junction? (May 2019)**

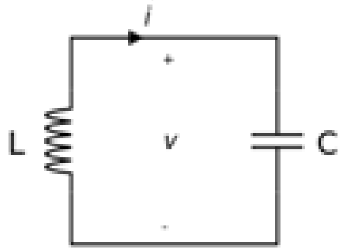
The input impedance of a differential amplifier with R_E at its emitter junction is:

$$R_i = 2h_{ie} + (1 + h_{fe})R_E$$

Where, h_{ie} is the input impedance and h_{fe} is the forward current gain.

8 **Draw the ideal tuned circuit and write the expression for its resonant frequency. (May 2015)**

Where,L=inductance in Henrys and C=capacitance in Farads



$$f = \frac{1}{2\pi\sqrt{LC}}$$

9 **Explain why constant current source biasing is preferred for differential amplifier.**

Besides supplying constant emitter current, the constant current bias also provides a very high source resistance since the ac equivalent or the dc source is ideally an open circuit. The constant current source biasing is preferred for differential amplifier in order to increase the input resistance and to make the common mode gain zero.

10 **Explain how the differential amplifier can be used as an emitter coupled phase inverter**.

A differential amplifier may be used as an emitter coupled phase inverter. In this case, the signal is applied at one base only leaving the second base unexcited but with proper bias. The output voltage is then picked up from the collectors. These two voltages are equal in magnitude and opposite in phase, thus the differential amplifier acts as a phase inverter or phase amplifier.

11 **What are the different types of neutralization?**

1. Hazeltine neutralization
2. Rice neutralization
3. Neutrodyne neutralization

12 **What is the need for neutralization? (Nov 2015, Apr 2020)**

The effect of collector to base capacitance of the transistor is neutralized by introducing a signal that cancels the signal coupled through collector base capacitance. This process is called neutralization.

13 **What is a single tuned amplifier?**

An amplifier circuit that uses a single parallel tuned circuit as a load is called single tuned amplifier. The values of capacitances and inductances are selected such that its resonant frequency is equal to the frequency to be amplified

14 **What is the current gain for a darlington pair?**

The current gain for a darlington pair is given by,

$$A_i = \frac{(1 + h_{fe})^2}{(1 + h_{oe} h_{fe} R_e)}$$

Where hfe - forward current gain for common emitter amplifier.

hfc - forward current gain for common collector amplifier.

hoe - output resistance for common emitter amplifier.

15 **What are the advantages & disadvantages of tuned amplifiers?**

Advantages:

(i) They amplify defined frequencies.
(ii) Signal to noise ratio at output is good.
(iii) They are suited for radio transmitters and receivers.

Disadvantages:

(i) The circuit is bulky and costly.
(ii) The circuit design is complex.

They are not suited to amplify audio frequencies

16 **What is a stagger tuned amplifier?**

It is a circuit in which two single tuned cascaded amplifiers having certain bandwidth are taken and their resonant frequencies are adjusted such that they are separated by an amount equal to the bandwidth of each stage. Since resonant frequencies are displaced it is called stagger tuned amplifier.

Advantages: The advantage of stagger tuned amplifier is to have better flat, wideband characteristics.

17 **The CMRR of an amplifier is 100 dB. Calculate common mode gain if the differential gain is 1000.(Dec 2016)**

$$CMRR = 20\log\left(\frac{A_d}{A_c}\right); 100 = 20\log\left(\frac{1000}{A_c}\right); 5 = log\frac{1000}{AC}; 10^5 = \frac{1000}{AC}; A_c = 0.01$$

18 **What is a single tuned amplifier?**

An amplifier circuit that uses a single parallel tuned circuit as a load is called single tuned amplifier. The values of capacitances and inductances are selected such that its resonant frequency is equal to the frequency to be amplified.

19 **A tuned circuit has a resonant frequency of 1600Khz and a bandwidth of 10 Khz. What is the value of its Q factor? (May 2017,May 2019,Nov 2019)**

Q = fr / B.W

= 1600 Khz / 10 Khz = 160.

20 **Compare the characteristics of CE,CB and CC amplifier.(May 2016)**

Parameters	**CE**	**CB**	**CC**
Input resistance	Moderate	Low	High
Output resistance	High	High	Low
Voltage gain	High	High	About 1
Current gain	High	Low	High
Power gain	High	Moderate	Low
Phase shift	180 degrees	0 degree	0 degree

21 **A multistage amplifier employs five stages each of which has a power gain of 30db. What is the total gain of the amplifier in db?(Nov2017)**

$Gv = 20\log(5x30) = 20\log150 = 43.52db$

UNIT-III
PART-B

1 Explain the operation of BIMOS cascode amplifier with a neat diagram.(**Nov 2015)**

2 With neat circuit, explain and derive the gain and bandwidth of a single tuned amplifier. **(Nov 2015)**

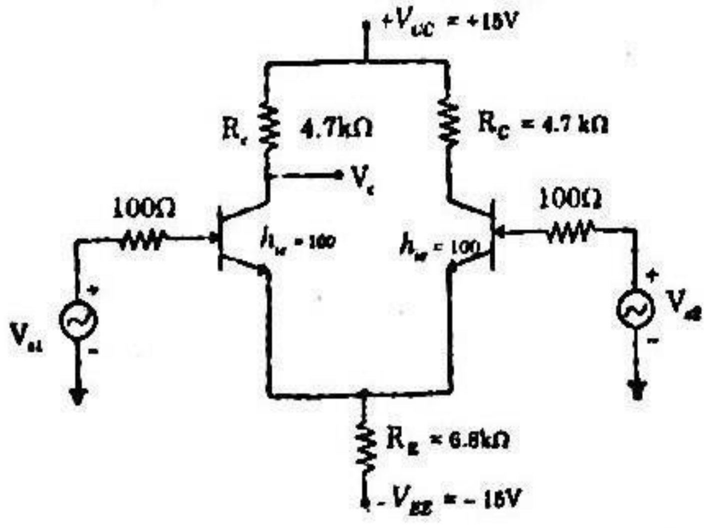
3 Explain with a neat sketch the working of single tuned voltage amplifier using FET.**(May 2019) (Nov 2020)**

4 Derive the frequency response of single tuned voltage amplifier and also give its limitations. **(May 2016)**

5 Explain the different types of neutralization technique used in tuning amplifier **(May 2015)(Dec 2016)(May 2016)(May 2018)**

6 Discuss the effects of cascading of amplifiers.
Differential amplifier has the following values $R_C = 50$ K, $R_e = 100$K and $R_s = 10$K. The transistor parameters are $r_{in} = h_{ie} = 50$K, $h_{fe} = V_o = 2 \times 10^3$, $r_o = 400$K. Determine A_d, A_c and CMRR in dB.

7 Draw the circuit diagram of an emitter coupled BJT differential amplifier and derive expressions for differential gain, common mode gain, CMRR, input impedance and output impedance. How CMRR can be improved.**(Nov 2017)(May 2018) (Nov 2018) (Nov 2019)**



UNIT IV - FEEDBACK AMPLIFIERS AND OSCILLATORS

Advantages of negative feedback – Voltage / Current , Series , Shunt feedback Amplifiers – positive feedback – Condition for oscillations , phase shift – Wein bridge , Hartley , Colpitts and Crystal oscillators.

UNIT-IV / PART-A

1 **Define positive and negative feedback?**

Positive feedback: If the feedback voltage (or current) is so applied as to increase the input voltage (i.e. it is in phase with it), then it is called positive feedback.

Negative feedback: If the feedback voltage (or current) is so applied as to reduce the input voltage (i.e. it is 180°out of phase with it), then it is called negative feedback.

2 **Discuss the advantages of negative feedback in amplifiers or What is the need for negative feedback in amplifiers? (Dec 2019) (April 2021)**

Negative feedback in an amplifier provides higher fidelity and stabilized gain, increased bandwidth, less distortion, reduces noise and input & output impedances can be modified as desired.

3 **List four basic types of feedback?**

(1) Voltage series feedback (2) Voltage shunt feedback
(3) Current series feedback and (4) Current shunt feedback.

4 **Negative feedback is preferred to other methods of modifying Amplifier characteristics. Why? (Dec 2018)**

Negative feedback is preferred to other methods of modifying Amplifier characteristics because it has the following advantages of reduction in distortion, stability in gain, increased bandwidth etc.

5 **State the condition in (1+Aβ) which a feedback amplifier must satisfy in order to be stable.**

The two important and necessary conditions are (1) The feedback must be positive, (2) Feedback factor must be unity i.e. $A\beta = 1$

6 **What is meant by phase and gain margin? (May 2019)**

Phase Margin: It is defined as 180^0 minus the magnitude of the Aβat the frequency at which Aβ is unity. If the phase margin is negative the system is stable otherwise unstable.

Gain Margin: It is defined as the value of (Aβ) in decibels at the frequency at which the phase angle of Aβ is 180^0. If the gain margin is negative the system is stable, otherwise the system is unstable.

7 **The open loop gain of an amplifier is 100.What will be the overall gain when the negative feedback of 0.5 is applied to the amplifier?**

The overall gain is $A_f = \frac{A}{1+A\beta} = \frac{100}{1+(100\times 0.01)} = 50$

8 **List the five characteristics of an amplifier which are modified by negative feedback. (Dec-13 & May 2015)**

(1) Increased stability, (2) Reduction in non-linear distortion, (3) Increased bandwidth, (4) Desensitivity of transfer Amplification & (5) Sensitivity of transfer gain.

9 **State the three fundamental assumptions which are made in order that the expression $A_f = A/(1+A\beta)$ be satisfied exactly?**

(1) The input signal should be transmitted to the output through the internal amplifier A and not through the feedback network. Thus, if A is set to zero by reducing h_{fe} or g_m of the transistor to zero, the output must drop to zero.

(2) The feedback signal travels from the output to the input through the β network and not through the amplifier.

(3) The reverse transmission factor β of the feedback network is independent of the load and the source resistance R_L and Rs.

10 **State Nyquist's stability criteria for feedback amplifiers.**

Nyquist's stability criterion states that in a complex S plane if Aβ +1 represents a circle of unit radius with its centre at the point –1+ j0 and if Aβ lies within the circle then 1+ Aβ < 1, feedback is positive. Even with this positive feedback the system will not oscillate unless Nyquist criterion is satisfied.

11 **What are the basic mathematical conditions for sustained oscillation in an oscillator? (or) What is Barkhausen criterion? (or) State the criterion for oscillation. (May-15, May 17, Nov 2017, Dec 2018, Dec 2019, April 2021)**

For getting sustained oscillations, the following two conditions should be satisfied. (i) The loop gain should be unity. When the loop gain is greater than unity, the amplitude of output sine wave goes on increasing exponentially. (ii) The loop phase shift should be 0° or 360°. This criterion is known as Barkhausen's criterion for oscillation.

12 **Classify the different sinusoidal oscillators.**

A number of circuits have been used as sine wave oscillator like (i) RC oscillator, (ii) LC oscillator, (iii) Negative resistance oscillator and (iv) Crystal oscillator.

13 **What are the factors needed to choose type of oscillators?**

The factors needed to choose type of oscillators are (i) The nature of generated wave form, (ii) The frequency of generated signals, (iii) The type of associated circuit of components and (iv)The fundamental mechanism involved.

14 **What is a resonant circuit oscillator?**

The Oscillators using resonant LC tank circuits are most often used for sources of radio frequency (RF) energy are called as resonant circuit oscillator.

15 **Give the condition of oscillation for Hartley oscillator.**

The condition of oscillation for Hartley oscillator is

$$h_{fe} = \frac{X_1}{X} = \frac{L_1 + M}{L + M}$$

16 **Name two low frequency oscillators. (Nov 2017)**

(i) RC phase shift oscillator, (ii) Wein bridge oscillator

17 **Name two high frequency oscillators. (Nov 2017)**

(i) Hartley oscillator, (ii) Colpitts oscillator.

18 **In a Hartley oscillator, if L1=0.2mH, L2=0.3mH and C=0.003µF. Calculate the frequency of oscillation. (May 2017)**

The total inductance L=L1+L2=0.5mH. Frequency of oscillation can be calculated using the formula

$f_r = \frac{1}{2\pi \sqrt{LC}}$. Therefore $f_r = \frac{1}{2\pi \sqrt{0.5\times10^{-3} \times 0.003\times10^{-6}}} = 130\text{kHz}$

19 **The quartz crystal has Cm=1pF, Ls=3H Cs=0.05pF and Rs=1k.Calculate the series and parallel resonant frequencies. (Dec 2015)**

Ceq = Cm Cs/ Cm +Cs = 0.0476F

$f_s = 1 / 2\pi \sqrt{Ls\,Ceq}$ =0.06 Hz

$f_p = 1 / 2\pi \sqrt{Ls\,Cm}$ = 0.02754 µf

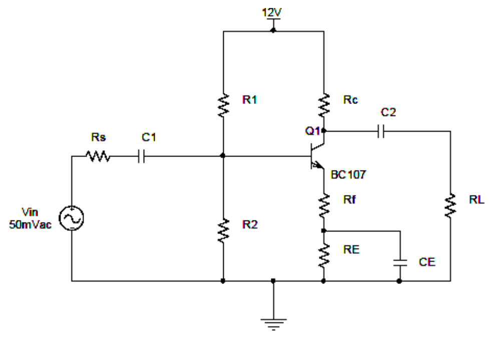
20 **In a negative feedback amplifier, A=100, β=0.04, and Vs=50mV, find a) Gain with feedback, (b) Output Voltage, (c) Feedback factor (Dec13, May 16)**

(a) Gain with feedback $A_f = A/(1+A\beta) = 100/(1+100x0.04) = 20$

(b) Output Voltage $V_o = A_f \times V_s = 20x50x10^{-3} = 1000mV$.

(c) Feedback factor $(\beta) = 0.04$

21 **Draw a single stage amplifier with current series feedback. (June-14)**



22 **Define Voltage Amplifier.**

Voltage Series feedback amplifier is called as voltage amplifier since the sampling at the output side is voltage and both the parameters in the gain are in voltage.

23 **What is the other name for current series and current shunt feedback amplifier?**

Current Series Amplifier is called as Transconductance amplifier and current shunt feedback amplifier is called as Current Amplifier.

24 **Define 'feedback factor' of a feedback amplifier. (June-12)**

Feedback factor is the fraction of the amplifier output signal which is fed back to the amplifier input. It is denoted by β.

25 **State the effect on current shunt feedback on input and output resistance of the amplifier. (June-12)**

The output resistance is increased, and the input resistance is decreased.

26 **The voltage gain without negative feedback is 40 dB. What is the new voltage gain if 3% negative feedback is introduced? (May 2015, Nov 2017)**

$\beta = 3\% = 3/100 = 0.03$; $Av = 40$; $A_{vf} = A_v / 1 + \beta A_v = 40 / 1 + 0.03(40) = 18.18$

27 **List the effects of negative feedback on the noise and bandwidth of an amplifier (or) What will happen for noise, if we introduce negative feedback at amplifier. (May 16/ Nov 16, May 17)**

Reduction in noise $N_f = N/1+A\beta$ Increase in bandwidth $(B.W)_f = B.W(1+A\beta) = B.W \times D$

28 **A Negative feedback amplifier has a bandwidth of 250kHz and de-sensitivity factor of 4. What is the bandwidth of the basic amplifier without feedback? (Dec 15)**

$D = 4$; $(B.W)_f = 250$ kHz

$(B.W)_f = B.W(1+A\beta) = B.W X D$; $B.W = (B.W)_f / D = 250 X 10^3 /4 = 62.5$ kHz

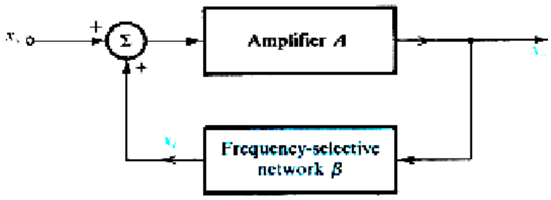
29 **An amplifier has an open loop gain of 1000 and feedback ratio of 0.04.If the loop gain changes by 10% due to temperature, find the % change in gain of the amplifier with the feedback. (Nov 16)**

$\beta = 0.04$; $A_v = 1000$; $dA/A = 10$:

$dA_{vf} / A_{vf} = (dA_v / A)(1/D)$ where $D = 1 + \beta A_v$

$= 10 (1/(1+0.04*1000)) = 0.25\%$

30 **Draw the diagram depicting the basic structure of a sinusoidal oscillator.(Dec 2018)**



31 **Write the feedback factor expression for BJT based Wein bridge oscillator.**

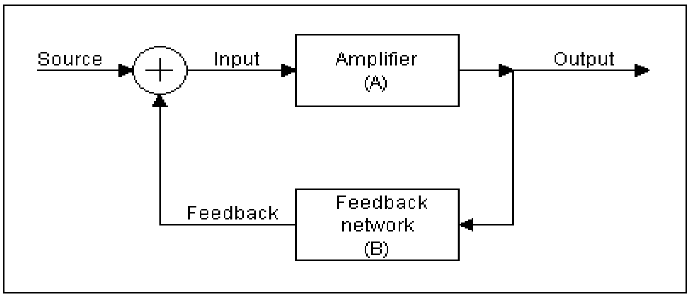
$Z_1 / (Z_1 + Z_2)$ where $Z_1 = R_1 / 1 + j\omega R_1 C_1$; $Z_1 = R_2 + 1 / j\omega C_2$

32 **Find the operating frequency of a colpitt oscillator, if C1= .001uf, C2 = .01uf, and L = 15mH.**

$$f = \frac{1}{2\pi \sqrt{LC}}$$, C= .0011f

F = 1/2π√15mH x .0011 F = 1/2 π x .00406 F = 39.18Hz

33 **Draw the general structure of feedback amplifier. (Dec 2018)**



34 **What is the need for amplitude control in oscillators? (May 19)**
The amplitude of the oscillators need to be controlled by stabilization using negative feedback. Without this stabilisation the oscillations would either die away and stop (damped oscillation) or rapidly increase in amplitude until the amplifier produces severe distortion due to the transistors within the amplifier becoming "saturated" . To produce a constant amplitude output the gain of the amplifier is automatically controlled during oscillation.

35 **How Barkhausen conditions are satisfied in Twin-T Oscillator? (Dec 2015)**
The phase shift introduced in the feedback loop of two T – Network is 0, and the gain of theamplifier is 3.

36 **Mention the advantages and disadvantages of RC phase shift oscillators. (May 2016 / Nov 2016)**
Advantage: For the generation of low frequency signals, the LC circuits become impracticable and the RC phase shift oscillators are more suitable. With the advantage of IC technology RC network is the only feasible solution. It is very difficult to make an inductance that too of very high value in an IC.
Disadvantage: The output is small and It is due to smaller feedback. The frequency stability is not as good as that of the Wien bridge oscillator. It is difficult for the circuit to start oscillations as the feedback is usually small.

37 **Negative feedback stabilizes the gain. Justify the statement. (June-14)**
The gain of the Amplifier with negative feedback is given by $A_f = A/(1+A\beta)$. When it is assumed that $A\beta >> 1$, the above equation may be written as $A_f = A/A\beta$ ie $A_f = 1/\beta$. Thus, the gain of the feedback amplifier A_f has been made independent of the internal gain A. It depends only on β which in turn depends only on the passive elements such as resistors, capacitors and inductors whose values are maintained constant. And hence the gain is stabilized.

UNIT-IV / PART-B

1 Draw the block diagram of 4 types of feedback topologies and compare them with respect to gain, input & output resistance. Give one example for each. **(Dec 14)**

2 Draw the circuit of an emitter follower. Identify the type of negative feedback. Calculate the gain, input & output resistance with & without feedback. **(Dec14)**

3 **(i)** Draw the block diagram of voltage series amplifier and derive for A_{vf}, R_{if} & R_{of}. Draw a two-stage amplifier with voltage series feedback. (10) **(May-2015, Nov 2017, May 2018)**
(ii) Derive for bandwidth with feedback BW_f (6) **(Jun14)**

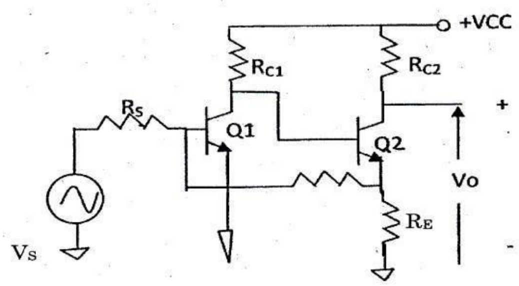
4 Explain about Current shunt and Current series feedback connection and derive the expression for input impedance, output impedance and voltage gain. Or with relevant expressions, analyze the shunt – shunt and shunt – series feedback amplifiers. **(Nov 16, Nov 2017, May 2018, Dec 2019, April-21)**

5 With an example circuit, explain the method of identifying the feedback topology. Also determine the feedback factor. **(May 15)**

6 With a neat diagram explain about RC phase shift oscillator using BJT and derive the expression for frequency of oscillation and condition of sustained oscillation. Also discuss about frequency stability of an oscillator **(May-2015, Dec 2019, April 2021)**

7 With a neat diagram explain about Wien Bridge oscillator and derive the expression for frequency of oscillation and condition of oscillation. (**May 15, Dec 15, Nov 2017)**

8 **(i)** Identify the nature of the feedback in figure- 1. Let R_{c1} = 3 kΩ, R_{c2} = 5 00 Ω, R_E = 50Ω, $R_S = R_F$ = 1.2 kΩ, hfe = 50, hie= 1.1 kΩ, hre = hoe = 0. Determine overall voltage gain (Avf), overall current gain (Aif), input impedance (Rif) and output impedance (Rof) **.(Nov 2017)**



(ii) Identify the type of feedback amplifiers shown in figure 2 (a) and 2 (b) **(May 2015)**

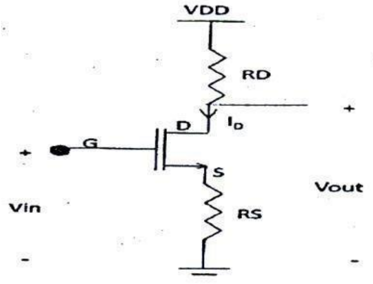


Figure 2(a)

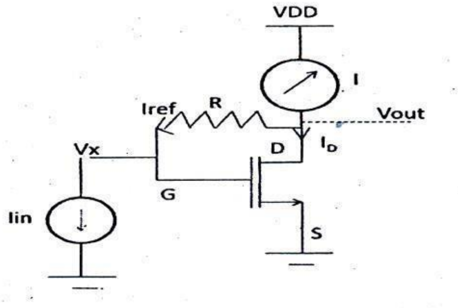


Figure 2(b)

9 (i) Explain in detail the stability of three pole amplifier.
Given the loop gain function $T(f)=\beta(100)/(1+jf/10^5)^3$, determine the stability of the amplifierfor β=0.2 and β=0.02. **(Dec 2015)**

10 **(i)** With a neat diagram explain about Colpitt oscillator & derive the expression for frequency of oscillation and condition of oscillation. **(May 15, Dec 15, May 17, April 2021)**

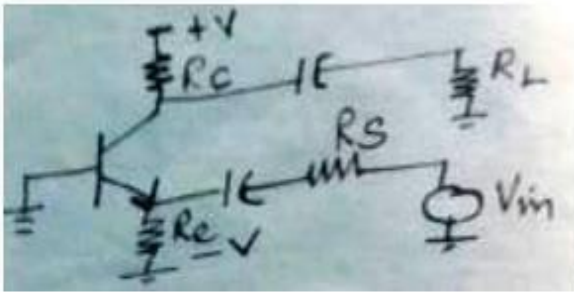
(ii) Design a clap oscillation to generate 12kHz Sine wave using BJT amplifier with a gain of 110.Given gm=30mA/V, hfe=150.Draw the designed circuit Vec=20V. **(Dec 15)**

11 With relevant diagrams explain the operations of

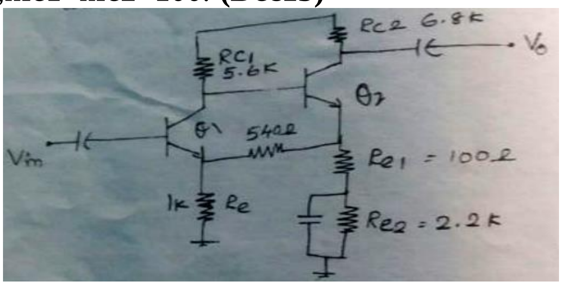
(i) Ring oscillator and (ii) Crystal oscillator. **(May 2019)**

12 With a neat diagram explain about Hartley oscillator & derive the expression for frequency ofoscillation and condition of oscillation.

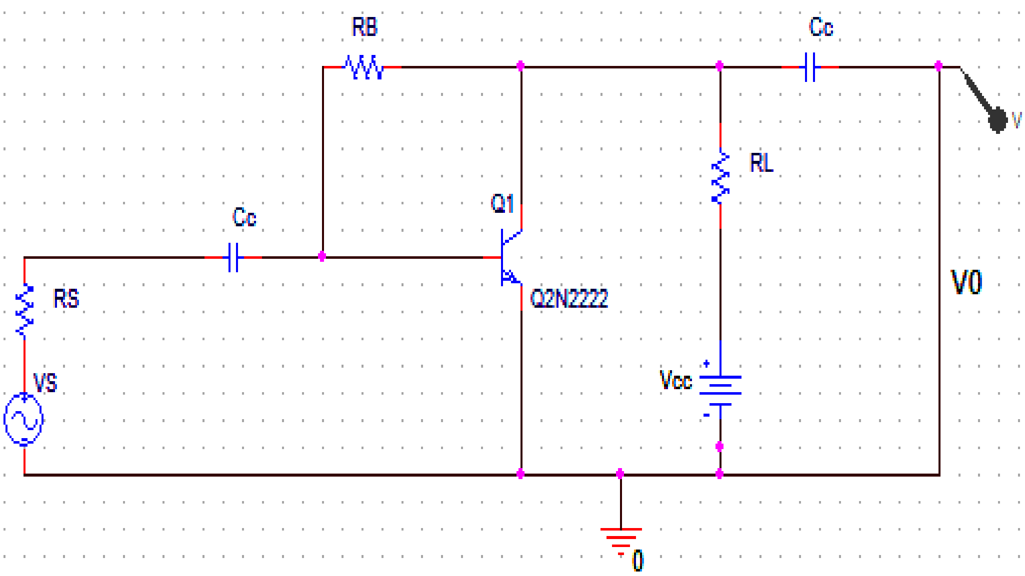
13 (i) Draw the basic amplifier of the feedback amplifier shown below with equivalent circuit of basic amplifier,derive for its transfer gain and hence find its loop gain. **(Dec 2015)**



ii) Identify the feedback topology. Find the open and closed loop gain of the circuit given. Assume hie1=hie2=2k,hfe1=hfe2=100. **(Dec15)**



14 Identify the feedback topology for the network shown below, which have Rs= 600Ω, hie= 5 kΩ,hfe = 80, $R_{L=}$ 2 kΩ and $R_{L=}$ 2 kΩ. Calculate Calculate A_v, R_{if} ,A_{vf} , R_{of} and R_{of}' **(Nov 16)**



15 (i) Sketch the block diagram of a feedback amplifier and derive the expression for gain with positive feedback and with negative feedback.
(ii) An amplifier has voltage gain with feedback as 100. If the gain without feedback changes by 20% and the gain with feedback should not vary more than 2%, determine the values of open loop gain A and feedback ratio β. **(May 17)**

16 i) Explain about voltage shunt and Current series feedback and derive the expression for input impedance, output impedance and voltage gain.
ii) Write about the Nyquist criterion for stability of feedback amplifiers **(May 17)**

17 Consider a three pole feedback amplifier with a loop gain given by.

$$T(f) = \frac{5 \times 10^5}{\left(1 + j\frac{f}{10^6}\right)\left(1 + j\frac{f}{10^7}\right)\left(1 + j\frac{f}{10^8}\right)}$$

Determine the frequency of the dominant pole to stabilize the feedback system. Assume the phase margin is at least 45°.**(Nov 2017)**

18 Discuss the effects of negative feedback on the properties of amplifier in detail with relevant analytical expressions. **(May 19)**

19 Discuss in detail about the impact of feedback on the amplifier with single and two poles. **(May 19)**

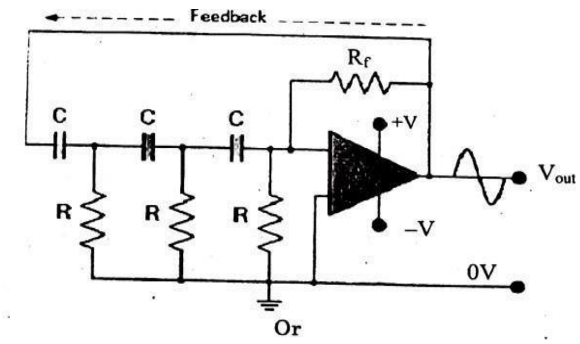
20 Consider a three –pole amplifier with a loop gain function given by

$$T(f) = \frac{10^5}{\left(1 + j\frac{f}{5 \times 10^5}\right)\left(1 + j\frac{f}{10^2}\right)\left(1 + j\frac{f}{5 \times 10^8}\right)}$$

Stabilize the circuit by inserting a new dominant pole. Assume the original poles are not altered. What frequency must the new pole be placed to achieve a phase margin of 45 degree? **(May 19)**

21 Discuss on the impact of negative feedback amplifier on gain, sensitivity and bandwidth. **(Dec 2018)**

22 Derive the expression for frequency of oscillation for the given circuit. For R=10k Ω and C=16nF, Find the frequency of oscillation and the minimum required R_f value to set the oscillations. **(Dec 18)**



23 A crystal with L=.4H, C=.0855pf and C_M = 1pf with R = 5k, find
i) series resonant frequency
ii) parallel resonant frequency
iii) by what percent does parallel resonant frequency exceed theseries resonant frequency iv) find the Q factor**.(May 2018)**

24 Derive the general form for frequency of oscillation for LC oscillator with suitable diagram **(Nov 2016)**

UNIT V – POWER AMPLIFIERS AND DC CONVERTORS

Power amplifiers- class A-Class B-Class AB-Class C-Power MOSFET-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

UNIT-V / PART-A

1 **Define class A, B, C, AB power amplifier**.

Class A: It is an amplifier in which the input signals and the biasing is such that the output current flows for full cycle of the input signal.

Class B: It is an amplifier in which the input signal and the biasing is such that the output current flows for half cycle of the input signal

Class C: It is an amplifier in which the input signal and the biasing is such that the output current flows for less than half cycle of the input signal.

Class AB: It is an amplifier in which the input signal and the biasing is such that the output Current flows for more than half cycle but less than full cycle of the input signal.

2 **Which power amplifier gives minimum distortion? Why? (Dec 2019)**

Class A amplifier has the highest linearity and the lowest distortion. The amplifying element is always conducting and close to the linear portion of its transconductance curve. The point where the device is almost off is not at a zero-signal point and hence its distortions compared to other classes are less.

3 **Give two applications of class C power amplifier**.

1. It is used to generate pulses.
2. It is used to trigger other devices.

4 **What is a push pull amplifier?**

Class B amplifier is used as a push pull amplifier which uses two transistors. Both the transistors work as a push pull arrangement. i.e. one transistor will be on at a time.

Advantages:

The harmonic distortions are removed.
The efficiency is increased.

5 **What is cross over distortion? How it can be eliminated? (April 2021)**

There is a 0.7V delay in between every half cycle. Due to this the sine wave will not be as continuous wave. This is called cross over distortion. It can be eliminated by class AB amplifier.

6 **What is complementary symmetry amplifier?**

The class B amplifier which uses both NPN and PNP transistor also both the halves are symmetrical is called complementary symmetry amplifier.

7 **What is constant frequency control of chopper?**

The chopper frequency is kept constant. Hence total period T remains constant. T_{on} and T_{off} both are varied to vary the duty cycle.

8 **What is the principle of on-off control?**

Thyristor's switch connects the AC supply to load for a time t_{on}, the switch is turned off by a gate pulse inhibiting for time t_{off}.

9 **Define the term Total Harmonic Distortion. (May 2019)**

The total harmonic distortion (THD) is a measurement of the harmonic distortion present in a signal and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.

10 **Differentiate between single quadrant and two quadrant DC chopper.**

Single quadrant	Two Quadrant
Load current flows from source to load	Load current flows from load to source.
Both voltage and current are positive	Voltage is positive, current is either positive or negative.

11 **What is meant by time ratio or PWM control (duty cycle) of a DC chopper?**

The ratio of a period to the total time period is known as time control ratio (or) duty ratio. It is given by T_{on}/T.

12 **What is the principle of step - up DC chopper?**

A constant voltage is applied to the inductor. Hence the current through the inductor increases linearly during the period T_{on}. After the SCR is turned off, the energy in the inductor is transferred to the load along with supply voltage.

13 **What are the applications of DC Chopper?**

(i) Electric locomotives (ii) Battery operated cars. (iii) Power supplies.

14 **What are the advantages of DC choppers?**

(i) Flexible, (ii) Easy to control & compact, (iii) Closed loop control can be implemented.

15 **What are the disadvantages of frequency modulated chopper?**

Design of filter is difficult, interference with commutation signals.

16 **Define current limit control in dc-to-dc converter?**

The switch is controlled by the current amplitude limits. The current is allowed to fluctuate or change only between 2 values i.e. maximum current (I max) and minimum current (I min)

17 **Write advantages of buck-boost regulator.**

It provides inverted output, high efficiency, both Buck\boost operation simulation and short circuit protection can be easily implemented.

18 **What is chopper?**

Chopper is DC to DC converter, It converts fixed dc to variable dc.

19 **Write the disadvantages of boost regulator.**

High peak current through device, output voltage is highly sensitive to change in duty cycle,large inductance & capacitance are required.

20 **Write the output voltage expression of step up\step down chopper.**

$$V_o = \frac{\alpha}{(1-\alpha)} V_s$$

21 **What are the different classification of chopper depending upon the direction of current and voltage?**

Different types of choppers are,

Class A chopper

Class B chopper

Class C chopper

Class D chopper

Class E chopper

22 **What is the need for DC/DC converter? (May 2019, April 2021)**

Unstable or improper voltage supplies can lead to characteristics degradation and even malfunction. To prevent this, a DC-DC converter is needed to convert and stabilize the voltage. A device that stabilizes the voltage using a DC-DC converter is referred to as a voltage regulator. Chopper is a DC / DC converter. It converts fixed DC into variable DC.

23 **What is the effect of load inductance on the load current waveforms in the case of DC chopper?**

If load inductance is high, it will reduce the ripple in the output currents waveforms. Load current becomes continuous.

24 **What are the two types of control strategies?**

a. Time ratio control b. Current limit control

25 **List the applications of MOSFET power amplifier. (Dec 2019)**

1. Linear power supplies 2. Switching power supplies
3. DC-DC converters 4.Low voltage motor control

UNIT-V / PART-B

1 **(i)** Explain about Class A transformer coupled audio power amplifier and derive the expression for efficiency of the same. **(Dec 2019)**

(ii) Explain the term conversion efficiency & maximum value of efficiency used in audio power amplifiers. **(Dec 2019)**

2 Explain with circuit diagram Class B power amplifier and derive the expression for its efficiency.

3 ***i)*** Explain with relevant diagrams, the operation of Class AB power amplifier. ***(April 2021)***

ii) Discuss the advantages and disadvantages of any three classes of power amplifiers**.**

4 Explain about RC coupled Class A amplifier and Class C amplifier and derive the expression for efficiency of the same.

5 Explain the working of boost converter with neat waveform also derive the expression of peak-to-peak voltage across the capacitor.

6 Explain the basic circuit and waveform and principle of operation of step-up converter.

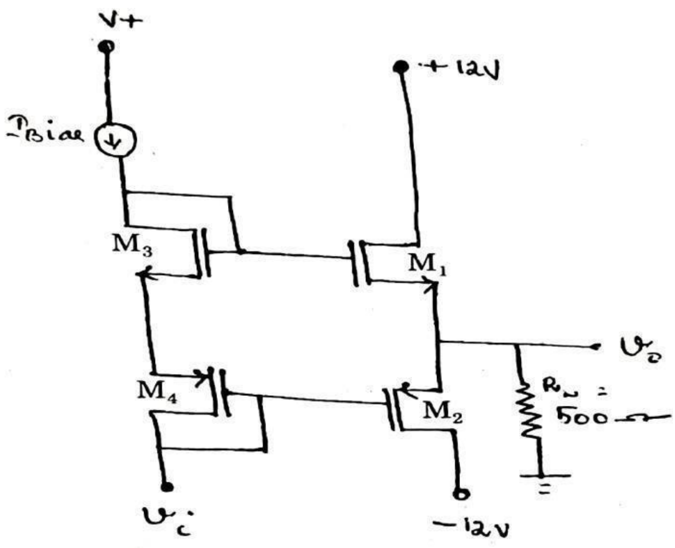
7 A voltage commutated chopper circuit provides the speed control of DC separately excited motor. The source voltage is 80V the staring current is 60A & thyristor turn off time is 20µs. Calculate the values of commutating capacitor & inductor if chopping period is 2000µs**.**

8 Explain the different classes of power amplifier and compare them**. (May-2019)**

9 An enhancement mode MOSFET class AB output stage is shown in the Fig. The threshold voltage of each transistor is $V_{TN}=-V_{TP}=1v$ and the conduction parameters of the output transistors are $K_{n1}=K_{p2}=5mA/V^2$.Let $I_{Bias}=200\mu A$.

(i) Determine $K_{n3}=K_{p4}$ such that the quiescent drain current inM_1 and M_2 are 5mA.

(ii) Find the small –signal voltage gain $A_v=d_{v0}/d_{v1}$ at $V_0=5v$. **.(May-2019)**



10 (i) Explain the operation of class-C and class-D types of two quadrant chopper?

Draw the power circuit diagram of Cuk regulator and explain its operation with equivalent circuit for different modes with necessary waveforms?

11 (i) Explain the Control strategies applied to dc chopper.

(ii) A step up chopper is used to deliver load voltage of 660V from 220V dc source if non conduction time of chopper is 100µs, Compute the pulse width. If pulse width is halved find new output voltage**.**

12 (i) Explain the operation of working of buck and boost converter with neat waveform and necessary voltage equations.

Explain the working of buck-boost converter for continuous current mode of operation withneat waveform also derives the expression of peak-to-peak voltage across the capacitor.

13 Explain the working principle of voltage commutated chopper showing the current and voltage waveform across each device.

14 Explain the working of the three commonly used DC/DC converters with circuit and response diagrams. **.(May-2019, April 2021)**

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