

K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE – 637 215. (Autonomous)
DEPARTMENT OF ECE
COURSE / LESSON PLAN SCHEDULE

Name : R.Poornima
Class : II year ECE
Subject : 16EC413 -Linear Integrated Circuits

TEXT BOOKS:

1. Sergio Franco, Design with operational amplifiers and analog integrated circuits, 3rd Edition, Tata McGraw-Hill, 2015.
2. D.Roy Choudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 4th Edition 2015.

REFERENCES:

1. S.Salivahanan & V.S. Kanchana Bhaskaran, Linear Integrated Circuits, TMH, 2nd edition, 2015.
2. Ramakant A.Gayakwad, OP-AMP and Linear ICs, Prentice Hall / Pearson Education, 4th Edition, 2012.
3. Gray and Meyer, Analysis and Design of Analog Integrated Circuits, Wiley International, 5th Edition, 2013.
4. B.S.Sonde, System design using Integrated Circuits, New Age Pub, 2nd Edition, 2013.
5. NPTEL Course Link: <http://nptel.ac.in/video.php?subjectid=108106068>

LEGEND:

L -Lecture; BB- Black Board; OHP- Over Head Projector, LCD - Liquid Crystal Display; Tx- Text; Rx- Reference; pp-Pages.

S.No	Lecture Hour	Topic(s) to be covered	T.A. Req.	Book No. / Page No.
UNIT I IC FABRICATION AND CIRCUIT CONFIGURATION FOR LINEAR IC				
1	L 1	Advantages of ICs over discrete components, Manufacturing process of monolithic Ics	BB	Rx1/pp 1-12 , Tx2/pp 3-12, Rx3/pp79-88
2	L 2	Construction of monolithic bipolar transistor, Monolithic diodes	BB	Rx1/pp 13-22 , Tx2/pp 17-20, Rx3/pp88-95
3	L 3	Integrated Resistors, Monolithic Capacitors , Inductors	BB	Rx1/pp 22-26 , Tx2/pp 22-27, Rx3/pp120-121
4	L 4	Current mirror and current sources, Current sources as active loads	BB	Rx1/pp 37-46,51 , Tx2/pp 65-70,Rx3/pp 251-297
5	L 5	BJT Differential amplifier with active loads	BB	Rx1/pp 78-81 , Tx2/pp53-65, Rx2/pp 96-102 Rx3pp/330-332
6	L 6	General operational amplifier stages	OHP	Rx1/pp 92-95 , Tx2/pp53,Rx2/pp2-3, Rx3/pp 341-375
7	L 7	DC and AC characteristics	BB	Rx1/pp 102-124,133-134 , Tx1/pp217-240, Tx2pp/104-127,Rx2/pp 110-136, 162-184, Rx3/ pp 681-694, Rx4/pp65-72
8	L8	Open and closed loop configurations &	BB	Rx1/pp 128-140 , Tx1/pp 259-267,Rx2/pp 44-47
9	L9	Differential Amplifier	BB	Rx1/pp 61,154-159
UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS				
10	L10	Sign Changer, Scale Changer, Phase Shift Circuits	BB	Rx1/pp 172-174 , Tx2/pp135-136
11	L11	Voltage Follower, V-to-I and I-to-V converters	BB	Rx1/pp 174-183 , Tx1/pp 61-67,Tx2/pp 49, 146-147, Rx2 pp/217-226,,Rx4/pp80, Rx5/pp55-58
12	L12	Adder, Subtractor, Instrumentation amplifier	BB	Rx1/pp 183-193 , Tx1/pp79-91, Tx2/pp 135-144, Rx2/pp200-208, Rx4/pp85
13	L13	Integrator, Differentiator, Logarithmic amplifier	BB	Rx1/pp 195-210 , Tx1/pp115-118,608, Tx2/pp 164, Rx2/pp 229-238, Rx3/pp406-407, Rx4/pp87
14	L14	Antilogarithmic amplifier, Comparators	LCD	Rx1/pp 210-212,224-230 , Tx1/pp399-415, 399-415, Tx2/pp 157-159,207-210,Rx2 pp/314-317,Rx5/pp518-532
15	L15	Schmitt trigger, Precision rectifier, Peak detector, Clipper, Clamper	BB	Rx1/pp 230-245 , Tx1/pp 416-428, 433-436, Tx2/pp 148-153,212-216, Rx2 pp/317, 351-361, Rx4/pp79,91
16	L16	First order low-pass, High-pass filters	BB	Rx1/pp253-257, 266-268 , Tx1/pp118-120,Tx2/pp 262-272, Rx2/pp250-264, Rx5/pp359-424
17	L17	Phase shift and Wien bridge oscillator,	BB	Rx1/pp 324-334 ,Tx1/pp451-465, Tx2 pp/ 216 -220,

		Astable and Monostable multivibrators		222-228,Rx2/pp279-284, Rx4/pp 88-91,Rx5/pp290-304
18	L18	Triangular wave generator -Saw-tooth wave generator, Diode Tester	BB	Rx1/pp 246-247,334-339 , Tx1/pp471-478, Rx2/pp 289-294, Tx2/pp220-222, 272-280
UNIT III ANALOG MULTIPLIER AND PLL				
19	L19	Analog Multiplier using Emitter Coupled Transistor Pair	BB	Rx1/pp 395-398 , Tx1/pp615-618, Rx3/pp704-706
20	L 20	Gilbert Multiplier cell	OHP	Rx1/pp 398-404 , Rx3/pp706-716
21	L 21	Variable transconductance technique, Analog multiplier ICs and their applications	BB	Rx1/pp 404-411 ,Tx1/pp618-620, Rx4/113-116
22	L22	Operation of the basic PLL, Closed loop analysis	BB	Rx1/pp 415-419 ,Tx1/pp627-635,Tx 2/pp327-333, Rx2pp/413-419,Rx3/pp716-728, Rx4/pp104-110
23	L23	Voltage controlled oscillator	LCD	Rx1/pp 424-428 ,Tx1pp/473-475,Tx2/pp334-336, Rx2/pp294-297
24	L 24	Monolithic PLL IC 565	BB	Rx1/pp 429-435 , Tx1/pp635-641,Tx2/pp337-342, Rx2/pp420-423
25	L25	Application of PLL for AM detection, FM detection	BB	Rx1/pp 437-448 , Tx1/pp 635-640 , Tx2/pp342-345, Rx2/pp424-427 ,Rx4/pp110-113
26	L26	FSK modulation and demodulation and Frequency synthesizing &	BB	Rx1/pp 440-443 ,Tx1/pp641-642,Rx4/pp110-113
27	L27	Jittering Effects in PLL when it is operated at High frequency Environment	BB	Rx1/pp 443-446 , Tx2/pp 344-345
UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS				
28	L28	Analog and Digital Data Conversions, D/A converter specifications	BB	Rx1/pp 447-450 , Tx1/pp 561-567, Tx2/pp348, 366
29	L29	Weighted resistor type, R-2R Ladder type	BB	Rx1/pp 451-458 , Tx1/pp 567-570,Tx2/pp 348,366 Rx2/pp 342-346
30	L30	Voltage Mode and Current-Mode $R \square$ - 2R Ladder types	BB	Rx1/pp 458-460 , Tx1/pp 570-580
31	L31	Switches for D/A converters, High speed sample and hold circuits	BB	Rx1/pp 461-463,472-473 , Rx2/pp 362-3649
32	L32	A/D Converters , Specifications , Flash type	BB	Rx1/pp 474-482 , Tx1/pp 590-591, Tx2/pp 358-360 Rx4/pp 221-222
33	L33	Successive Approximation type , Single Slope type	OHP	Rx1/pp 484-489 , Tx1/pp 586-588, Tx2/pp 361-363, Rx2/pp 348-349
34	L34	Dual Slope type , A/D Converter using Voltage-to-Time Conversion	BB	Rx1/pp 489-492 , Tx1/pp592-595 Tx2/pp 363-365,Rx4/pp 230
35	L35	ADC – 0801 Analog to Digital IC	BB	Rx1/pp 492-495 , Tx1/pp595-602
UNIT V SPECIAL FUNCTION ICs				
36	L36& L37	Timer IC 555	BB	Rx1/pp 342-356 , Tx1/pp465-471, Rx2/pp400-412, Tx2/pp311-324
37	L38	IC Voltage regulators , Three terminal fixed and adjustable voltage regulators	OHP	Rx1/pp 364-375 , Tx1/pp 519-535, Tx2/pp241-248, Rx2/pp437-446,Rx4/pp 99-104
38	L39	IC 723 general purpose regulator	BB	Rx1/pp 375-382 , Tx2/pp248-255,Rx2/pp 446-453
39	L40	Monolithic switching regulator	OHP	Rx1/pp 387-390 , Tx1/pp535-543, Rx4/pp99-104,Rx5/pp107-122, Tx2/pp255-258
40	L41	Switched capacitor filter IC MF10	BB	Rx1/pp 309-311 , Tx1/pp 199-203,Tx2/pp 298-300, Rx2/pp391-394
41	L42	Frequency to Voltage and Voltage to Frequency converters,	BB	Rx1/pp 507-516 , Tx1/pp486-492 , Rx2/pp330-336
42	L43	ICL8038 function generator, Audio Power amplifier	BB	Rx1/pp 339-342,521-528 , Tx1/pp 479-486,Tx2/pp191-194
42	L44	Video Amplifier, Isolation Amplifier	BB	Rx1/pp 528-532,537-541 , Rx4/pp86-87
43	L45	Opto-couplers and fibre optic IC & ICMAX3738 Laser driver	BB	Rx1/pp 535-537,541-543,547-550

LINEAR INTEGRATED CIRCUITS**UNIT – I IC FABRICATION AND CIRCUIT CONFIGURATION FOR LINEAR ICS****1. List the advantages of integrated circuits. (June 2015)(Nov/Dec2014)(June 2016) (R)**

*Miniaturization and hence increased equipment density. *Cost reduction due to batch processing.
 *Increased system reliability due to the elimination of soldered joints. *Improved functional performance.
 *Matched devices. *Increased operating speeds. *Reduction in power consumption.

2. Write down the various processes used to fabricate IC's using silicon planar technology.(U)

*Silicon wafer preparation. *Epitaxial growth. *Oxidation. *Photolithography. *Diffusion. *Ion implantation.
 *Isolation. *Metallization. *Assembly processing and packaging.

3. What is the purpose of oxidation? (R)

*SiO₂ is an extremely hard protective coating and is unaffected by almost all reagents. * By selective etching of SiO₂, diffusion of impurities through carefully defined windows can be accomplished to fabricate various components.

4. Why aluminum is preferred for metallization? (R) (May/June 2013)

*It is a good conductor. *It is easy to deposit aluminum films using vacuum deposition. *It makes good mechanical bonds with silicon. *It forms a low resistance contact.

5. What are the popular IC packages available? (R)**(April/May 2011)**

*Metal can package. *Dual-in-line package. *Ceramic flat package.

6. Define an operational amplifier. (R)**(April/May 2011)**

An operational amplifier is a direct-coupled, high gain amplifier consisting of one or more differential amplifier. By properly selecting the external components, it can be used to perform a variety of mathematical operations.

7. Mention the characteristics of an ideal op-amp. (R) (June 2017) (Dec2016) (April/May 2015)

* Open loop voltage gain is infinity. *Input impedance is infinity. *Output impedance is zero. *Bandwidth is infinity. *Zero offset voltage. *Infinite CMRR. * Infinite slew rate.

8. Define input offset voltage. (R) (Nov/Dec2013)

A small voltage applied to the input terminals to make the output voltage as zero when the two input terminals are grounded is called input offset voltage.

9. Define input offset current. State the reasons for the offset currents at the input of the op-amp. (R)

The difference between the bias currents at the input terminals of the op-amp is called as input offset current. The input terminals conduct a small value of dc current to bias the input transistors. Since the input transistors cannot be made identical, there exists a difference in bias currents.

10. Define CMRR of an op-amp. (R) (June2016)**(April/May 2011) (May/June 2013)**

The relative sensitivity of an Op-Amp to a difference signal as compared to a common mode signal is called the common mode rejection ratio (CMRR) & it gives the figure of merit ρ for the differential amplifier. $CMRR \rho = \left| \frac{A_d}{A_c} \right|$, $A_d \rightarrow$ Differential mode gain, $A_c \rightarrow$ Common mode gain.

CMRR is expressed in Db. Higher the value of CMRR, better the Op-Amp

11. Justify the reasons for using current sources in integrated circuits. (E) (June 2015) (Nov/Dec 2010)

*Superior insensitivity of circuit performance to power supply variations and temperature.
 *More economical than resistors in terms of die area required providing bias currents of small value.
 *When used as load element, the high incremental resistance of current source results in high voltage gains at low supply voltages.

12. What is the advantage of Widlar current source over constant current source? (R)

Using constant current source output current of small magnitude (micro amp range) is not attainable due to the limitations in chip area. Widlar current source is useful for obtaining small output currents. Sensitivity of widlar current source is less compared to constant current source.

13. Mention the advantages of Wilson current source. (R)

*Provides high output resistance. *Offers low sensitivity to transistor base currents.

14. What do you mean by a band-gap referenced biasing circuit? (R)

The biasing sources referenced to V_{BE} have a negative temperature co-efficient and V_T has a positive temperature co-efficient. Band gap reference circuit is one in which the output current is a weighted sum of V_{BE} and V_T so that by proper weighting, zero temperature co-efficient can be achieved.

15. What is the need for frequency compensation in practical op-amps? (U)

Frequency compensation is needed when large bandwidth and lower closed loop gain is desired. Compensating networks are used to control the phase shift and hence to improve the stability.

16. Mention the frequency compensation methods. (R)

*Dominant-pole compensation *Pole-zero compensation.

17. What are the merits and demerits of Dominant-pole compensation? (R)

*Noise immunity of the system is improved.*Open-loop bandwidth is reduced.

18. Define slew rate. (R) (Dec 2016) (April/May 2015) (June 2016) (April/May 2011)(Nov/Dec2010)

The slew rate is defined as the maximum rate of change of output voltage caused by a step input voltage. An ideal slew rate is infinite which means that op-amp's output voltage should change instantaneously in response to input step voltage.

19. What causes slew rate? (R) (April/May 2015) (Dec 2016)

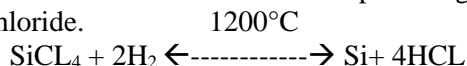
There is a capacitor with-in or outside of an op-amp to prevent oscillation. It is this capacitor which prevents the output voltage from responding immediately to a fast changing input.

20. Define an integrated circuit. (R) (April/May 2011)

An Integrated Circuit (IC) is a miniature, low cost electronic circuit consisting of active and passive components fabricated together on a single crystal of silicon. The active components are transistors and diodes and passive components are resistors and capacitors.

21. Write the basic chemical reaction in the epitaxial growth process of pure silicon. (U)(April/May2011)

The basic chemical reaction in the epitaxial growth process of pure silicon is the hydrogen reduction of silicon tetrachloride.



22. List out the steps used in the preparation of Si – wafers. (R)

1. Crystal growth & doping
2. Ingot trimming & grinding
3. Ingot slicing
4. Wafer polishing & etching
5. Wafer cleaning

23. What are the two important properties of SiO₂? (R)

1. SiO₂ is an extremely hard protective coating and is unaffected by almost all reagents except by hydrochloric acid. Thus it stands against any contamination.
2. By selective etching of SiO₂, diffusion of impurities through carefully defined windows in the SiO₂ can be accomplished to fabricate various components.

24. Write the classifications of monolithic resistors. (R)

1. Diffused resistors.
2. Epitaxial resistors.
3. Pinched resistors.
4. Thin film resistors

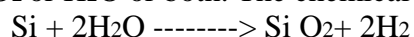
25. Draw the pin configuration of IC741. (A)

(Nov/Dec2010)



26. Explain the process of oxidation. (U)

The silicon wafers are stacked up in a quartz boat & then inserted into quartz furnace tube. The Si wafers are raised to a high temperature in the range of 950 to 1150°C & at the same time, exposed to a gas containing O₂ or H₂O or both. The chemical action is



27. Distinguish between Dry etching & Wet etching. (ANA)

Dry etching	Wet etching
1. Gaseous mixture is used as the chemical reagent	Chemical reagents used are in the liquid form.
2. Smaller line openings ($\leq 1\mu\text{m}$) are possible with dry etching	Line opening are larger. ($> 1\mu\text{m}$)
3. It produces straight walled etching process.	It produces patterns with undercutting.

28. What are the two requirements to be met for a good current source? (R) (May/June 2012)

- 1) To reduce power supply variations
- 2) More economical than resistors in terms of die, area required to provide bias current is of small value.

29. List the various methods of realizing high input resistance in a differential amplifier. (R) (May/June 2012)

- 1) By employing a current source and current mirrors.
- 2) Switched capacitor filter.

30. What is meant by monolithic IC? (R) (Nov/Dec2014)

In monolithic integrated circuits, all circuit components, both active and passive elements and their interconnections are manufactured into or on top of a single chip of silicon.

32. A differential amplifier has a differential voltage gain of 2000 and a common mode gain of 0.2. Determine the CMRR in dB. (E) (April/May2015)

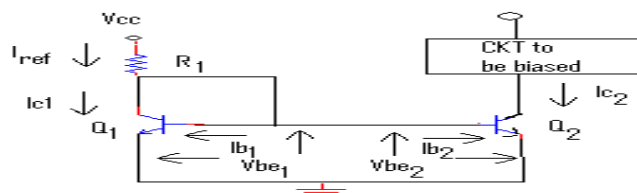
$$\text{CMRR} = 2000/0.2 = 10000\text{dB}$$

33. An operational amplifier has a slew rate of 4V/μs. Determine the maximum frequency of operation to produce a distortion less output swing of 12V. (E) (April/May2015)

$$f_{\max} = \text{slew rate}/2\pi V_m = 53\text{kHz}$$

Big Questions

1. Explain in detail the fabrication of ICs using silicon planar technology. (R) (June 2017) ((June 2016)
2. Discuss in detail the steps involved in the process of fabricating the transistor using monolithic IC technology. (C) (June 2014) (Nov/Dec2013) (Nov/Dec2014) (June 2015) (June 2016)
3. Explain the working of a BJT differential amplifier with active load. (R) (Nov/Dec2013)
4. Design a Widlar current source and obtain the expression for output current. Also prove that widlar current source has better sensitivity than constant current source. (A) (Dec 2016) (June 2016) (June2017)
5. Obtain the frequency response of an open-loop op-amp and discuss about the methods of frequency compensation. (U) (April/May2015) (Nov/Dec2010)
6. i) With neat circuit diagrams, explain the operation of (May/June 2012)
 - a) Voltage reference circuit using temperature compensation.
 - b) Voltage reference circuit using avalanche diode reference.
- ii) The current mirror shown below, is to provide a 1mA current with $V_{cc}=10\text{v}$. Assume $\beta=125$ and $V_{BE}=0.7\text{v}$



- a) Determine the value of R1.
- b) Also, for a collector current of 10 micro amperes, find the value of R1. (E)
7. i) List and explain the non-ideal DC characteristics of an operational amplifier. (R) (June 2016) (April/May2015)
- ii) Explain the AC characteristics of an operational amplifier. (U) (June2017) (Nov/Dec2014)
8. i) Compare different configurations of differential amplifier. (ANA)
- ii) For a dual input, balanced output differential amplifier, $R_c=2.2\text{k}\Omega$, $R_E=4.7\text{k}\Omega$, $R_{s1}=R_{s2}=50\Omega$. The supply voltages are $\pm 10\text{v}$. The h_{fe} for the transistor is 50. Assume silicon transistors and $h_{ie}=1.4\text{k}\Omega$. Determine the operating point values, differential gain, common mode gain and CMRR. (E) (June2016)
9. (i) Define slew rate, give the methods of improving slew rate. (R)
- (ii) Explain Wilson current source. Derive the expression for the same. (R) (June 2014)
10. (i) With simple schematic of differential amplifier, explain the function of Operational Amplifier. (U)
- (ii) Briefly explain about constant current source. (R) (April/May2015)
11. List the levels of integration in ICs. Explain with neat diagrams the various steps involved in the fabrication of monolithic BJT, resistor and capacitor. (U) (April/May2015) (June 2017)
12. Draw the circuit of basic current mirror and explain its operation. (R) (Dec 2016)

13. (i) Use appropriate block diagram, explain the general stages of an op-amp IC. (R) (Dec 2016)
 (ii) Derive the transfer characteristics of dual input differential amplifier showing the linear and limiting regions. Comment the same. (U) (Dec 2016)

UNIT – II APPLICATIONS OF OPERATIONAL AMPLIFIERS

1. List some of the linear applications of op – amps. (R)

Adder, Subtractor, voltage –to- current converter, current –to- voltage converters, Instrumentation amplifier, Analog computation, Power amplifier are some of the linear op-amp circuits.

2. List some of the non – linear applications of op-amps. (R)

Rectifier, peak detector, clipper, clamper, sample and hold circuit, log amplifier, anti –log amplifier, multiplier are some of the non – linear op-amp circuits.

3. What are the areas of application of non-linear op- amp circuits? (R)

Industrial instrumentation, Communication, Signal processing

4. What is the need for an instrumentation amplifier? (U)

(Nov/Dec2010)

In a number of industrial and consumer applications, the measurement of physical quantities is usually done with the help of transducers. The output of transducer has to be amplified So that it can drive the indicator or display system. This function is performed by an instrumentation amplifier.

5. List the features of instrumentation amplifier. (R)

* High gain accuracy * High CMRR *High gain stability with low temperature co-efficient.*Low dc offset
 *Low output impedance

6. What are the applications of V-I converter? (R) (Dec 2016)

* Low voltage dc and ac voltmeter * LED * Zener diode tester

7. What do you mean by a precision diode? (R)

(Nov/Dec2014)

The major limitation of ordinary diode is that it cannot rectify voltages below the cut – in voltage of the diode. A circuit designed by placing a diode in the feedback loop of an op – amp is called the precision diode and it is capable of rectifying input signals of the order of mill volt.

8. Write down the applications of precision diode. (R)

(Nov/Dec2010)

*Half - wave rectifier * Full - Wave rectifier * Peak – value detector * Clipper * Clamper

9. List the applications of Log amplifiers. (R)

(Nov/Dec2010)

*Analog computation may require functions such as $\ln x$, $\log x$, $\sin hx$ etc. These functions can be performed by log amplifiers. *Log amplifier can perform direct dB display on digital voltmeter and Spectrum analyzer. *Log amplifier can be used to compress the dynamic range of a signal

10. What are the limitations of the basic differentiator circuit? (U) (June 2014)

At high frequency, a differentiator may become unstable and break into oscillations. The input impedance decreases with increase in frequency, thereby making the circuit sensitive to high frequency noise.

11. What is a comparator? Write the applications of comparator? (R) (May /June 2012)

A comparator is a circuit which compares a signal voltage applied at one input of an op-amp with a known reference voltage at the other input. It is an open loop op - amp with output + V_{sat} .

Application: * Zero crossing detector * Window detector * Time marker generator * Phase detector

12. What is a Schmitt trigger? (R)

Schmitt trigger is a regenerative comparator. It converts sinusoidal input into a square wave output. The output of Schmitt trigger swings between upper and lower threshold voltages, which are the reference voltages of the input waveform.

13. What is a multivibrator? (R)

Multivibrators are a group of regenerative circuits that are used extensively in timing applications. It is a wave shaping circuit which gives symmetric or asymmetric square output. It has two states stable or quasi- stable depending on the type of multivibrator.

14. What do you mean by monostable multivibrator? (R) (June2015)

Monostable multivibrator is one which generates a single pulse of specified duration in response to each external trigger signal. It has only one stable state. Application of a trigger causes a change to the quasi-stable state. An external trigger signal generated due to charging and discharging of the capacitor produces the transition to the original stable state.

15. What is an astable multivibrator? (R)

Astable multivibrator is a free running oscillator having two quasi-stable states. Thus, there are oscillations between these two states and no external signals are required to produce the change in state.

16. What are the requirements for producing sustained oscillations in feedback circuits? (U)

For sustained oscillations, the total phase shift around the loop must be zero at the desired frequency of oscillation, f_o . ie, $A\beta = 0$ (or) 360° at f_o , the magnitude of the loop gain $|A\beta|$ should be equal to unity.

17. Mention any two audio frequency oscillators. (R)

*RC phase shift oscillator * Wein bridge oscillator

18. What are the demerits of passive filters? (R)

Passive filters work well for high frequencies. But at audio frequencies, the inductors become problematic, as they become large, heavy and expensive. For low frequency applications, more number of turns of wire must be used which in turn adds to the series resistance degrading inductor's performance ie, low Q, resulting in high power dissipation.

19. What are the advantages of active filters? (R)

Active filters use op-amp as the active element and resistors and capacitors as passive elements.

*By enclosing a capacitor in the feedback loop, inductor less active filters can be obtained *Op-amp used in non inverting configuration offers high input impedance and low output impedance, thus improving the load drive capacity.

20. Mention some commonly used active filters. (R)

(Nov/Dec2010)

* Low pass filter * High pass filter * Band pass filter * Band reject filter.

21. What is filter? (R)

(April/May 2011)

A filter is a frequency selective circuit that allows a certain band of the input signal frequency components to pass through and attenuates undesired frequency components.

22. What is a voltage follower? (R)

The circuit in which the output voltage follows the input voltage both in magnitude & phase is called the voltage follower circuit. It is a non-inverting amplifier with infinite input resistance & zero feedback resistance.

23. What is an integrator? (R)

By interchanging the resistor and capacitor of a differentiator, we obtain an integrator. The output is $-1/RfC_1$ times the integral of the input where RfC_1 is the time constant of integrator.

$$V_{out} = \frac{1}{R_1 C_f} \int_0^t V_o(t) dt + V_o(0)$$

24. What is a differentiator? (R)

Op-amp circuit that contains capacitor acts as differentiation or differentiating amplifier.

The output wave form is the derivative of the input waveform.

$$V_o = -R_f C_1 (dV_i / dt)$$

25. What is Clamper? (R)

It can be explained as introducing a dc level into an ac signal or shifting the ac signal to a predetermined dc level other than zero. These also called as dc restorers.

26. What is Clipper? (R)

Clipping or limiter circuits are designed to reduce the positive or negative extremities of an input waveform to a predetermined value which may be zero.

27. Why active guard drive is necessary for an instrumental amplifier? (R) (May/June 2012)

Active Guarding is to reduce errors in an instrumentation amplifier.

28. Define Bandwidth of a filter. (R)

(Nov/Dec2014)

The difference between upper cutoff frequency and lower cutoff frequency is called Bandwidth of a filter.

29. Design a second order LPF with a cut off frequency of 2 kHz. (A)

(June 2014)

Given: $N=2$, $f_H = 2\text{kHz} = 1/2\pi RC$

Let $C = 0.1\mu\text{F}$, we get $R = 0.8\text{k}\Omega$. For $N=2$, $\alpha = 1.414$

The pass band gain $A = 3 - \alpha = 3 - 1.414 = 1.586$

Hence the transfer function of second order LPF

$$H(s) = A/s^2 + 1.414s + 1 = 1.586/s^2 + 1.414s + 1$$

Here, $A = 1 + R_f/R_i = 1.586$, Therefore $R_f/R_i = 0.586$

Let $R_f = 5.86\text{k}\Omega$, Hence $R_i = 10\text{k}\Omega$

30. Mention the difference between Schmitt trigger and comparator. (R) (June 2015) (June 2016)

A basic comparator compares the input signal with the reference voltage then yields the output. A Schmitt trigger operates between two reference points namely LTP and UTP. Schmitt trigger employs positive feedback and for comparator, it need not consist of feedback. The output of the Schmitt trigger is square wave and the comparator output need not be square wave.

31. What is the difference between normal rectifier and precision rectifier? (U) (April/May 2015)

The silicon rectifiers, cut in voltage is 0.7V and so voltage less than this value cannot be rectified. This is the main defect in silicon rectifiers. This defect is overcome by precision rectifiers by using op-amp rectifiers and the voltage in milli volt range can be obtained.

32. What is hysteresis and mention the purpose of hysteresis in a comparator? (R) (April/May 2015)

In a Schmitt trigger the difference between two threshold voltages (upper threshold and lower threshold) is called hysteresis voltage. The voltage span of hysteresis is set to be greater than the peak-to-peak noise voltage. Therefore, there will not be any incorrect output variations due to noise signals.

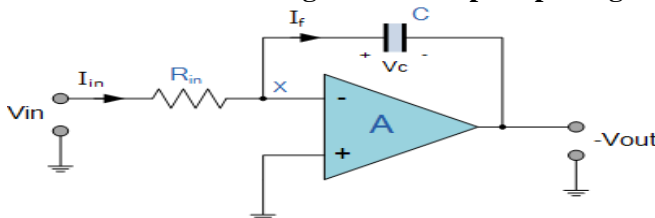
33. State reasons why integrator is called “lossy”. (U) (April/May 2015)

1. The presence of the input signal also, the offset voltage and bias current contribute an error voltage at the output. Thus it is not possible to get a true integration of the input signal at the output. Output distorted due to such an error voltage.

2. Bandwidth of integrator is very small, hence ideal integrator can be used for very small frequency range of the input only.

Because of above limitations ideal integrator is not used in practice. A few additional components are along with the ideal integrator circuit to minimize the effect of the error voltage. Such an integrator is called practical or lossy integrator.

34. Draw the circuit diagram of an Op-amp Integrator. Mention the applications. (June 2017) (U)



Applications:

- Analog computers,
- Analog-to-digital converters
- Wave-shaping circuits

35. For the non inverting operational amplifier with input resistance 2k and feedback resistance of 10k, find the output voltage due to input voltage of 0.5 volts. (June 2017)

$$\begin{aligned} V_0 &= V_i (1 + R_f/R) \\ &= 0.5 (1 + 5) = 3\text{V} \end{aligned}$$

Big Questions:

1. Discuss the need for an instrumentation amplifier? Give a detailed analysis for the same. (R) (May/June 2013) (April/May 2015) (June 2016) (June 2015) (Nov/Dec2014) (Nov/Dec2013) (June 2014)
2. With circuit and waveforms explain the application of op-amp as (i) Summer (ii) Differentiator (iii) Integrator. (U) (Nov/Dec2010) (Nov/Dec2013)
3. Discuss how a log and antilog amplifier is realized with op-amp circuitry. (R) (June 2015) (April/May 2015)
4. Sketch the peak detector using op-amp and explain its operation. (U) (April/May 2011)
5. Draw the comparator circuit using op-amp and explain its operation. (U) (April/May 2011)
6. Draw and explain clipper and clamper circuit. (U) (Nov/Dec2010)
7. Draw the schematic of an active second order LPF and sketch the frequency response. (U)
8. Sketch the basic circuit using op-amp to perform the mathematical operation of Differentiation and explain. What are the limitations of an ordinary OP-AMP differentiator? (U) (June 2016) (Dec 2016)

9. Draw and explain the circuit of voltage to current converter and current to voltage converter. (U)(June 2017)
10. Explain the working of OP-AMP based Schmitt trigger circuit. (R)(April/May 2015) (June 2017)
11. i) What do you understand by an integrator? (E) (May/June 2013)
- ii) Draw and Explain an ideal active op-amp Integrator circuit.
- iii) Draw the I/O waveforms for: Integrator
 - 1) Step input signal 2) Square wave input signal 3) Sine wave input signal
- iv) Derive the expression for change in output voltage.
- v) List the applications of practical integrator.
- vi) Design a practical integrator circuit with a dc gain of 10, to integrate a square wave of 10 kHz.
12. Explain the working of i) Precision full wave rectifier ii) Schmitt trigger. (U)(Nov/Dec2014) (June 2016)
13. With neat block diagram explain the working of function generator IC 8038. (R)(June 2014)
14. Discuss in detail the operation of Astable multivibrator. (R) (April/May 2011)
15. Discuss in detail the operation of Monostable multivibrator. (R) (April/May 2011) (Nov/Dec2013)
16. Explain the operation of triangular wave generator saw tooth wave generator. (R) (Dec 2016)(June2017)
17. What are the requirements for producing sustained oscillations in feedback circuits? Discuss any two sine wave generators? (U) (June 2015)
18. Design a wideband pass filter having $f_L = 400\text{Hz}$, $f_H = 2\text{kHz}$ and pass band gain of 4. Find the value of Q of the filter. (ANA) (April/May 2015)
19. (i) With the neat circuit diagram and mathematical expressions, explain the operation of scale changer.(R)
- (ii) Design an OP-AMP based first order active low pass filter. (U) (Dec 2016)

UNIT – III ANALOG MULTIPLIER AND PLL

- 1. Mention some areas where PLL is widely used. (R) (May/June 2013)**
 *Radar synchronization. *Satellite communication systems. *Air borne navigational systems
 *FM communication systems. *Computers.
- 2. List the basic building blocks of PLL. (R)**
 *Phase detector/comparator *Low pass filter *Error amplifier *Voltage controlled oscillator
- 3. What are the three stages through which PLL operates? (R) (Nov/Dec2010)**
 *Free running *Capture *Locked/ tracking
- 4. Define lock-in range of a PLL. (R) (June 2017) (June 2016) (Nov/Dec2013)**
 The range of frequencies over which the PLL can maintain lock with the incoming signal is called the lock-in range or tracking range. It is expressed as a percentage of the VCO free running frequency.
- 5. Define capture range of PLL. (R) (June 2016)**
 The range of frequencies over which the PLL can acquire lock with an input signal is called the capture range. It is expressed as a percentage of the VCO free running frequency.
- 6. Define Pull-in time. (R)**
 The total time taken by the PLL to establish lock is called pull-in time. It depends on the initial phase and frequency difference between the two signals as well as on the Overall loop gain and loop filter characteristics.
- 7. For perfect lock, what should be the phase relation between the incoming signal and VCO output signal? (U)**
 The VCO output should be 90 degrees out of phase with respect to the input signal.
- 8. What is a voltage controlled oscillator? (R) (June 2015) (Nov/Dec2010)**
 Voltage controlled oscillator is a free running multivibrator operating at a set frequency called the free running frequency. This frequency can be shifted to either side by applying a dc control voltage and the frequency deviation is proportional to the dc control voltage.
- 9. Give the expression for the VCO free running frequency. (U)**

$$f_o = 0.25 / R_T C_T$$
- 10. Define Voltage to Frequency conversion factor. (R)**
 Voltage to Frequency conversion factor is defined as, $K_v = f_o / V_c = 8f_o / V_{cc}$ where, V_c is the modulation voltage required to produce the frequency shift f_o .
- 11. What is the purpose of having a low pass filter in PLL? (U) (June 2015) (Dec 2016)**

*It removes the high frequency components and noise. *Controls the dynamic characteristics of the PLL such as capture range, lock-in range, band-width and transient response. *The charge on the filter capacitor gives a short- time memory to the PLL.

12. Mention some typical applications of PLL in the field of communications. (R) (April/May 2015)

- Frequency multiplication/division • Frequency translation • AM detection • FM demodulation
- FSK demodulation.

13. A PLL frequency multiplier has an input frequency of f and a decade counter is included in the loop.

What will be the frequency of the PLL? (E) (May/June 2013)

$F_0 = Nf_s$ F_0 =output frequency, f_s = input frequency, N = scaling factor of the counter

14. Draw the pin configuration of VCO. (U)

(April/May 2011)



15. What are the advantages of variable transconductance technique?(R) (June 2016)

1. Simple to integrate into monolithic chip
2. Provides good accuracy
3. Very cheap hence economical.
4. It provides high speed of operation which is 2 to 3 time more than logarithmic method.

16. VCO is also called as V-F converter. Why? (R) (May/June 2012) (Dec 2016)

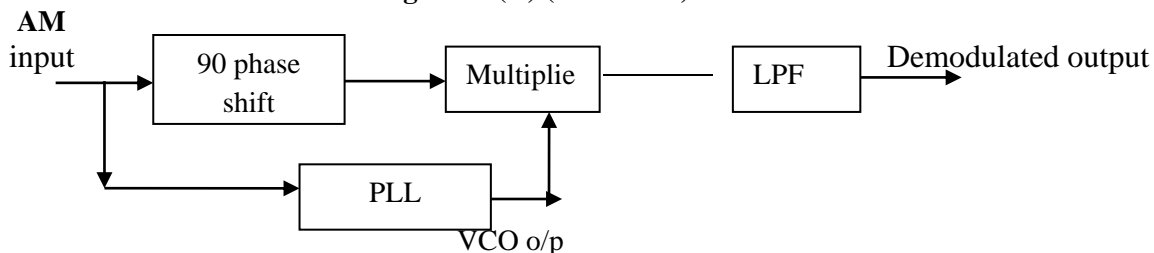
In VCO, applied input voltage controls output frequency. Therefore convert applied voltage into corresponding frequency.

17. What is FSK? Give its application. (R) (June 2014)

Frequency shift keying is a type of frequency modulation, in which the binary data or code is transmitted by means of carrier frequency, which is shifted between two fixed frequency values f_i representing logic 0 and f_c representing logic 1 and the two frequencies are called mark and space corresponding to logic 1 and logic 0 respectively.

Application: Digital data communications and computer peripheral.

18. Draw the AM detector using PLL. (U) (June 2014)



19. Name a few applications of an analog multiplier? (R)

1. Frequency doubling
2. Multiplication
3. Frequency Shifting
4. Division
5. Phase angle detection
6. Waveform generation
7. Squaring

20. How do you convert a basic multiplier to a squaring and square root circuit? (A) (April/May 2011)

In a multiplier circuit both input signals are same the output must be equal to the square of the input.so multiplier circuit act as squarer when both inputs are same. Both inputs of the multiplier is connected to the output of the op-amp then the output voltage is square root of the input.

21. What is four quadrant multiplier? (R) (June 2017)

If both inputs are positive, the IC is said to be a one-quadrant multiplier. A two-quadrant multiplier will function properly if one input is held positive and the other is allowed to swing both positive and negative. If both inputs are either positive or negative, the IC is called a four -quadrant multiplier.

Big Questions:

1. Briefly explain the block diagram of PLL and derive the expression for Lock range and capture range.

(R) (June 2016) (June 2015) (April/May 2015) (Nov/Dec2013)

2. With a neat functional diagram, explain the operation of VCO. Also derive an expression for f_o . (U)

(Dec 2016) (June 2016)

3. Analyses the Gilbert's four quadrant multiplier cell with a neat circuit diagram. Discuss its applications. (ANA) (June2017) (Dec 2016) (June 2014) (Nov/Dec2013)
4. i) List and define the various performance parameters of a Multiplier IC. (April/May 2015) (May/June 2012)
 ii) How the multiplier is used as voltage divider?
 iii) How the multiplier is used as frequency doubler? (R) (June 2016) (Dec 2016)
5. Explain, with neat block diagrams, how PLL is used as (R) (Nov/Dec 2014) (June 2015) (June2017)
 i) AM Detector ii) FM Detector iii) Frequency Synthesizer iv) FSK modulation and demodulation
6. Explain the working of IC565. (R) (June 2014) (June 2014) (Nov/Dec2013)
7. i) What do you mean by variable Transconductance analog multiplier. (U)
 ii) State the advantages of variable Transconductance technique for analog multiplication.
 iii) Draw the circuit and explain the working of one quadrant variable transconductance analog multiplier.
8. Explain in detail about the closed loop analysis of PLL. (R)
9. Describe the working of a analog multiplier using emitter coupled transistor pair. (U) (Nov/Dec 2014)
10. Explain the application of VCO for FM generation. (R) (April/May 2015)

UNIT IV A/D AND D/A CONVERTERS

1. List the classification of ADCs. (R) (June2015)

(i) Direct type ADC:

*Flash (comparator) type converter. *Counter type converter.*Tracking or servo converter.*Successive approximation type converter.

(ii) Integrating type ADC: *Charge balancing ADC.* Dual slope ADC

2. What is integrating type converter? (R)

An ADC converter that perform conversion in an indirect manner by first changing the analog I/P signal to a linear function of time or frequency and then to a digital code is known as integrating type A/D converter.

3. Explain in brief the principle of operation of successive Approximation ADC. (R)

The circuit of successive approximation ADC consists of a successive approximation register (SAR), to find the required value of each bit by trial & error. With the arrival of START command, SAR sets the MSB bit to 1. The O/P is converted into an analog signal & it is compared with I/P signal. This O/P is low or high. This process continues until all bits are checked.

4. What are the main advantages of integrating type ADCs? (R)

*The integrating type of ADC's do not need a Sample/Hold circuit at the input. *It is possible to transmit frequency even in noisy environment or in an isolated form.

5. Where is the successive approximation type ADC's used? (U)

The Successive approximation ADCs are used in applications such as data loggers & instrumentation where conversion speed is important.

6. What is the main drawback of a dual-slope ADC? (R) (May/June 2012)

The dual slope ADC has long conversion time. This is the main drawback of dual slope ADC.

7. State the advantages of dual slope ADC. (R)

It provides excellent noise rejection of ac signals whose periods are integral multiples of the integration time T.

8. Define conversion time. (R)

(Nov/Dec2010)

It is defined as the total time required to converter an analog signal into its digital output. It depends on the conversion technique used & the propagation delay of circuit components. The conversion time of a successive approximation type ADC is given by $T_c = T(n+1)$, where T = clock period

T_c =conversion time, n= Number of bits.

9. Define resolution of a data converter. (R)

(Dec 2016)

(Nov/Dec2014)

The resolution of a converter is the smallest change in voltage which may be produced at the output or input of the converter.

Resolution (in volts)= $V_{FS}/2^n - 1 = 1$ LSB increment. The resolution of an ADC is defined as the smallest change in analog input for a one bit change at the output.

10. Define accuracy of converter. (R) (June 2015)

Absolute accuracy: It is the maximum deviation between the actual converter output & the ideal converter output.

Relative accuracy: It is the maximum deviation after gain & offset errors have been removed. The accuracy of a converter is also specified in form of LSB increments or % of full scale voltage.

11. What is settling time? (R) (May/June 2012)

It represents the time it takes for the output to settle within a specified band $\pm 1/2$ LSB of its final value following a code change at the input (usually a full scale change). It depends upon the switching time of the logic circuitry due to internal parasitic capacitance & inductances. Settling time ranges from 100ns to 10 μ s depending on word length and type of circuit used.

12. Explain in brief stability of a converter. (U)

The performance of converter changes with temperature age & power supply variation. So all the relevant parameters such as offset, gain, linearity error & monotonicity must be specified over the full temperature & power supply ranges to have better stability performances.

13. What is meant by linearity? (R)**(Nov/Dec2010)**

The linearity of an ADC/DAC is an important measure of its accuracy & tells us how close the converter output is to its ideal transfer characteristics. The linearity error is usually expressed as a fraction of LSB increment or percentage of full-scale voltage. A good converter exhibits a linearity error of less than $\pm 1/2$ LSB.

14. What is monotonic DAC? (R)

A monotonic DAC is one whose analog output increases for an increase in digital input.

15. What is multiplying DAC? (R)

A digital to analog converter which uses a varying reference voltage V_R is called a multiplying AC (MDAC). If the reference voltage of a DAC, V_R is a sine wave given by $V(t) = V_{in} \cos 2\pi f t$ Then, $V_o(t) = V_o \cos(2\pi f t + 180^\circ)$

16. What are the specifications of D/A converter? (U)**(April/May 2011)(May/June 2013)**

The important specifications of D/A converter are accuracy, offset voltage, monotonicity, resolution and setting time.

17. For an n-bit flash type A/D converter what is the number of comparators required and write the disadvantages of that type of converter. (A) (June 2016) (April/May 2011) (May/June 2013)

The number of comparators required are $2^n - 1$ where n is the described number of bits. The main disadvantage is that the number of comparators required almost doubles for each added bit

18. How many clock periods are required for an 8-bit successive time ADC for single conversion?

Eight (8) clock periods are required.

(U)**(April/May 2011)****19. State advantage of inverted R-2R ladder. (R)****(Nov/Dec2010)**

- Ladder node voltage remains constant
- The stray capacitance not able to produce slow down effects

20. What are the limitations of flash type ADC? (U)**(Nov/Dec2010)**

*Accuracy is less

*Input hold speed time is very less

*It is very costly

21. State the principle of single slope A/D converter. (U)**(Nov/Dec2013)**

These converter techniques are based on comparing the unknown analog input voltage with a reference voltage that begins at 0V and increases linearity with time.

22. What is the conversion time of 8 –bit successive approximation type A/D converter with clock frequency of 3kHz. (E) (June 2014)

Conversion time : $T_c = T[n+1] = 1/3\text{kHz} [8+1] = 3 \text{ ms}$

23. What would be produced by a DAC, whose output range is 0 to 10V and whose input binary number is 10111100 (for a 8 bit DAC). (E) (April/May 2015)

$$V_o = 10 [1 \times 1/2 + 0 \times 1/2^2 + 1 \times 1/2^3 + 1 \times 1/2^4 + 1 \times 1/2^5 + 1 \times 1/2^6 + 0 \times 1/2^7 + 0 \times 1/2^8]$$

$$= 10[1/2 + 1/8 + 1/16 + 1/32 + 1/64] = 7.34\text{V}$$

24. Define gain error and monotonicity with respect to data converters. (U) (April/May 2015)

The output of a D/A converter is 0V when all the bits of binary input word are 0s. But in practice, there is a very small output voltage is developed. Therefore, the difference between calculated gain to the actual gain is called gain error.

The D/A converter is monotonic if its output value increases as the binary inputs are incremented from one value to the next. That is, the staircase output can have no downward step as the binary input is incremented.

25. Compare and contrast binary ladder and R-2R ladder DAC? (June 2016) (Dec 2016) (June 2017)

Binary weighted resistor DAC	R-2R ladder DAC
1. Requires a wide range of resistor values	1. Requires only two values of resistors
2. Due to the higher values of resistor required for the LSB, the use of this type is restricted to below 8 bits.	2. No such restriction as only two resistor values are used whatever may be the number inputs.

Big Questions:

1. What is integrating type converter? Explain the operation of dual slope ADC. (R) (June 2014)
2. Explain the principle of operation of successive Approximation ADC. (R) (June 2017) (June 2016)
3. Explain the various types of digital to analog converters. (R) (April/May 2011)
4. i) Explain the following types of electronic switches used in D/A converter, (R) (May/June 2012)
with suitable diagrams. 1) Totem pole MOSFET switch 2) CMOS inverter as a switch
(ii) Explain the working R-2R ladder DAC, by taking example of a three bit DAC circuit. Sketch the corresponding equivalent circuits and hence obtain the equation for output. (U) (June 2014) (May/June 2013)
5. (i) With a neat circuit diagram and waveform of output, explain the working of dual slope A/D converter.
(ii) Give a table of comparison of Flash, dual slope and successive approximation ADC's, in terms of parameters like speed, accuracy, resolution, input hold time. (U) (June 2016) (May/June 2012)
6. Explain the working of weighted resistor D/A converter. (R) (Nov/Dec 2014) (June 2016) (June 2017)
7. i) Compare single slope and dual slope ADC. (ANA) (April/May 2015)
ii) For a particular dual slope ADC, t_1 is 83.33ms and the reference voltage is 100mv. Calculate t_2 if
1) v_1 is 100mv and 200mv. (E)
8. Draw the block diagram and explain the working of
i) Charge Balancing VFCS ii) Voltage to time converter (R)
9. Discuss the operation of flash type A/D converter. (E) (June 2014) (Nov/Dec 2014) (April/May 2015)
10. (i) Explain the operation of dual slope ADC. (R)
(ii) A dual slope ADC uses a 16 bit counter and a 4MHz clock rate. The maximum input voltage is $\pm 10V$. The maximum integrator output voltage should be -8V when the counter has cycled through 2^n counts. The capacitor used in the integrator is $0.1\mu F$. Find the value of the resistor R of the integrator. (E) (June 2015)
11. (i) With circuit, explain current mode type of DACs. Compare with voltage mode type. (ANA)
(ii) What are oversampling data converters. (R) (April/May 2015)
12. (i) Explain the working of a voltage to time converter. (R) (Dec 2016)
(ii) Discuss the specifications of ADC. (R) (Dec 2016)

UNIT –V SPECIAL FUNCTION ICs**1. Mention some applications of 555 timer. (R) (Nov/Dec 2013)**

*Oscillator. *Pulse generator. *Ramp and square wave generator. *Mono-shot multivibrator
*Burglar alarm. *Traffic light control.

2. List the applications of 555 timer in monostable mode of operation. (R)

*Missing pulse detector *Linear ramp generator *Frequency divider *Pulse width modulation

3. List the applications of 555 timer in Astable mode of operation.

*FSK generator *Pulse-position modulator

4. What is a voltage regulator? (R)

A voltage regulator is an electronic circuit that provides a stable dc voltage independent of the load current, temperature, and ac line voltage variations.

5. Give the classification of voltage regulators. (R)

(April/May 2011)

*Series / Linear regulators- series and Shunt voltage regulators

*Switching regulators-transformer based type, buck switched type, boost switched type.

6. What is a linear voltage regulator? (R)

Series or linear regulator uses a power transistor connected in series between the unregulated dc input and the load and it conducts in the linear region. The output voltage is controlled by the continuous voltage drop taking place across the series pass transistor.

7. What is a switching regulator? (R)

Switching regulators are those which operate the power transistor as a high frequency on/off switch, so that the power transistor does not conduct current continuously. This gives improved efficiency over series regulators.

8. What are the advantages of IC voltage regulators? (R)

(Nov/Dec 2010)

*Low cost *High reliability *Reduction in size *Excellent performance

9. Give some examples of monolithic IC voltage regulators. (R)

78XX series fixed output, positive voltage regulators.

79XX series fixed output, negative voltage regulators.

723 general purpose regulator.

11. 10. Define line regulation. (R) (Dec 2016) (June 2016) (Nov/Dec 2014) (April/May 2011) (Nov/Dec 2013)
Line regulation is defined as the percentage change in the output voltage for a change in the input voltage. It is expressed in mill volts or as a percentage of the output voltage.

11. Define load regulation. (R) (Dec 2016) (June 2016) (Nov/Dec 2014) (April/May 2011)
Load regulation is defined as the change in output voltage for a change in load current. It is expressed in mill volts or as a percentage of the output voltage.

12. Give the drawbacks of linear regulators. (R)

*The input step down transformer is bulky and expensive because of low line frequency.

*Because of low line frequency, large values of filter capacitors are required to decrease the ripple.

*Efficiency is reduced due to the continuous power dissipation by the transistor as it operates in the linear region.

13. What is the advantage of switching regulators? (R) (June 2017)

*Greater efficiency is achieved as the power transistor is made to operate as low impedance switch. Power transmitted across the transistor is in discrete pulses rather than as a steady current flow.

*By using suitable switching loss reduction technique, the switching frequency can be increased so as to reduce the size and weight of the inductors and capacitors.

14. What is an opto-coupler IC? Give examples. (R) (June 2014)

Opto-coupler IC is a combined package of a photo-emitting device and a photo sensing device. Examples for opto-coupler circuit: LED and a photo diode, LED and photo transistor, LED and Darlington. Examples for opto-coupler IC: MCT 2F, MCT 2E.

15. Mention the advantages of opto-couplers. (R)

*Better isolation between the two stages. *Impedance problem between the stages is eliminated.

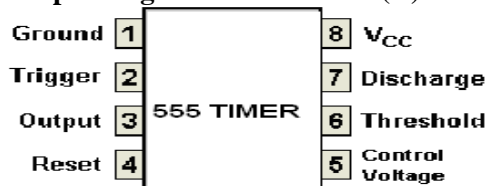
*Wide frequency response. *Easily interfaced with digital circuit.

*Compact and light weight. *Problems such as noise, transients, contact bounce, are eliminated.

16. What is an isolation amplifier? (R) (Nov/Dec 2010)

An isolation amplifier is an amplifier that offers electrical isolation between its input and output terminals.

17. Draw the pin diagram of 555 timer. (U)



18. What the packages that is available for optocoupler? (R)

1. 6 pin Dual in – line (ex: MCTZE, MCTZ).
2. 8 pin dual isolating optocoupler.
3. 16 pin quad isolating opto coupler.

19. What is the Bandwidth of an opto couplers? (R)

The maximum signal frequency that can be usefully passed through an opt coupler when the device is operated in its normal mode is the Bandwidth of an opt couplers.

20. Name the application of an isolation amplifier. (U)

Pressure Sensors, Flow meters, Thermocouples, RTDs, Medical Instrumentation

21. What is a power amplifier? (R)

Power amplifier is basically used to amplify an audio signal. The loads to such amplifiers are loud speaker and servomotors requiring power amplifiers or large signal amplifiers.

22. What are features of power amplifiers? (R)

- (1) Large amount of power to be delivered to load.
- (2) Power efficiency.
- (3) Impedance matching to output device.

23. List the features of IC 555 timer. (R)

(Nov/Dec 2010)

- It has two basic operating modes: monostable and astable
- It is available in three packages. 8 pin metal can, 8 pin dip, 14 pin dip.
- It has very high temperature stability.

24. Define duty cycle? (R) (May/June 2013)

The ratio of high output and low output period is given by a mathematical parameter called duty cycle. It is defined as the ratio of ON Time to total time.

25. What are the limitations of three terminal regulator? (R)

(May/June 2012)

- There is no current limit protection
- Low voltage regulators

26. What is a switched capacitor filter? (R)**(May/June 2012)**

R & C are required to fabricate filter circuits with large values which are not possible inside the IC. To realize R&C, MOSFET's are arranged in such a way used as a Capacitor Regulators. The applied gate voltage (high or low) will determine the range of resistance values and capacitance values.

27. What are the different protection circuits inside the monolithic IC regulators?(U) (Nov/Dec2014)

1. Zener Diode. 2. An op-amp circuit used as an error amplifier. 3. A series pass transistor capable of a 150mA output current. 4. Transistor used to limit output current.

28. In a monostable multivibrator using 555 timer R = 100 kΩ and time delay =100ms. Find the values of C. (E) (June 2014)

$$\text{Time delay } T = 1.1 RC$$

$$100\text{ms} = 1.1 \times 100 \text{ k}\Omega \times C$$

$$C = 0.9\mu\text{F}$$

29. What is the purpose of having input and output capacitors in three terminal IC voltage regulators? (U) (June 2014)

The input capacitor is used to remove inductive effects of the long distribution leads and the output capacitance is used to improve the transient response.

30. Differentiate between linear and switching regulators. (ANA) (April/May 2015)

Linear regulators	Switching Regulators
The series pass transistor operates in the active region as a linear device as a switching device.	The series pass transistor operates either at cut-off or at saturation.
Since the pass transistor is always in the active region, power dissipation is more.	Power dissipation is less.
The efficiency is less.	The efficiency is more.

31. State the need for current limiting in voltage regulators. (U) (April/May 2015)

1. Protecting the load from the over current operation.
2. Protecting the regulator itself.

Big Questions:

1. What is 555 timer? What are the features of 555 timer? Explain the monostable mode in detail? (R)(June 2017)
2. In detail discuss the 723 IC general purpose voltage regulator. (R)(June2015)(May/June2012) (June2017)
3. Explain the operation of switching regulators. Give its advantages. (U) (Dec2016) (April/May 2015)
4. Explain the functional diagram of LM 380 power amplifier and video amplifier. (U) (June 2015)(June2014)
5. Draw the circuit diagram of V/F converter using 9400 and explain. (U) (Nov/Dec2010)
6. (i)With a neat diagram, explain the working principle of isolation amplifier . (R) (June 2017) (Dec2016)
(ii)With a neat diagram, explain the working principle of Opto-Couplers. (R) (June 2016) (Dec2016)
7. Write detailed notes on the following. (U) (May/June 2013)
i) Low noise op-amps ii) Integrated fiber optic system (iii) Switched capacitor filter
8. State the advantages of IC voltage regulator. Explain the features and internal structure of general Purpose linear IC723 regulator. Design a regulator using IC723 to meet the following Specifications: $V_o=5\text{v}$; $I_o=100\text{mA}$; $V_{in}=15\pm 20\%$; $I_{sc}=150\text{mA}$; $V_{sense}=0.7\text{v}$. (R)
9. (i) Write short notes on series voltage regulator. (U)
(ii) Draw and explain the function of frequency to voltage converter. (U) (June 2014)
10. Compare frequency to voltage and voltage to frequency converters.(ANA) (April/May 2015)(Nov/Dec2010)
11. (i) Discuss about the video amplifier. (R) (Dec 2016)
(ii) Discuss in detail the function of 555 timer an astable mode and derive the expression for the pulse width.