# LINEAR IC APPLICATIONS (EC404PC)

# COURSE FILE

## I. COURSE OVERVIEW:

Integrated Circuits design can be divided into the broad categories of digital and analog IC design. The physical world is inherently analog indicating that there is always need for analog circuitry. Today the growth of any industry is dependent upon electronics to a great extent. Integrated circuit is electronics and this course IC application acquaints the students with general analog principles and design methodologies using practical devices and applications. It focuses on process of learning about signal condition, signal generation, instrumentation, timing and control using various IC circuitry. With modern digitization advantages we need to work with digital data and hence digital ICs play a crucial role in connecting physical world to the more sophisticated digital world. This course focuses on analysis, design and applications of modern digital integrated circuits.

## II.PREREQUISITE(S):

1. Electronic Devices & Circuits
2. Switching Theory and Logic
3. Electronic Circuit Analysis.

## III:COURSE OBJECTIVES:

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| 1 | To introduce the basic building blocks of linear integrated circuits. |
| 2 | To teach the linear and non - linear applications of operational amplifiers. |
| 3 | To introduce the theory and applications of analog multipliers and PLL |
| 4 | To teach the theory of ADC and DAC. |
| 5 | To introduce the concepts of waveform generation and introduce some special function ICs. |
| 6 | To understand and implement the working of basic digital circuits |

## IV:Course Outcomes:

| S.No. | Description | Bloom's Taxonomy Level |
|---|---|---|
| 1 | Understand the internal operation of Op-Amp and its specifications. | Knowledge, Understand (Level1, Level2) |
| 2 | Analyze and design linear applications like adder, subs tractor, instrumentation amplifier and etc. using Op-Amp. | Apply, Analyze (Level 3, Level 4) |
| 3 | Analyze and design non linear applications like multiplier, comparator and etc, using Op-Amp. | Apply, Analyze (Level 3, Level 4) |
| 4 | Classify various active filter configurations based on frequency response and construct using 741 Op-Amp. | Analyze (Level 4) |
| 5 | Operate 555 timers in different modes like bistable, monostable and astable operations and study their | Apply, Analyze (Level 3, Level 4) |

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| | applications. | |
| 6 | Determine the lock range and capture range of PLL and use in various applications of communications. | Knowledge, Understand (Level1, Level2) |

**V: HOW PROGRAM OUTCOMES ARE ASSESSED:**

| PO's | Program Outcomes (PO) | Level | Proficiency assessed by |
|---|---|---|---|
| PO 1 | **Engineering knowledge**: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. | 3 | Assignments |
| PO2 | **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. | 2 | Hands on Practice Sessions |
| PO3 | **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. | 3 | Lab Sessions |
| PO4 | **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. | 2 | Assignments & Exercises |
| PO5 | **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. | 2 | Seminars, Discussions |
| PO6 | **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. | 1 | Projects |
| PO7 | **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. | 1 | Projects |
| PO8 | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. | -- | ---- |

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|---|---|---|---|
| PO9 | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. | 1 | Projects |
| PO10 | **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. | 1 | Seminars /Presentation |
| PO11 | **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. | 2 | Projects |
| PO12 | **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. | 2 | Competitive Examination |

**1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None**

**VI: HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:**

| Program Specific Outcomes (PSO) | | Level | Proficiency assessed by |
|---|---|---|---|
| PSO1 | **Professional Skills**: An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems. | 2 | Assignments, Tests |
| PSO2 | **Problem-Solving Skills**: An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions | 2 | Assignments, Tests |
| PSO3 | **Successful Career and Entrepreneurship**: An understanding of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur. | 2 | Assignments |

**1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None**

**JNTUH SYLLABUS:**

**UNIT-1:**

Integrated Circuits: Classification, chip size and circuit complexity, basic information of Op-amp,ideal and practical Op-amp, internal circuits, Op-amp characteristics, DC and AC Characteristics, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential.

**UNIT-2**: Op-amp and Applications: Basic information of Op-amp, instrumentation amplifier, ac amplifier, V to I and I to V converters, Sample & hold circuits, multipliers and dividers, differentiators and integrators, comparators, Schmitt trigger, Multivibrators, introduction to voltage regulators, features of 723.

**UNIT-3:**

Active Filters & Oscillators: Introduction, 1st order LPF, HPF filters, Band pass, Band reject and all pass filters. Oscillator types and principle of operation - RC, Wien and quadrature type, waveform generators - triangular, sawtooth, square wave and VCO.

**UNIT-4:**

Timers & Phase Locked Loops: Introduction to 555 timer, functional diagram, monostable and astable operations and applications, Schmitt Trigger. PLL - introduction, block schematic, principles and description of individual blocks of 565.

**UNIT-5:** D-A and A-D Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC dual slope integration type ADC, DAC and ADC specifications.

**TEXT BOOKS:**

1. Op-amps & linear ICs- Ramakanth A.Gayakwad, PHI.2003.
2. Digital Fundamentals-Floyd and Jain, Pearson education, 8th edition 2005.

**REFERENCE BOOKS:**

1. Linear Integrated Circuits –D. Roy Chowdhury, New Age International (p) Ltd, 2ndEd., 2003.
2. Op Amps and Linear Integrated Circuits-Concepts and Applications James M. Fiore,Cengage Learning/ Jaico, 2009.
3. Operational Amplifiers with Linear Integrated Circuits by K. Lal Kishore – Pearson,2009.
4. Linear Integrated Circuits and Applications – Salivahanan, MC GRAW HILLEDUCATION.
5. Modern Digital Electronics – RP Jain – 4/e – MC GRAW HILL EDUCATION, 2010.

**GATE SYLLABUS**

Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and opamp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

**ESE SYLLABUS**

Basics of linear ICs, operational amplifiers and their applications-linear/non-linear, Active filters, timers, multipliers, wave shaping, A/D-D/A converters

**LESSON PLAN-COURSE SCHEDULE:**

| Lecture | Unit No | Date | Topics to be covered | Link for PPT | Link for PDF | Link for Small Projects/ N... | Course learning outcomes | Teaching Method | Reference |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **1** | | Integrated Circuits: Classification, chip size and circuit complexity | https://docs.google.com/presentation/d/1cHIs17_b_Ca2MFqRQcAlEAF | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view | **Small Projects / Numericals(if any)** | To understand IC ,its classification | ppt and digital writing pad | Linear Integrated Circuits, D. Roy |

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| | | | | 5C3ykbLAc/edit?usp=drive_web&ouid=104551979477683023110&rtpof=true | ?usp=sharing | **Link** | | | Chowdhury, New Age International(p) Ltd. |
| **2** | | | Basic information of Op-amp | https://drive.google.com/file/d/1KWp09KHotOTYwYej7OQrdGNvzXWD0MFh/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numericals(if any) Link** | To understand op amp | ppt and digital writing pad | |
| **3** | | | ideal and practical Op-amp | https://drive.google.com/file/d/17AIQckwxOP02XHlH-qA4w0yNpHgdfRpw/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numericals(if any) Link** | understand difference between practical and ideal op amp | ppt and digital writing pad | |
| **4** | | | internal circuits | https://drive.google.com/file/d/1_NbyAgHqt-HGQfcn9Il4PKV-Uszk9EaQ/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study the internal circuit of op-amp | ppt and digital writing pad | |
| **5** | | | Differential amplifier | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study Differential amplifier | ppt and digital writing pad | |
| **6** | | | Op-amp characteristics:DC and AC Characteristi | https://drive.google.com/file/d/1P9bs9wEGKGd | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yR | **Small Projects / Numeri** | know the dc and ac characteristics of op- | ppt and digital writing pad | |

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| | | | cs | LT1trHlJWkFtxn5qI7cB9/view?usp=sharing | q0jECGpLIc6X8ifrt/view?usp=sharing | **cals(if any) Link** | amp | | |
| **7** | | | 741 op-amp and its features | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numeri cals(if any) Link** | study 741 IC op amp | ppt and digital writing pad | |
| **8** | | | modes of operation-inverting | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numeri cals(if any) Link** | study op amp operating modes | ppt and digital writing pad | |
| **9** | | | modes of operation:non-inverting | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numeri cals(if any) Link** | study op amp operating modes | ppt and digital writing pad | |
| **10** | | | modes of operation:differentia | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numeri cals(if any) Link** | study op amp operating modes | ppt and digital writing pad | |
| **11** | | | numericals | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **Small Projects / Numeri cals(if any) Link** | numericals | ppt and digital writing pad | |
| **12** | | | numericals | https://drive.google.com/ | https://drive.google.com/f | **Small Projects** | numericals | ppt and digital | |

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| | | | | file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | ile/d/1eOoBIc_Tmc2s9yRq0jECGpLIc6X8ifrt/view?usp=sharing | **/ Numericals(if any) Link** | | writing pad | |
| **13** | | | students presentation | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | | **Small Projects / Numericals(if any) Link** | | | |
| **14** | | | students presentation | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | | **Small Projects / Numericals(if any) Link** | | | |
| **15** | | | **MOCK TEST 1** | | | | | | |
| **16** | **2** | | Op-amp and Applications: Basic information of Op-amp | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study basic application of op amp | ppt and digital writing pad | |
| **17** | | | instrumentation amplifie | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to know instrumentation amplifier as application of op amp | ppt and digital writing pad | |
| **18** | | | ac amplifier | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7c | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp= | **Small Projects / Numericals(if any)** | to know AC amplifier as application of op | ppt and digital writing pad | Op-Amps & Linear ICs, Ramak |

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| | | | | B9/view?usp=sharing | sharing | **Link** | amp | | anth A. Gayakwad, PHI |
| **19** | | | V to I and I to V converters | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to know voltage to current as application of op amp | ppt and digital writing pad | |
| **20** | | | Sample & hold circuits | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study Sample & hold circuits using op amp | ppt and digital writing pad | |
| **21** | | | multipliers and dividers | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study multipliers and dividers using op amp | ppt and digital writing pad | |
| **22** | | | differentiators and integrators | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study differentiators and integrators using op amp | ppt and digital writing pad | |
| **23** | | | comparators | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study comparators using op amp | ppt and digital writing pad | |
| **24** | | | Schmitt trigger | https://drive.google.com/file/d/1P9bs9wEGKGd | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz | **Small Projects / Numeri** | study Schmitt trigger using op | ppt and digital writing pad | |

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| | | | | LT1trHlJWkFtxn5qI7cB9/view?usp=sharing | 7qNfpiBc3uidz6j/view?usp=sharing | **cals(if any) Link** | amp | | |
| **25** | | | Multivibrators | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study Multivibrators using opa mp | ppt and digital writing pad | |
| **26** | | | introduction to voltage regulators | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to understand voltage regulators | ppt and digital writing pad | |
| **27** | | | features of 723 | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | know the features of 723 ic | ppt and digital writing pad | |
| **28** | | | students presentation | PPT Link | | **Small Projects / Numericals(if any) Link** | | | |
| **29** | | | students presentation | PPT Link | | **Small Projects / Numericals(if any) Link** | | | |
| **I Mid Examinations** | | | | | | | | | |

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| **30** | **3** | | Active Filters & Oscillators: Introduction | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to knowActive Filters & Oscillators | ppt and digital writing pad | Op-Amps & Linear ICs, Ramakanth A. Gayakwad, PHI |
| **31** | | | 1st order LPF | **https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing** | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | study 1st order LPF | ppt and digital writing pad | |
| **32** | | | HPF filters | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to understand HPF filters | ppt and digital writing pad | |
| **33** | | | Band pass | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to study Band pass | ppt and digital writing pad | |
| **34** | | | Band reject and all pass filters | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to study Band reject and all pass filters | ppt and digital writing pad | |
| **35** | | | Oscillator types and principle of operation - RC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJW | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uid | **Small Projects / Numericals(if** | to study Oscillator types and principle of | ppt and digital writing pad | |

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| | | | | kFtxn5qI7cB9/view?usp=sharing | z6j/view?usp=sharing | **any) Link** | operation - RC | | |
| **36** | | | Wien and quadrature type | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | understand Wien and quadrature type | ppt and digital writing pad | |
| **37** | | | waveform generators - triangula | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to study waveform generators - triangula | ppt and digital writing pad | |
| **38** | | | sawtooth | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to study sawtooth | ppt and digital writing pad | |
| **39** | | | square wave and VCO | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | to study square wave and VCO | ppt and digital writing pad | |
| **40** | | | students presentation | PPT Link | | **Small Projects / Numericals(if any) Link** | | | |
| **41** | | | students presentation | PPT Link | | **Small Projects / Numeri** | | | |

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| | | | | | | **cals(if any) Link** | | | |
| **42** | **4** | | Timers & Phase Locked Loops: Introduction to 555 timer | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | Timers & Phase Locked Loops: Introduction to 555 timer | ppt and digital writing pad | |
| **43** | | | functional diagram | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | functional diagram | ppt and digital writing pad | |
| **44** | | | monostable and astable operations and applications | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | monostable and astable operations and applications | ppt and digital writing pad | |
| **45** | | | Schmitt Trigger | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | Schmitt Trigger | ppt and digital writing pad | |
| **46** | | | PLL - introduction, block schematic | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | PLL - introduction, block schematic | ppt and digital writing pad | |
| **47** | | | principles and description of individual | https://drive.google.com/file/d/1P9bs | https://drive.google.com/file/d/10xWaSBo | **Small Projects /** | principles and descriptio | ppt and digital writing | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | blocks of 565. | 9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | AG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Numericals(if any) Link** | n of individual blocks of 565. | pad | |
| **48** | | | students presentation | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | | | |
| **49** | | | students presentation | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | | | |
| **50** | **5** | | D-A and A-D Converters: Introduction | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | D-A and A-D Converters: Introduction | ppt and digital writing pad | |
| **51** | | | basic DAC techniques | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | basic DAC techniques | ppt and digital writing pad | |
| **52** | | | weighted resistor DAC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | weighted resistor DAC | ppt and digital writing pad | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **53** | | | R-2R ladder DAC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | R-2R ladder DAC | ppt and digital writing pad | |
| **54** | | | inverted R-2R DAC,IC 1408 DAC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | linkhttps://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | inverted R-2R DAC,IC 1408 DAC | ppt and digital writing pad | |
| **55** | | | Different types of ADCs - parallel comparator type ADC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | Different types of ADCs - parallel comparator type ADC | ppt and digital writing pad | |
| **56** | | | counter type ADC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | counter type ADC | ppt and digital writing pad | |
| **57** | | | successive approximation ADC dual slope integration type ADC | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7cB9/view?usp=sharing | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp=sharing | **Small Projects / Numericals(if any) Link** | successive approximation ADC dual slope integration type ADC | ppt and digital writing pad | |
| **58** | | | DAC and ADC specifications | https://drive.google.com/file/d/1P9bs9wEGKGdLT1trHlJWkFtxn5qI7c | https://drive.google.com/file/d/10xWaSBoAG_Q2Ot1yz7qNfpiBc3uidz6j/view?usp= | **Small Projects / Numericals(if any)** | DAC and ADC specifications | ppt and digital writing pad | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | B9/view?usp=sharing | sharing | **Link** | | | |
| **II Mid Examinations** | | | | | | | | | |

## IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

| Course Outcomes | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO 4 | PO 5 | PO 6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 | PSO3 |
| CO1 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | - | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | - | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| CO3 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | - | 3 | 1 | 3 | 3 | 1 | 1 | 2 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 1 | 2 | - | 2 | 2 | 2 | 2 | 1 | 2 | 2 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | - | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO6 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 3 | 3 | 3 | 3 | 2 | 3 | 2 |
| Average | 2.67 | 2.5 | 2.5 | 2.5 | 2.5 | 1.67 | 1.67 | - | 2.5 | 2 | 2.5 | 2.5 | 1.33 | 2 | 2.17 |
| Average (Rounded) | 3 | 3 | 3 | 3 | 3 | 2 | 2 | - | 3 | 2 | 3 | 3 | 1 | 2 | 2 |

**1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None**

## XI. QUESTION BANK: (JNTUH)

### UNIT I

### Long Answer Questions:

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | Draw the differential amplifier circuit using op-amp and explain its working | Understand | 1 |
| 2. | Design a subtractor circuit whose output is equal to the difference between the two inputs. Use a basic differential op-amp configuration. | Analyze | 1 |
| 3. | Draw the circuit diagram of an Instrumentation amplifier and explain its working. | Analyze | 2 |
| 4. | The input signal to an op-amp is 0.03 sin ($1.5 \times 10^5$t). What can be the maximum Gain of an Op-Amp with the slew rate of 0.4V/μsec? | Remember | 2 |
| 5. | Classify ICs based on application, device used and chip complexity. | Understand | 3 |
| 6. | What is the operation performed by an inverting Op-Amp amplifier if its feedback resistance is replaced by a capacitance? Explain the functioning of such circuit. What are the practical difficulties associated with this circuit? | Remember | 2 |
| 7. | The Op-amp is configured as an inverting amplifier with $R_1$=1KΩ and $R_f$=10KΩ. Calculate exact closed loop gain, ideal closed loop gain and compare these two results. | Understand | 2 |
| 8. | Explain the operation of a Schmitt trigger circuit using IC 741. | Understand | 1 |

| | | | |
|---|---|---|---|
| 9. | Explain practical integrator circuit using IC 741. | Analyze | 1 |
| 10. | Explain the internal structure of voltage regulator IC 723. Also draw a low voltage Regulator circuit using IC 723andexplain its operation. | Analyze | 2 |
| 11. | Explain the following terms in an OP-AMP. 1. Input Bias current 2. Input offset voltage 3. Input offset current | Remember | 2 |
| 12. | Explain non inverting comparator using op-amp. | Understand | 3 |
| 13. | Derive the gain for non inverting op-amp. | Remember | 2 |
| 14. | Write a technical note on frequency response characteristics of differential amplifier. State the importance of frequency compensation. | Understand | 2 |
| 15. | What is t instrumentation amplifier? What are the required parameters of an instrumentation amplifier? Explain the working of instrumentation amplifier with neat circuit diagram. | Understand | 1 |
| 16. | Explain various DC and AC characteristics of an op.amp. Distinguish between ideal and practical characteristics. | Understand | 1 |
| 17. | With circuit and waveforms explain the application of OPAMP as differentiator and write the advantages of practical differentiator. | Remember | 1 |
| 18. | An IC op-amp 741 used as an inverting amplifier with a gain of 100. The voltage gain vs frequency characteristic is flat up to 12 kHz. Find the maximum peak to peak input signal that can be feed without causing any distortion to the output. | Remember | 1 |

**Short Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | Define Linear and Digital ICs. | Remember | 1 |
| 2. | Classify the ICs. | Understand | 1 |
| 3. | Define CMRR. | Understand | 2 |
| 4. | How fast can the output of an op-amp change by 10V, if its slew rate is 1V/μs? | Remember | 2 |
| 5. | Mention the reasons why open loop is not preferred for linear applications. | Analyze | 3 |
| 6. | List out the ideal characteristics of op-amp. | Remember | 2 |
| 7. | Write the features of 741 op-amp. | Analyze | 2 |
| 8. | Define thermal drift. | Remember | 1 |
| 9. | How fast can the output of an op-amp change by 10V, if its slew rate is 1V/μs? | Remember | 1 |
| 10. | Mention the advantages of integrated circuits. | Remember | 1 |
| 11. | List the applications of IC 741. | Understand | 1 |
| 12. | What is the purpose of IC 741 | Understand | 1 |
| 13. | Define an operational amplifier. | Remember | 1 |

| | | | |
|---|---|---|---|
| 14. | Mention the characteristics of an ideal op-amp. | Analyze | 1 |
| 15. | Define input offset voltage | Remember | 1 |
| 16. | What are the applications of current sources? | Analyze | 1 |
| 17. | Define sensitivity of an op-amp. | Remember | 1 |
| 18. | What is slew rate? Discuss the methods of improving slew rate. | Understand | 1,2 |
| 19. | Explain pole zero compensation and frequency compensation in op-amp. | Remember | 1 |
| 20. | Define band gap reference? Explain in detail about the reference circuit | Remember | 1 |
| 21. | Briefly explain the method of using constant current bias for increasing CMRR in differential? | Remember | 1 |
| 22. | Why Integrated circuits are needed? | Understand | 1 |
| 23. | List all ideal characteristics of Op-amp | Analyze | 1,2 |
| 24. | What is the effect of negative feedback in non-inverting amplifier | Understand | 2 |

**UNIT II Long Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | Explain the operation of I-V converter | Evaluate | 1 |
| 2. | Explain the operation of a differentiator using Op-amp | Evaluate | 1 |
| 3. | Explain the operation of instrumentation amplifier | Evaluate | 1 |
| 4. | Explain the operation of multiplier using Op-amp | Evaluate | 1 |
| 5. | Explain the operation of a comparator using Op-amp | Analyze | 1, |
| 6. | Explain the operation of a Schmitt trigger using Op-amp | Analyze | 2 |
| 7. | Explain the operation of a monostable multivibrator | Analyze | 2 |
| 8. | Draw the circuit diagram of quadrature oscillator and derive the equation for frequency of oscillations and also design such a ciruict to generate oscillations at a frequency of 159Hz | Evaluate | 2 |
| 9. | Design a op amp circuit which can give the output as $V_0 = 2V_1 - 3V_2 + 4V_3 - 5V_4$. | Analyze | 2 |
| 10. | Explain and draw the output waveforms of the ideal integrator circuit when the input is i) sine wave ii) square wave and iii) step input. | Evaluate | 2 |

**Short Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1 | What is the necessity of a sample & hold circuit? | Remember | 1 |
| 2 | What do you mean by voltage regulator? Discuss the types in it. | Understand | 1 |
| 3 | Discuss the following: input bias current, input off set current and thermal drift. | Remember | 1 |
| 4 | Explain the operation of V-I converter | Remember | 1 |
| 5 | Explain the operation of divider using Op-amp | Remember | 1,2 |
| 6 | Design and draw the circuit diagram of a Wein bridge Oscillator using op-amp to produce sustained oscillations of a time period of 0.1 m sec. | Remember | 2 |
| 7 | Explain how a Multiplier can be used as a voltage divider | Understand | 2 |
| 8 | Explain the operation of an integrator using Op-amp | Apply | 2 |
| 9 | Discuss the amplitude stabilization of Phase shift Oscillator. | Understand | 2 |
| 10 | Draw the circuit sample and hold circuit | Apply | 2 |

**UNIT III**

**Long Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | Design a second order low pass filter. | Evaluate | 3 |
| 2. | Draw the circuit of a 1st order low pass filter and derive its transfer function. | Understand | 3 |
| 3. | Derive the expression for the transfer function of first order high pass filter | Remember | 3 |
| 4. | Explain the operation of VCO | Understand | 3 |
| 5. | Discuss the operation of Wein Bridge Oscillator | Understand | 3 |
| 6. | Draw the schematic diagram of Wein Bridge Oscillator and explain its working | Understand | 3 |
| 7. | Design a first order active high pass filter with cutoff frequency of 2KHz with Op-amp. Why this is called active filter. | Analyze | 3 |
| 8. | Design a triangular wave generator with $f_0$ = 1.5KHz and $V_0$(PP) =5V | Analyze | 3 |
| 9. | Discuss the applications of VCO | Analyze | 3 |
| 10. | Explain the principle of operation of RC phase shift oscillator and obtain the expression for frequency of oscillation. | Analyze | 3 |
| 11. | Explain the operation of triangular waveform generator using op-amp. | Understand | 3 |
| 12. | Design a notch filter so that $f_o$ = 8kHz, Q =10. Choose C = 500pF. | Understand | 3 |
| 13. | Design and draw the circuit diagram of a Wein bridge Oscillator using op-amp to produce sustained oscillations of a time period of 0.1 m sec. | Analyze | 3 |

**Short Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1 | Why active filters are preferred? | Remember | 3 |
| 2 | What is meant by cut off frequency of a high pass filter and how it is found out in a first order high pass filter | Remember | 3 |
| 3 | What are the limitations of active filters | Remember | 3 |
| 4 | Give the principle of operation of VCO | Understand | 3 |
| 5 | Mention the differences between band pass and band reject filter | Understand | 3 |
| 6 | What is an active filter? What are the advantages offered by it over a passive filter. | Understand | 3 |
| 7 | Design a notch a filter to eliminate a 120Hz signal. | Understand | 3 |
| 8 | What is VCO? Discuss | Understand | 3 |
| 9 | List different types of Filters. | Understand | 3 |
| 10 | State the Barkhausen criterion. | Understand | 3 |
| 11 | What are the limitations of active filters? | Remember | 3 |
| 12 | Design a phase shift oscillator to have output frequency of 500Hz. Use ±12V supply. | Understand | 3 |

| | | | |
|---|---|---|---|
| 13 | Mention the differences between band pass and Band Reject filter. | Understand | 3 |

**UNIT IV**

**Long Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1 | What is the functional block diagram of 555 timer and explain its operation. | Apply | 4 |
| 2 | What are the applications of 555 timer and explain any one application in detail. | Analyze | 4 |
| 3 | Explain the role of low pass filter and VCO in PLL | Remember | 4 |
| 4 | How PLL is used for frequency multiplier? Explain. | Remember | 4 |
| 5 | Explain the functioning of 555 in Monostable configuration | Evaluate | 4 |
| 6 | Describe any four applications of Phase Locked Loop with the help of suitable circuit diagrams. | Evaluate | 4 |
| 7 | Discuss the application of 555 timer as missing pulse detector. | Apply | 4 |
| 8 | Design a monostable multivibrator to produce a pulse width of 100ms. | Apply | 4 |
| 9 | Discuss the application of 555 timer as a pulse width modulator. | Remember | 4 |
| 10 | Design a 555 based square wave generator to produce a symmetrical square wave of 1KHz. If $V_{CC}$=12V draw the voltage across timing capacitor and the output. | Remember | 4 |
| 11 | Give the applications of Astable multivibrator. | Understand | 5 |
| 12 | Derive the Lock range and capture range in PLL. | Remember | 5 |
| 12 | Explain the PLL as a FM detector. | Apply | 5 |

**Short Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | What are the basic building blocks of PLL? | Remember | 4 |
| 2. | What are the basic differences between the two operating modes of the 555 timer? | Understand | 4 |
| 3. | Mention the applications of the Schmitt trigger. | Remember | 4 |
| 4. | What is the importance of Pin 5 of IC 555? | Understand | 4 |
| 5. | List the applications of PLL. | Understand | 4 |
| 6. | Define pull in time and lock range of PLL | Understand | 4 |
| 7. | What are the features of 555 timers? | Understand | 4 |
| 8. | Mention the blocks present in IC565. | Remember | 4 |
| 9. | List various applications of IC 555 Timer. | Remember | 4 |
| 10. | List the applications of Astable multivibrator. | Understand | 4 |

**UNIT V**

**Long Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | Explain the working of a Weighted resistor D/A converter. | Evaluate | 5 |
| 2. | Explain successive approximation A/D converter. | Understand | 5 |
| 3. | Explain the working of a dual slope A/D converter. | Remember | 6 |
| 4. | With neat diagram, explain the working principle of inverter R-2R ladderDAC. | Understand | 6 |
| 5. | Explain the working of a counter type A/D converter and state it's important feature. | Understand | 5 |
| 6. | Write the specifications of DAC. | Understand | 5 |
| 7. | Write the specifications of ADC. | Analyze | 6 |
| 8. | With neat diagram, explain the working principle of R-2R ladder type DAC. | Analyze | 6 |
| 9. | Explain the operation of parallel comparator type ADC. | Analyze | 5 |
| 10. | Design 4 bit weighted resistor DAC. | Analyze | 5 |
| 11. | Draw the circuit diagram of Dual slope ADC and explain its working. | Understand | 6 |
| 12. | What is the role of DAC in successive approximation ADC? | Understand | 6 |
| 13. | For the D/A converter using R-2R ladder network, determine the size of each step if $R_f$ = 27KΩ and also calculate the output voltage when the inputs $b_0$, $b_1$, $b_2$ and $b_3$ are at 5V | Understand | 5 |
| 14. | Describe Parallel Comparator type ADC operation. | Analyze | 5 |
| 15. | Explain the working of Inverted R-2R ladder D/A converter. | Analyze | 6 |
| 16. | Find out the Step size and Analog output when input is 0011 and 1011. Assume $V_{ref}$ = +5V. | Understand | 6 |
| 17. | Explain Successive Approximation ADC with the help of block diagram | Understand | 5 |
| 18. | Discuss the operation of counter type ADC. | Understand | 5 |
| 19. | Explain the operation of flash type ADC. | Analyze | 6 |
| 20. | Explain the operation of weighted resistor DAC | Analyze | 6 |
| 21. | Explain the working of weighted resistor D/A converter and state its features. | Understand | 5 |
| 22. | Find the resolution of a 12 bit D/A converter. | Understand | 5 |
| 23. | Draw the IC 1408 DAC pin diagram and explain. | Understand | 6 |

**Short Answer Questions:**

| S. No | Question | Blooms Taxonomy Level | Course Outcome |
|---|---|---|---|
| 1. | List the various A/D conversion techniques. | Remember | 8 |

| | | | |
|---|---|---|---|
| 2. | List the draw backs of Binary weighted Resistor technique D/A conversion. | Remember | 8 |
| 3. | What is meant by resolution of DAC? | Remember | 8 |
| 4. | What is the conversion time of counting type ADC and parallel comparator ADC?[ | Understand | 8 |
| 5. | An 8 bit successive approximation type ADC is driven by a 1MHz clock. Find the conversion time. | Understand | 8 |
| 6. | What are the different sources of errors in DAC? | Understand | 8 |
| 7. | Explain how Dual-slope ADC provides noise rejection? | Understand | 8 |
| 8. | Compare R-2R and Weight Resistor types of ADC. | Understand | 8 |
| 9. | Calculate basic step of 9 bit DAC is 10.3 mV. If 000000000 represents 0V, what output produced if the input is 101101111? | Apply | 8 |
| 10. | What is the advantage of R-2R ladder D/A converter over the one with binary weighted resistors? | Understand | |
| 11. | What are the different types of ADCs and compare them in terms of speed of operation | Understand | |

**OBJECTIVE QUESTIONS:**

**OBJECTIVE QUESTIONS:**

**UNIT-1**

1. OPAMP is a/an: [ ]
   (a) Differential amplifier (b) Oscillator (c) Rectifier (d) none of the above
2. OPAMP operates at: [ ]
   a) High voltage (~ 100 KV) (b) Medium voltage (~ 220 Volt)
   c) Low voltage (~ 12 Volt) (d) Very low voltage (~ 10 mili Volt)
3. Voltage gain of an ideal op-amp is: [ ]
   (a) infinte (b) very high (c) low (d) very low
4. Bandwidth of an ideal op-amp is: [ ]
5. infinte (b) very high (c) low (d) very lowOutput impedance of an ideal op-amp is: [ ]
   (a) infinte (b) very high (c) low (d) zero
6. CMRR of an ideal op-amp is: [ ]
   (a) infinte (b) very high (c) low (d) zero
7. Slew rate of an ideal op-amp is: [ ]
   a) infinte (b) very high (c) low (d) zero
8. *Op-amp is a:* [ ]
   *a) Voltage-controlled voltage source* (b) *Voltage-controlled current source*
   c) *Current-controlled voltage source* (d) *Current-controlled current source*
9. Op-Amp uses: [ ]
   a) Only +ve Voltage (b) *Only –ve voltage* (c) *Dual supply, i.e.,* $\pm V_{cc}$ (d) None of the above
10. Virtual ground of an op-amp means: [ ]
    a) Terminal is grounded directly

b) The terminal is not physically grounded but terminal voltage is zero due to the other terminal is connected to the ground due to op-amp properties.
c) Both (a) and (b)
d) None of the above

11. Op-Amp uses: [ ]
(a) Negative feedback (b) Positive feedback (c) No feedback (d) None of the above

12. Common-mode gain signifies: [ ]
a) The ability to reject the common mode signals like noise and interference
b) Increase the noise
c) Increase the distortion
d) All of the above

13. Slew rate is defined as the: [ ]
a) Maximum rate of change of output voltage with time
b) Minimum rate of change of output voltage with time
c) Moderate rate of change of output voltage with time
d) None of the above

14. Op-amp integrator uses: [ ]
a) Capacitor as feedback element
b) Resistor as feedback element
c) Inductor as feedback element
d) A simple wire as feedback element

1. An Op-amp has_____ number of inputs and _____ output.
2. Op-amp responds only to the _____ between its input voltages.
3. Op-amp does not have _____ terminal.
4. An ideal Op-amp has _____ open loop gain.
5. The two basic configurations of Op-amp are _____ and _____
6. The voltage gain of an inverting amplifier is the ratio of _____
7. The voltage gain of a non-inverting amplifier is..: _____
8. The Ideal voltage transfer curve is a plot between _____and _____
9. The gain of an Op-amp with _____ is termed as closed loop gain.
10. The bandwidth of ideal operational amplifier is..: _____
11. An op-amp is so named because _____.
12. The value of $A_{VOL}$ and BW for an ideal op-amp are _____.
13. If $V_i$ = 1V, $A_{VCL}$ = 100, $V_0$ of op-amp with + *Vcc* = 10V and - *Vcc* = 10V, is _____.
14. The value of PSRR and CMRR for ideal op-amp are respectively _____.
15. The op-amp voltage follower circuit is also known as _____.
16. The temperature range in which 741C op-amp. is used is _____.
17. Offset adjustment in an op-amp is done with the pin numbers _____.
18. The maximum value of + *Vcc* and – *Vcc* that can be given to op-amp. are _____.

19. The expression for input offset voltage drift is _____.
20. If $V_0 = V \sin(\omega t)$, the expression for slew rate (SR) is _____.

**UNIT-2**

1. Inverting differential Amplifiers is also called as _____
2. Output of summer is _____
3. Differentiator can be constructed from _____
4. In Voltage follower gain of Op-amp is _____
5. Op-amp with diodes are called as _____
6. Output of Half-wave rectifier is_____
7. Zero crossing detectors is also called as _____
8. When Op-amp is used as comparator _____
9. Advantages of instrumentation amplifier _____
10. Integrator can be constructed from _____
11. The advantage of using an op-amp for current or voltage measurement is _____.
12. An op-amp current to voltage converter is also called _____.
13. In the case of op-amp voltage reference sources, the regulation is _____.
14. The advantage of an op-amp half wave rectifier circuit is _____.
15. The logarithmic amplifiers, the element used in the feedback path of op-amp is _____.
16. In analog multipliers, the important functional block is _____.
17. In logarithmic amplifiers, temperature compensation is _____.
18. An op-amp function generator circuit produces _____ type of waveforms.
19. The expression for frequency of oscillations in the case of an op-amp function generator circuit with usual notation is _____.
20. An op-amp HWR circuit is also known as _____.

**UNIT-3**

1. In the case of active filters, voltage gain Av can be_____.
2. By using active filters, loading effect can be_____.
3. With higher order filters, the sharpness of the frequency response curve_____ .
4. An op-amp differentiator circuit can be used as a _____ filter.
5. An op-amp integrator circuit can be used as a _____ filter.
6. The transfer function represents a _____ filter.
7. The transfer function represents a _____ filter.
8. The transfer function of an all pass filter circuit is_____ .
9. The kink in the frequency response of an active filter circuit will be more if the value of the damping coefficient K is_____ typical value is_____.
10. To obtain band reject filter, LPF and HPF must be connected in_____.

**UNIT-4**

1. The maximum output current IO that can be delivered from a 555 IC is _____.
2. The expression for T1 in the case of a 555 astable multivibrator is _____.

3. The expression for f, the frequency of oscillations in the case of 555 astable multi is _____.
4. To get 50% duty cycle in a 555 circuit, if RA is made zero, then the difficulty with discharge transistor is ____.
5. With 555 monostable circuit, if tp > 2T, _____ operation is obtained.
6. For a divide by two operation, the relation between tp and T is _____.
7. XR 2556 IC is _____
8. XR 210, CA3090, and MC1310B are _____ ICs.
9. The relation between lock range and capture range is _____.
10. Digital PLL employs _____ input _____ type logic gate as the phase comparator.
11. The expression for f0 in the case of PLL 565 IC is _____.
12. The frequency range over which a 565 PLL IC can be used is _____.

**UNIT-5**

*1.* What is the level of the output voltage of a ladder-network conversion? [ ]
   a) The analog output voltage proportional to the digital input voltage
   b) The digital output voltage proportional to the linear input voltage
   c) A fixed digital value Vref
   d) A fixed analog value Vref
2. Which of the following is not a linear/digital IC? [ ]
   a) Phase-locked loop
   b) Voltage-controlled oscillator
   c) Passive filter
   d) Comparator
3. What is the minimum number of conversions per second of a clock rate of 1 MHz operating a 10-stage counter in an ADC? [ ]
   (a)1000 (b) 976 (c) 769 (d) 697
4. What is the first phase of the dual-slope method of conversion? [ ]
   a) Connecting the analog voltage to the integrator for a fixed time
   b) Setting the counter to zero
   c) Connecting the integrator to a reference voltage
   d) All of the above
5. What is the maximum conversion time of a clock rate of 1 MHz operating a 10-stage counter in an ADC? [ ]
   (a) 1.024 s (b) 102.3 ms (c) 10.24 ms (d) 1.024 ms
6. On which of the following does the conversion depend in ladder-network conversion? [ ]
   a) Comparator (b) Control logic (c) Digital counter (d) Clock
7. What is the function of a ladder network?
   a) Changing an analog signal to a digital signal
   b) Changing a linear signal to a digital signal
   c) Changing a digital signal to an analog signal

d) None of the above

8. Which of the slope intervals of the integrator does the counter in the analog-to-digital converter (ADC) operate? [ ]
   a) Positive (b) Negative (c) Both positive and negative (d) Neither positive nor negative
9. At which of the following period(s) is the counter advanced (incremented) in dual-slope conversion? [ ]
   a) During the charging of the capacitor of the integrator
   b) During the discharging of the capacitor of the integrator
   c) During both the charging and discharging of the capacitor of the integrator
   d) None of the above
10. What is (are) the input(s) to the comparator in the ladder-network conversion of an ADC? [ ]
    a) Staircase voltage b) Analog input voltage c) Both staircase and analog input voltage
    b) None of the above

1. The disadvantage of a weighted resistor network type DAC is _____ .
2. The disadvantage of an R–2R ladder network type DAC is _____ .
3. To account for variations in logic levels, DACs employ _____ .
4. For an n-bit DAC, the expression for resolution is _____ .
5. The range of settling time for a 12-bit DAC is_____ .
6. The slew rate in DACs is defined as _____ .
7. Between counter ramp type and successive approximation type ADCs, the one having lesser conversion time for a given input is_____ .
8. The major advantage of a dual slope integrating type ADC is _____ .
9. The voltage resolution of an 8-stage ladder network _____.
10. The number of comparators required in the case of a simultaneous conversion type ADC for n-bit conversion is _____.

**XII. GATE QUESTIONS:**

**XIII. WEBSITES:**

1. https://technicalpublications.org/index.php/ebooks/linear-and-digital-ic-applications.html
2. http://www.slideshare.net/guest3f9c6b/linear-and-digital-ic-applications-jntu-model-paperwwwstudentyogicom
3. http://www.linear.com/
4. http://ecmsnist.weebly.com/linear--digital-ic-applications-ldic.html
5. http://unowyteyifinoh.j.pl/linear-digital-integrated-circuits-pdf.html

**XIV. EXPERT DETAILS:**

1. Sai Pavan Sudha Manager – Ami Tech India Pvt. Ltd.
2. P. Raghu Sr. Hardware Engineer – Ami Tech India Pvt. Ltd.
3. Pratap Reddy Prof. JNTUH
4. Dr. E. Venkat Reddy Prof. BIET

**XV. JOURNALS:**

**INTERNATIONAL**

1. International Journal of Electronics and Communication Engineering (IJECE)
2. International Journal of Electronic Networks, Devices and Fields (IJENDF)
3. International Journal of Applied Engineering Research (IJAER)
4. International Journal of Electronics Engineering Research **(IJEER)**
**5.** International Journal of Microcircuits and Electronics(IJME)

**NATIONAL**

1. Analog Integrated Circuits and Signal Processing
2. IETE Journal of Research
3. Journal of Electromagnetic Waves and Application
4. Journal of VLSI Signal Processing
5. Journal of Supercomputing

## XVI. LIST OF TOPICS FOR STUDENT SEMINARS

1. IC, their types with pin diagram descriptions
2. Recent development in Ic and the future scope
3. Instrumentation amplifiers principle, types and principle
4. Oscillators principle and types
5. Filters principle and types
6. Timer 555 IC
7. D & T FF's & their conversion
8. Shift registers & applications
9. Different types of ADC
10. IC Interfacing-TTL driving of CMOS

## XVII. CASE STUDIES / SMALL PROJECTS:

(a) Designing of HALF ADDER using ICs
(b) Designing of FULL ADDER using ICs
(c) Designing of MULTIPLEXER using ICs
(d) Designing of BINARY COUNTER using ICs