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| **COURSE CODE** | **COURSE TITLE** | **L** | **T** | **P** | **C** |
| **1151EC103** | ANALOG ELECTRONICS | **2** | **2** | **0** | **3** |

1. **Preamble:**

This Course provides the basic and design knowledge about electronic circuit analysis using BJT and CMOS which involves feedback, oscillator, high frequency amplifiers and its applications.

1. **Pre-requisite:**

Basic Electronics Engineering

1. **Related courses:**

Linear Integrated Circuits, Communication Systems.

1. **Course outcomes:**

Upon the successful completion of the course, students will be able to:

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| **Co**  **Nos.** | **Course Outcomes** | **Level of learning domain (Based on revised Bloom’s taxonomy)** |
| CO1 | Evaluate the importance of the biasing in transistor circuits. | K2 |
| CO2 | Examine the transistor circuits with two port system approach using hybrid parameters. | K3 |
| CO3 | Assess the transistor feedback amplifier and oscillators | K2 |
| CO4 | Defend the MOSFET amplifier as an active load and current mirror | K2 |
| CO5 | Explain the applications of transistors with power amplifiers , multivibrators and CMOS linear applications | K2 |

1. **Course content :**

**UNIT-I DC Biasing of Transistor 6+3 = 9**

Review of Transistor characteristics, Thermal runaway, thermal stability, DC Biasing-BJT: Different types of biasing circuits. Compensation techniques- Design of biasing for MOSFET

**UNIT-II Transistor AC Analysis or Small signal analysis 6+3 = 9**

Amplification in AC Domain, BJT Transistor modeling, re model for CB,CE and CC, Two port system approach, The Hybrid Equivalent model, Approximate Hybrid equivalent circuit, Hybrid ∏ model : CE, CC and CB configurations. Small signal analysis of MOSFET, Source follower and common gate amplifier.

**UNIT-III Feedback Amplifier and Oscillators 6+3 = 9**

Basic concept of Feedback, Feedback connection types, Input and output impedance of feedback configurations. Advantages of negative feedback,

Oscillators**:** Principles of sinusoidal oscillator - Barkhausen criteria - RC oscillators - phase shift- Wienbridge - LC oscillators - Hartley , Colpitts -Clapp oscillator, crystal oscillator.

**UNIT-IV IC MOSFET Amplifier 6+3 = 9**

IC Amplifiers- IC biasing Current steering circuit using MOSFET- MOSFET current sources- PMOS and NMOS current sources. Amplifier with active loads - enhancement load, Depletion load and PMOS and NMOS current sources load- CMOS common source and source follower- CMOS differential amplifier- CMRR.

**Unit-V Applications of Transistors and CMOS 6+3 = 9**

**Tuned amplifier** - Analysis of single tuned, double tuned and stagger tuned amplifier.

**Power amplifiers** - Transformer coupled Class A power amplifier, Class B amplifier operation, Transformer coupled Push pull circuits, Complimentary symmetry circuits.

**Multivibrators -** Bistable, Monostable and Astable operation, Schmitt trigger.

**CMOS** Linear Applications - Cascading Amplifiers for Higher Gain

**Total= 45 Periods (30+15)**

**8. Text books:**

1. Sedra & Smith, Microelectronic circuits, Oxford University Press, 5th edition.
2. Donald .A. Neamen, Electronic Circuit Analysis and Design –2nd Edition, Tata Mc Graw Hill, 2009.
3. Boylestead&Neshelsky, Electronic Devices & Circuits, Pearson Education/PHI Ltd, 10th edition, 2010.
4. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw-Hill, 2007.
5. David .A. Bell, Electric Circuits and Electronic Devices Oxford University Press, 2010.

**9. References:**

1. Bapat K N , Electronic Devices & Circuits , Mc Graw Hill,1992.
2. J. Millman and Halkias .C, " Integrated Electronics ",2nd Edition, Tata McGraw-Hill, 2001.
3. Donald L.Schilling and Charles Belove**,** **'**Electronic Circuits**'**, Tata McGraw Hill, 3rd Edition, 2003.

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| **S.No** | **Topic** | **Text Book -1 (Page No)** | | **Text book -2 (Page No)** | **Text book -3 (Page No)** | **Web Link/ Other Resources** | **Delivery Method** |
| **Unit I DC Biasing of Transistor** | | | | | | | |
| 1 | Review of Transistor characteristics |  | |  | 131 |  | **1/2/6/7** |
| 2 | Thermal runaway, thermal stability, |  | |  | 212 |  |
| 3 | Fixed bias and Emitter Bias |  | |  | 162,164 |  |
| 4 | Voltage divider,Collector feedback bias |  | |  | 171,176 |  |
| 5 | Emitter follower,Common base Bias |  | |  | 183,188 |  |
| 6 | Compensation techniques- Design of biasing for MOSFET |  | |  | 429,433 |  |
| 7 | Tutorial-I |  | |  | T3 |  |
| 8 | Tutorial-II |  | |  | T3 |  |
| 9 | Tutorial-III |  | |  | T3 |  |
| **Unit Test-1 (CO1)** | | | | | | | |
| **Unit II Transistor AC Analysis or Small signal analysis** | | | | | | | |
| 10 | Amplification in AC Domain, BJT Transistor modeling |  | |  | 247,248 |  |  |
| 11 | re model for CB,CE and CC |  | |  | 251-271 |  |
| 12 | Two port system approach, The Hybrid Equivalent model |  | |  | 311 |  |
| 13 | Approximate Hybrid equivalent circuit, Hybrid ∏ model : CE, CC and CB configurations. |  | |  | 316-329 |  |
| 14 | Small signal analysis of MOSFET , |  | |  | 497 |  |
| 15 | Source follower and common gate amplifier. |  | |  | 489,490 |  |
| 16 | Tutorial-I |  | |  | T3 |  |
| 17 | Tutorial-II |  | |  | T3 |  |
| 18 | Tutorial-III |  | |  | T3 |  |
| **Mid Term Test-1(CO1,CO2)** | | | | | | | |
| **Unit III Feedback Amplifier and Oscillators** | | | | | | | |
| 19 | Basic concept of Feedback, Feedback connection types | |  |  | 740,741 |  | **1/2/6** |
| 20 | Input and output impedance of feedback configurations. Advantages of negative feedback, | |  |  |  | Electronic Circuits – II  UA Bakshi  Pg 6 - 30 |
| 21 | Principles of sinusoidal oscillator - Barkhausen criteria | |  |  | 755 |  |
| 22 | RC oscillators - phase shift- | |  |  | 756 |  |
| 23 | .Wienbridge LC oscillators | |  |  | 759,760 |  |
| 24 | Hartley , Colpitts -Clapp oscillator, crystal oscillator | |  |  | 760-763 |  |
| 25 | Tutorial-I | |  |  | T3 |  |
| 26 | Tutorial-II | |  |  | T3 |  |
| 27 | Tutorial-III | |  |  | T3 |  |
| **Unit Test-2 (CO3)** | | | | | | | |
| **Unit IV IC MOSFET Amplifier** | | | | | | | |
| 28 | IC Amplifiers- IC biasing Current steering circuit using MOSFET | | Ch.6;pg562-565 |  |  |  |  |
| 29 | MOSFET current sources- PMOS and NMOS current sources. | |  | **Ch.11;pg704-715** |  |  |
| 30 | Tutorial | | Ch.6;pg666-668 |  |  |  |
| 31 | Amplifier with active loads - enhancement load, Depletion load | |  | Ch.11;pg721-730 |  | . |
| 32 | Amplifier with active loads - PMOS and NMOS current sources load. | | pg582-583 | Ch.11;pg729-730 |  |  |
| 33 | Tutorial | | Ch.6;pg666-668 |  |  |  |
| 34 | CMOS common source and source follower | | Ch.6;582-587  Ch.6; pg635-638 |  |  |  |
| 35 | CMOS differential amplifier- CMRR | | Ch.6;pg680-681 |  |  |  |
| 36 | Tutorial | |  | Ch.11;pg795-821 |  |  |
| **Unit V** | | | | | | | |  | 2-Ch.6;pg780-785 |
| 37 | **Tuned amplifier**- Analysis of single tuned amplifier | | 382 |  |  |  |  |
| 38 | Double tuned and stagger tuned amplifier | | 383 – 385 |  |  |  |
| 39 | **Power amplifiers** - Transformer coupled Class A power amplifier, Class B amplifier operation, Transformer coupled Push pull circuits, Complimentary symmetry circuits | |  | Ch.8;pg**(**561-593) |  |  |
| 40 | Tutorial | |  | Ch.7;pg745-776 |  |  |
| 41 | **Multivibrators -** Bistable, Monostable | | 207 |  |  |  |
| 42 | Astable operation, Schmitt trigger. | |  |  |  | Schilling and Belove, Electronic Circuits, 3rd Edition, TMH, 2002.  Pg 203, 295 |
| 43 | Tutorial | | T1 |  |  |  |
| 44 | **CMOS** Linear Applications - Cascading Amplifiers for Higher Gain | |  |  |  | <http://www.shrubbery.net/>  ~heas/willem/PDF/NSC/AN/AN-88.pdf |
| 45 | Tutorial | |  |  |  | <http://www-inst.eecs.berkeley.edu/> ~ee247/fa08/files07/lectures/L21\_f08.pdf |
| **Mid Term Test-II (CO3,CO4 and CO5)** | | | | | | | |
| **TOTAL NO OF PERIODS=45 PERIODS** | | | | | | | |