**Techno India NJR Institute of Technology**



**Course File**

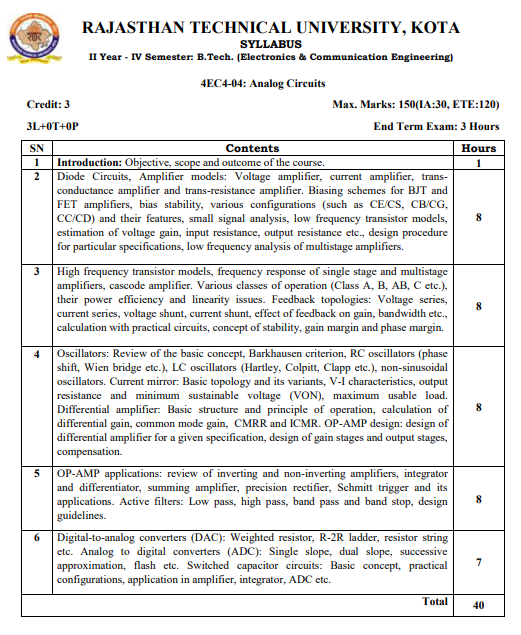
**Session 2023-24**

**Analog Circuits (4EC4-04)**

Mr. Hitesh Sen

(Asst. Professor)

**Department of ECE**



**Course Overview:**

This course on Analog Circuits has been designed primarily as a core course for undergraduate students and, as a refresher course for master level students and circuit designers working in industry. It starts with basic circuit components and circuit concepts and then, gradually moves to practical building blocks of analog electronic systems. In this course, a serious attempt has been made to make a balance between theory and practice so that the discussed circuits can be constructed in an undergraduate level laboratory class and their measured performance can be easily compared with the analytically predicted performance. It helps to build confidence on theory. The other important feature of this course is, it covers both BJT based circuits and MOSFET based circuits parallel so that similarities and performance differences between these two classes of circuits are understandable. Moreover, the BJT based circuits discussed here can be easily constricted on bread board to verify their characteristic through measurement. On the other hand, analysis of the MOSFET based circuits provides the necessary foundation for Analog VLSI circuit/system design, a next level course in Microelectronics and VLSI Design.

**Course Outcomes:**

|  |  |  |
| --- | --- | --- |
| **CO.NO.** | **Cognitive Level** | **Course Outcome** |
| 1 | Knowledge | Understand the characteristics of diodes and transistors |
| 2 | Application | Design and analyze various rectifier and amplifier circuits |
| 3 | Application | Design sinusoidal and non-sinusoidal oscillators |
| 4 | Application | Understand the functioning of OP-AMP and design OPAMP based circuits |
| 5 | Knowledge | Understanding the designing of ADCs and DACs |

**Prerequisites:**

1. Knowledge of semiconductor Physics
2. Electrical technology and, Semiconductor Devices

**Course Outcome Mapping with Program Outcome:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Outcome** | **Program Outcomes (PO’s)** | | | | | | | | | | | |
| **CO. NO.** | **Domain Specific** | | | | | **Domain Independent** | | | | | | |
|  | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| CO1 | 3 |  | 1 | 1 | 2 |  |  |  |  |  |  |  |
| CO2 | 1 | 1 | 2 |  | 1 |  |  |  |  |  |  |  |
| CO3 | 3 | 1 |  | 1 |  |  |  |  |  |  |  |  |
| CO4 | 2 |  |  |  | 2 |  |  |  |  |  |  |  |
| CO5 | 2 | 3 |  | 2 |  |  |  |  |  |  |  |  |
| 1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High) | | | | | | | | | | | | |

**Course Coverage Module Wise:**

|  |  |  |
| --- | --- | --- |
| **Lecture No.** | **Unit** | **Topic** |
| 1 | **1** | **INTRODUCTION:** Objective, scope and outcome of the course. |
| 2 | **2** | **DIODE CIRCUITS, AMPLIFIER MODELS:**  Diode circuit, I-V Characteristics of diode, diode applications |
| 3 | 2 | Voltage amplifier, current amplifier |
| 4 | 2 | Transconductance amplifier, Transconductance amplifier |
| 5 | 2 | Biasing schemes for BJT and FET, Bias stability |
| 6 | 2 | Various configuration (such as CE/CS, CB/CG, CC/CD) |
| 7 | 2 | Low frequency transistor model, Estimation of gain, input resistance, output resistance |
| 8 | 2 | Design procedure for particular specification, Low frequency analysis of multistage amplifier |
| 9 | **3** | **HIGH FREQUENCY TRANSISTOR MODEL:**  High frequency transistor model description |
| 10 | 3 | Frequency response of single stage and multistage amplifier, Cascode amplifier |
| 11 | 3 | Various class of operation (Class A, B, AB, C etc.) |
| 12 | 3 | Power amplifier efficiency and linearity issues, Feedback topologies |
| 13 | 3 | Voltage series feedback topology, Voltage shunt feedback topology |
| 14 | 3 | Current series feedback topology, Current shunt feedback topology |
| 15 | 3 | Effect of feedback on gain and bandwidth etc. |
| 16 | 3 | Feedback amplifier calculation with practical circuits |
| 17 | 3 | Concept of stability, Gain margin, phase margin |
| 18 | **4** | **OSCILLATOR:**  Review the basic concept, Barkhausen criterion |
| 19 | 4 | RC phase shift oscillator, Wiens bridge oscillator |
| 20 | 4 | Current mirror basic topology and its variants |
| 21 | 4 | Current mirror V-I characteristics and output resistance |
| 22 | 4 | Minimum sustainable voltage (VON), Maximum usable load |
| 23 | 4 | Differential amplifier basic structure |
| 24 | 4 | Differential amplifier principle of operation |
| 25 | 4 | Calculation of differential gain, Calculation of common mode gain |
| 26 | 4 | CMRR and ICMR |
| 27 | 4 | OP Design**:**Design of differential amplifier for a given specification |
| 28 | 4 | Design of gain stage and output stage, Compensation |
| 29 | **5** | **OP- AMP APPLICATION:**review of inverting amplifier |
| 30 | 5 | Review of non-inverting amplifier, Integrator, Differentiator |
| 31 | 5 | Summing amplifier, Precision rectifier |
| 32 | 5 | Schmitt trigger and its application |
| 33 | 5 | Active filter: low pass, high pass |
| 34 | 5 | Band pass and band stop and its design guidelines |
| 35 | **6** | **DIGITAL TO ANALOG CONVERTER (DAC):**  Weighted resistor |
| 36 | 6 | R-2R ladder, resistor string etc. |
| 37 | 6 | Analog to digital converters (ADC): Single slop, dual slop |
| 38 | 6 | Successive approximation, flash etc. |
| 39 | 6 | Switched capacitor circuits: basic concept, practical configuration, application in amplifier |
| 40 | 6 | Integrator, ADC etc. |

**TEXT/REFERENCE BOOKS**

1. Microelectronic Circuits – Theory and Applications, Adel S Sedra, Kenneth C Smith and Arun N Chandorkar, Oxford University Press
2. Op-amps and linear integrated circuit technology, Ramakant A. Gayakwad,PHI
3. Electronic Devices and Circuits, J.B. Gupta, S.K. Kataria& Sons.

**Teaching and Learning resources:**

**MOOC (NPTEL): -** https://nptel.ac.in/courses/108/102/108102112/

|  |
| --- |
| **QUIZ Link**   1. <https://testbook.com/objective-questions/mcq-on-analog-electronics--5eea6a1239140f30f369ede5> |

**Assessment Methodology:**

1. Viva and circuit design in practical lab.
2. Numerical Assignment
3. Two Midterm exams where student have to showcase subjective learning.
4. Final Exam (subjective paper) at the end of the semester.

**TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR**

**B. TECH 2nd – YEAR (IV SEM.) – Assignment-I**

**Analog Circuits** (**4EC4-04**)

|  |
| --- |
| 1. Obtain Vrms for Full wave rectifier circuit. |
| 1. Short note on Clipper circuits. |
| 1. Find the expression of Miller Effect Capacitance. |
| 1. Explain in brief with diagram about the cross over distortion. |
| 1. Short note on type of amplifiers. |
| 1. What are the different feedback topologies and expression of β for each? |
| 1. Find the effect of feedback on amplifier open loop gain. |
| 1. Draw the circuit diagram of BJT in CE,CB & CC configuration |
| 1. An opamp has feedback resistor Rf = 12KΩ and R1 = 12kΩ, R2 = 2KΩ, R3 = 3KΩ and the corresponding V1 = +9V, V2 = -3V and V3 = -1V. Non inverting terminal is grounded. Calculate the Vout. |
| 1. Design a low pass filter using opamp having a cut-off frequency of 2KHz aith a pass band gain of 2.5. |

|  |
| --- |
| 1. Obtain the low frequency response for the FET amplifier. |
| 1. Obtain the low frequency response for the BJT amplifier. |

|  |
| --- |
| 2. Determine the following for the fixed bias configuration shown in the figure below IBQ , ICQ , VCEQ, VB, VC & VBC |
| 2. Using exact analysis determine the value of Q point for the given circuit |

|  |
| --- |
| 3. Perform the small signal analysis of the given circuit. |
| 3. Perform the small signal analysis of the given circuit. |

|  |
| --- |
| 4. Draw the circuit diagram for transformer coupled Class A amplifier and obtain the expression for the efficiency. |
| 4. Draw the circuit diagram of Class B Push Pull amplifier. Explain its working. Also Derive the overall efficiency for the same. |

|  |
| --- |
| 5. Show that the Bandwidth of an amplifier increases with negative feedback and also obtain its expression. |
| 5. Obtain the expression for input and output impedance of an amplifier with negative feedback. Also If the open loop gain Av = 10000, and feedback ration β = 1/10 then find the percentage change in closed loop gain when the open loop gain varies by 50%. |

**TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR**

**B. TECH 2nd – YEAR (IV SEM.) – Assignment -II**

**Analog Circuits** - **4EC4-04**

|  |  |
| --- | --- |
|  | What are clipper circuits? Describe the Biased clippers. |
|  | What is the need of Transistor biasing? |
|  | Voltage gain of the amplifier without feed-back is 60dB; it decreases to 40dB with feed-back. Find the value of feed-back factor. |
|  | Short note on Stability and gain margin. |
|  | Explain Barkhausen criteria for oscillators. |
|  | Short note on Input offset voltage & Input bias current. |
|  | Short note on Precision Rectifier circuit. |
|  | Short note on Schmitt trigger circuit. |
|  | What is Quantization Error? Also explain Nyquist Rate. |
|  | Short note on Switched Capacitor circuits. |

|  |
| --- |
| 1. Obtain the low frequency response for the FET amplifier. |
| 1. Obtain the low frequency response for the BJT amplifier. |

|  |
| --- |
| 1. Classify thee amplifiers on basis of selection of operating point. Compare the various configurations in terms of efficiency. |
| 2. Show that the Bandwidth of an amplifier increases with negative feedback and also obtain its expression. |

|  |
| --- |
| 1. A. Draw the circuit diagram and explain the working of **Hartley Oscillator**.   B. Draw the circuit diagram and explain the working of **Colpitt Oscillator**. |
| 3. A .Explain basic current mirror circuit with the expression for output current  B. Derive expression of output current for **Wilson current mirror.** |

|  |
| --- |
| 1. A. Draw the circuit diagram of **Op Amp Inverting** amplifier. Also derive the expression of **close loop voltage gain.**   B. A. Draw the circuit diagram of **Op Amp Non-Inverting** amplifier. Also derive the expression of **close loop voltage gain**. |
| 4. Explain following Active filters with the expression for cut-off frequency  **LPF,HPF,BPF & BSF** |

|  |
| --- |
| 1. **Explain working of following DAC:**   a. Weighted Resistor type b. R -2R Ladder network type |
| **5.** **Explain working of Following w.r.t ADC:**  a. SAR type ADC b. Resolution of ADC |

**TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR**

**Electronics & Communication Engineering**

**B. TECH II– YEAR (IV Sem)**

**Analog Circuits**

**VIVA**

Q.1. What is integrated circuit (IC)?

Q.2. What are linear ICs?

Q.3. What is an operational amplifier?

Q.4. What is the use of level translators?

Q.5. What is differential amplifier and its significance?

Q.6. What are the important features of differential amplifier?

Q.7. How differential amplifiers can be configured and what are they?

Q.8. What is common mode rejection ratio (CMRR)?

Q.9. How CMRR can be improved?

Q.10. What is the drawback of op amp IC 741?

Q.11. What is current mirror?

Q.12. What is the advantage of using a current mirror circuit?

Q.13. What is the advantage of using a constant current bias circuit?

Q.14. How ICs are classified?

Q.15. What are the important characteristics of an ideal op amp?

Q.16. Define slew rate.

Q.17. What is the importance of slew rate?

Q.18. What are the features of IC 741?

Q.19. Why op-amp is not used as an amplifier in the open loop configuration?

Q.20. What are the advantages of negative feedback?

Q.21. What is the difference between positive feedback and negative feedback?

Q.22. What is the virtual short or virtual ground concept?

Q.23. What is input offset voltage?

Q.24. What is input offset current?

Q.25. What is input bias current?

Q.26. What are the features of a voltage follower circuit and what is its application?

Q.27. What are op-amp characteristics and its significance?

Q.28. What is the output resistance of op-amp IC 741?

Q.30. What is power supply rejection ratio (PSRR)?

