Techno India NJR Institute of Technology

Course File

Session 2021-22

Analog Circuits (4EC4-04)

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

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RAJASTHAN TECHNICAL UNIVERSITY, KOTA

SYLLABUS

II Year - IV Semester: B.Tech. (Electronics & Communication Engineering)

4EC4-04: Analog Circuits

Credit: 3 | **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P | **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.	8
3	High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.	8
4	Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators. Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.	8
5	OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines.	8
6	Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog to digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.	7
	Total	**40**

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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)												

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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		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/

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.

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4E1219

Roll No. _______ Total No of Pages: 3

4E1219
B. Tech. IV - Sem. (Main) Exam., May - 2019
PCC Electronics & Comm. Engg.
4EC4-04 Analog Circuits
EC. EI

Time: 3 Hours Maximum Marks: 120

Instructions to Candidates:

Attempt all ten questions from Part A, five questions out of seven questions from Part B and four questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10x2=20]**

All questions are compulsory

Q.1 Explain why is base made thin?

Q.2 Why 'transistor' is called so?

Q.3 Explain how BJT amplifier, bias stability is achieved?

Q.4 Explain Gain Margin?

Q.5 Explain common mode gain for an oscillator.

Q.6 Explain low pass active filters

Q.7 Describe single slope of ADC.

Q.8 Design a low pass filter at a cut off frequency of 1 kHz with a pass band gain of 2.

Q.9 An operational amplifier has a slew rate of 2V/µs. If the peck output is 12V, what is the power bandwidth?

Q.10 Explain concept of stability?

PART – B

(Analytical/Problem solving questions) **[5×8=40]**

Attempt any five questions

Q.1 Explain low frequency analysis of multistage amplifiers.

Q.2 For a p-channel silicon FET with $a = 2 \times 10^{-4}$ cm and channel resistivity $\rho = 10\Omega$-cm

(i) Find the pinch off voltage http://www.rtuonline.com

(ii) Repeat (i) for a p-channel germanium FET with $\rho = 2\Omega$ - cm

Q.3 Calculate the operating frequency of a transistor Hartley oscillator if $L_1 = 100$ µH, $L_2 = 1$mH, mutual inductance between the coils, M = 10µH and C = 10pF.

Q.4 With a neat diagram, explain the action of Hartley and Colpitts oscillators.

Q.5 Explain Schmitt trigger and its applications.

Q.6 Explain Switched Capacitor Circuits?

Q.7 Describe concept of stability and gain margin?

PART – C

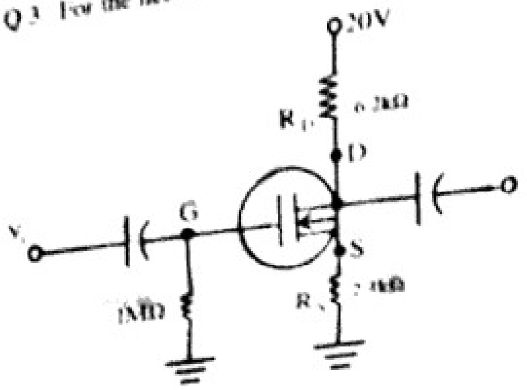
(Descriptive/Analytical/Problem Solving/Design Questions) [4×15=60]

Attempt any four questions

Q.1 Design and explain Digital to Analog Converters.

Q.2 Explain active filters with low pass, high pass, band pass and band stop

Q.3 For the network of figure below given I_{DSS} = 8 mA and V_P = -8 volt



Q.4 Explain differential amplifier, its basic structure and principle of operation.

Q.5 Explain current mirror, its basic topology and its variants.

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