Course Description and Outcome Form
Department of Computer Science and Engineering
School of Engineering and Computer Science
Brac University

A. Course General Information:

Course Code:	CSE251 CSE251L
Course Title:	Electronic Devices and Circuits Electronic Devices and Circuits Laboratory
Credit Hours (Theory+Lab):	3 + 0
Contact Hours (Theory+Lab):	3 + 3
Category:	Program Core
Type:	Required, Engineering, Lecture + Laboratory
Prerequisites:	CSE250
Co-requisites:	None

B. Course Catalog Description (Content):

Introduction to semiconductors, p-type and n-type semiconductors; I-V characteristics of Non-linear devices; p-n junction diode characteristics; Diode applications: half and full wave rectifiers, regulated power supply using zener diode, diode-logic circuits. Bipolar Junction Transistor (BJT): principle of operation, I-V characteristics; Operational Amplifiers (OPAMP): linear applications of OPAMPs – summer, subtractor, differentiator, integrator; gain, input and output impedances; Application of OPAMPs as comparator; Transistor circuit configurations (CE), BJT biasing, load lines; Switching circuits using BJTs; Small-signal analysis of single-stage amplifiers. Field Effect Transistors (FET): the principle of operation of MOSFET; Depletion and enhancement type NMOS and PMOS; biasing of FETs; Switching circuits using FETs; Mathematical analysis of BJT and MOSFET-based circuits; The course includes a compulsory 3-hour laboratory work each week.

C. Course Objective:

The objectives of this course are to:

a. Introduce Electronic Devices such as Diodes and Transistors, and the semiconductor physics principles used to make them
b. Introduce the Piece-Wise Linear modeling technique to analyze circuits with non-linear devices
c. Show the application of diodes in constructing various circuits, such as rectifiers, regulators, etc.
d. Show the application of transistors in building switching circuits and amplifiers with appropriate biasing methods.
e. Introduce students to the Operational Amplifier, its application as a comparator, and also in different circuits to perform analog signal-processing tasks, such as Summing, Subtracting, Exponentiating, etc.
f. Training students to prototype circuits in hardware and analyze their behavior

g. Exposing students to Circuit simulation tools to aid them in analyzing circuit behavior before implementing them in real life.

h. Guiding students to complete a project using transistors and Op-Amps to implement their knowledge of Non-linear devices.

D. Course Outcomes (COs):

Upon successful completion of this course, students will be able to

Sl.	CO Description	Weightage (%)
CO1	**Understand** and **compare** the characteristics and operation of electronic devices such as Diode, BJT, MOSFET, and Op-Amps.	10%
CO2	**Analyze** the behavior of electronic circuits consisting of different non-linear electronic devices such as Diodes, BJT, and MOSFETs using tools such as piece-wise linear modeling and the method of assumed states	25%
CO3	**Design** various electronic circuits for power-generation and analog signal-processing applications such as rectifiers, regulators, switching, analog-to-digital and digital-to-analog conversion, amplification, performing arithmetic operations on analog Signals, e.g, summing, subtracting, exponentiation, and generating voltage waveforms of different shapes.	35%
CO4	**Demonstrate** competence in using electronic laboratory equipment to build, test, and troubleshoot electronic circuits.	15%
CO5	Collaborate effectively in a group to design, build, and **execute** a project that demonstrates the application of electronic devices and circuits to a real-world problem.	10%

E. Mapping of CO-PO-Taxonomy Domain & Level- Delivery-Assessment Tool:

Sl.	CO Description	POs	Bloom's taxonomy domain/level	Delivery methods and activities	Assessment tools

CO1	**Understand** and **compare** the characteristics and operation of electronic devices such as Diode, BJT, MOSFET, and Op-Amps	**PO1**	Cognitive/Analyze, Understand	Lectures, Notes/Handouts, Simulation Demo	Quiz, Exam, Assignment
CO2	**Analyze** the behavior of electronic circuits consisting of different non-linear electronic devices i.e., Diodes, BJT, MOSFETs, using appropriate models and methods such as piece-wise linear models and Method of assumed states	**PO2**	Cognitive/Analyze, Apply	Lectures, Notes/Handouts, Simulation Demo	Quiz, Exam, Assignment
CO3	**Design** various electronic circuits for power-generation and analog signal-processing applications such as rectifiers, regulators with diodes, switching, and amplification using transistors, and perform arithmetic operations on Analog Signals, e.g, Summing, Subtracting, Exponentiation using Op-Amps.	**PO3, PO5**	Cognitive/Evaluate, Apply, Analyze	Lectures, Notes/Handouts, Simulation Demo	Quiz, Exam, Assignment
CO4	**Demonstrate** competence in using laboratory equipment to build, test, and troubleshoot electronic circuits	**PO3, PO9**	Cognitive/ Analyze, Apply, Psychomotor/ Precision, Manipulation	Lab Class	Lab Work, Lab Test
CO5	Collaborate effectively in a group to design, build, and **execute** an electronic project that demonstrates the application of electronic devices and circuits to a real-world problem.	**PO3, PO9**	Cognitive/Create, Analyze, Apply, Psychomotor/ Precision, Manipulation	Lab Class	Lab Work, Q/A, Presentation

F. Course Materials:

i. Text and Reference Books:

Sl.	Title	Author(s)	Publication Year	Edition	Publisher	ISBN
1	Foundations of Analog and Digital Electronic Circuits	Anant Agarwal, Jeffrey H. Lang	2005	1st ed.	Morgan Kaufmann Publishers	978–1–55–860735–4
2	Microelectronic Circuits	Adel S. Sedra, Kenneth C. Smith	2015	7th ed.	Oxford University Press	978–0–19–933913–6
3	The Art of Electronics	Paul Horowitz, Winfield Hill	2016	3rd ed.	Cambridge University Press	978–0–521–80926–9
4	Operational Amplifiers and Linear Integrated Circuits	Robert F. Coughlin, Frederick F. Driscoll	2001	6th ed.	Prentice Hall	978–0–130–14991–6

ii. Other Materials (Video Lectures)

a. CSE 251 Central Playlist - YouTube
b. CSE 251 Playlist by PDS - YouTube

G. Lesson Plan:

Theory

No	Topic	Week/Lecture#	Related CO (if any)
1	History and Importance of Electronic Devices – Diodes, Electronic Switches, and Amplifiers, Transition from Mechanical Switches to Vacuum Tubes to Solid State Devices, Current State-of-the-Art in Electronics/Semiconductor Technology	Lecture-1	CO1
2	Alternative circuit representation; Review of KCL, KVL, Nodal analysis	Lecture-2	CO3
3	Introduction to Operational Amplifiers – Differential Amplifiers; Solving Op-Amp based circuits using KCL, KVL, and Nodal Analysis; Op-Amp Circuits in Open-Loop Configuration – Square Wave Generator, Characteristics of Infinite Gain.	Lecture-3	CO1, CO2
4	Op-Amp Circuits in Closed Loop Configuration - Controlling Gain through Negative Feedback, Virtual Ground Op-Amp Circuits in Closed Loop Configuration – Inverting Amplifier, Non-Inverting Amplifier,	Lecture-4	CO2,CO3

5	Op-Amp applications in Follower, Buffer, Inverting Weighted Summer, Noninverting amplifier, Weighted Subtractor, Differentiator, Integrator, and VTC Graphs of Comparator, Inverting Amplifier, and Non-inverting Amplifier. Optional: Noninverting summer, Exponential Converter, Logarithmic Converter, Multiplier, Divider	Lecture-5	CO2,CO3
6	Introduction to I-V Characteristics. I-V Characteristics of: Simple Linear Elements – Resistors, Voltage Source, and Current Source; I-V Characteristics of: Degenerate Elements – Open-Circuit and Short-Circuit;	Lecture-6	CO2
7	Introduction to Diode; Shockley Diode Equation and Diode Logic Gates;	Lecture-7	CO1, CO3
8	CVD and CVD+r diode models; Solving Diode circuits with Method of Assumed States (M.A.S);	Lecture-8	CO2, CO3
9	Solving Diode Circuits;	Lecture-9	CO2
10	Problem-Solving Class	Lecture-10	CO1, CO2, CO3
11	Midterm Syllabus Review	Lecture-11	CO1, CO2, CO3
Mid-Term Exam			
12	Introduction to Rectifiers, Half-Wave Rectifiers and Transfer Characteristics, Full-Wave Rectifiers and Transfer Characteristics	Lecture-12	CO1, CO3
13	Rectifiers Revisited – Average Value of Output, Smoothing Capacitor, Peak-to-Peak Ripple, Ripple Factor	Lecture-13	CO2, CO3
14	Introduction to Electronic Switches, Basic Inverter, Introduction to Controlled Sources, Introduction to MOSFET, Designing Logic Gates with MOSFETs	Lecture-14	CO1,CO3
15	Constructing a *real* MOSFET – n/p-channel, enhancement/depletion-type MOSFETs. Operation of an Ideal FET- Cut-Off, Saturation and Triode Mode, Output Characteristics, PWL Model and Non-ideal Analysis, Static Analysis	Lecture-15	CO1
16	Different MOSFET circuit configurations	Lecture-16	CO2
17	Solving MOSFET Circuits using the Method of Assumed States,	Lecture-17	CO2
18	Introduction to BJT, Voltage-Current Conversion using Resistors, Constructing a *real* BJT – npn and pnp transistors, Ebers-Moll Equation, Current and Voltage controlled logic gates	Lecture-18	CO1
19	Operation of an Ideal BJT- Cut-Off, Active, and Saturation Mode, Ideal Output Characteristics, PWL Model & Non-ideal Analysis, Solving Transistor	Lecture-19	CO1,CO2

	Circuits using Method of Assumed States, Problem-Solving		
20	Different BJT circuit configurations, Problem Solving;	Lecture-20	CO2, CO3
21	Final Exam Review Class	Lecture-21	CO1, CO2, CO3
22	Final Exam Review Class	Lecture-22	CO1, CO2, CO3
Final Exam			

G. Lab Experiments & Probable Timeline:

Lab Activity	Lab Title
Exp-01	Review of Lab Equipment
Exp-02	Study of Op-Amp: Comparator, Non-Inverting Amplifier, Inverting Amplifier, Inverting Summing Amplifier, Study of VTC of Op-Amp Comparator, Non-Inverting Amplifier & Inverting Amplifier
Exp-03	Study of I-V Characteristics of Diode and Equivalent CVD Model Verification
LAB TEST-1	**Syllabus: Exp-1, Exp-2 & Exp-3**
Exp-04	Study of Half-Wave and Full-Wave Rectifier
Exp-05	Study of I-V Characteristics of Transistors (MOSFET) and Implementation of Logic Functions
Exp-06	Study of I-V Characteristics of Transistors (BJT) and Implementation of Logic Functions
LAB TEST-2	**Syllabus: Exp-4, Exp-5 & Exp-6**

H. Assessment Tools:

i. Theory:

Assessment Tools	Weightage (%)
Attendance and Class Participation	5
Quiz	14
Assignment	6
Midterm Examination	25
Final Examination	25
Total	**75%**

ii. Lab:

Assessment Tools	Weightage (%)
Lab Attendance	2
Lab Performance	4
Hardware Lab Report	5
Hardware Lab Test 1	7

Hardware Lab Test 2	7
Total	**25%**

I. CO Assessment Plan:

Assessment Tools	Course Outcomes					
	CO1	CO2	CO3	CO4	CO5	CO6
Quiz	✔	✔	✔			
Assignment	✔	✔	✔			
Midterm Examination	✔	✔	✔			
Lab Work				✔		
Lab Report					✔	
Hardware Lab Test				✔		
Final Examination	✔	✔	✔			

J. CO Attainment Policy:

As per the course outcome attainment policy of the Department of Computer Science and Engineering.

K. Grading Policy:

As per the grading policy of the Department of Computer Science and Engineering.

L. Course Coordinators:

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