Subject Description Form

Subject Code	EE2003C
Subject Title	Electronics
Credit Value	3
Level	2
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: EE2002C
Objectives	1. To introduce the principles, techniques, and skills for the operations, analysis, and experimentation of semiconductor-based electronic devices and circuits. 2. To introduce the principles and techniques for the implementation of frequency domain analysis on first-order ac circuits with sinusoidal driving sources.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Describe the fundamental principles for the operations of semiconductor-based electronic devices and circuits. b. Apply the appropriate techniques for the analysis of semiconductor-based electronic devices and circuits. c. Implement the frequency domain analysis on first-order ac circuits with sinusoidal driving sources. d. Conduct relevant laboratory experiments and report the findings with appropriate techniques and tools.
Subject Synopsis/ Indicative Syllabus	**Syllabus:** 1. Diodes and Diode Circuits Semiconductor materials and properties. Properties of p-n junctions. Structure, operation and characteristics of p-n junction diodes. Ideal and practical p-n junction diodes. Analysis of basic diode circuits. Analysis of specific diode circuits: rectifiers, peak detectors, clippers, clampers, etc. Load line concept and analysis. 2. Bipolar Junction Transistors (BJTs) and BJT Amplifiers Structures, operations and characteristics of n-p-n and p-n-p BJTs. DC analysis, load line and design techniques of BJT circuits. DC biasing schemes. Basic configurations, operations and characteristics of BJT amplifiers. AC analysis, load line and design techniques. Small-signal equivalent circuits and parameters. Small-signal voltage gain, current gain, input resistance and output resistance. Loading effect. 3. Metal-Oxide-Semiconductor Field-Effect Transistors (MOSFETs) and MOSFET Amplifiers Structures, operations and characteristics of n-channel and p-channel MOSFETs. DC analysis, load line and design techniques of MOSFET circuits. DC biasing schemes. Basic configurations, operations and characteristics of MOSFET amplifiers. AC analysis, load line and design techniques. Small-signal equivalent circuits and parameters. Small-signal voltage gain, current gain, input resistance and output resistance. Loading effect.

4. <u>Operational Amplifiers (Op-Amps) and Op-Amp Circuits</u>

   Transistor-level diagram and basic operation of op-amps. Ideal and practical op-amp equivalent circuits and characteristics. Golden rules. Basic op-amp circuits: inverting, non-inverting, summing, difference, integrating and differentiating amplifiers. Specific op-amp circuits: voltage follower, current-to-voltage converter, voltage-to-current converter, instrumentation amplifier, etc. Design applications.

5. <u>Frequency Domain Analysis</u>

   Power, voltage and current gains on linear and logarithmic scales. Concepts of "bel" and "decibel". Concepts of time *t*, angular frequency $j\omega$ and complex angular frequency *s* domains. Transfer functions in $j\omega$ and *s* domains. Introduction to Bode plot. Derivation of transfer functions of first-order ac circuits with sinusoidal driving sources. Implementation of Bode magnitude and phase plots. Concepts of pole and zero, corner/cutoff frequency as well as bandwidth.

Laboratory Experiments:

1. EE2003-E01: Basic Diode Circuits.
2. EE2003-E02: BJT Circuits
3. EE2003-E03: Op-Amp Circuits.

Teaching/ Learning Methodology

Assignments	a, b, c	Through assignments, students learn to *apply* the appropriate techniques to solve problems and *get familiarized* with the concepts they have learnt.
Lectures, supplemented with interactive questions and answers	a, b, c	In lectures, students are introduced to the *knowledge* of the subject, and *comprehension* is strengthened with interactive Q&A.
Tutorials, where problems are discussed and are given to students for them to solve	a, b, c	In tutorials, students *apply* what they have learnt in solving the problems given by the tutor.
Laboratory sessions, where students will perform experimental verifications. They will have to record results and write a report on one of the experiments.	a, b, d	Students acquire hands-on experience in using electronic equipment and apply what they have learnt in lectures/tutorials to experimentally validate the theoretical investigations.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% Weighting	Intended subject learning outcomes to be assessed			
		a	b	c	d
1. Assignments	16%	✓	✓	✓	
2. Mid-semester test/ Quizzes	16%	✓	✓	✓	
3. Laboratory works and reports	18%	✓	✓	✓	✓
4. Examination	50%	✓	✓	✓	
Total	100%				

	Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes: **Specific assessment methods/tasks** — Remark **Assignments** — Students will be given multiple assignments to evaluate their ability to apply the appropriate techniques for analysis of semiconductor-based electronic devices and circuits. **Laboratory works and reports** — Students will be required to perform three experiments and submit a report on the experiments. Assessment will be based on their ability to apply what they have learnt, report organization skills, and problem-solving techniques. **Mid-semester test/ Quizzes** — There will be test(s) to evaluate students' achievement of all the learning outcomes and give feedback to them for prompt improvement. **Examination** — There will be an end-of-semester examination to assess students' achievement of all the learning outcomes. These are mainly summative in nature.

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Mid-semester test/ Quizzes	There will be test(s) to evaluate students' achievement of all the learning outcomes and give feedback to them for prompt improvement.
Examination	There will be an end-of-semester examination to assess students' achievement of all the learning outcomes. These are mainly summative in nature.

Student Study Effort Expected	Class contact:	
	▪ Lecture/Tutorial	30 Hrs.
	▪ Laboratory	9 Hrs.
	Other student study effort:	
	▪ Revision and assignments	52 Hrs.
	▪ Laboratory logbook & report writings	14 Hrs.
	Total student study effort	105 Hrs.

Reading List and References

Textbook:

1. Donald A. Neamen, *Microelectronics: Circuit Analysis and Design*, 4th ed., Boston: McGraw-Hill, 2010.

References:

1. Adel S. Sedra, Kenneth C. Smith, Tony C. Carusone, and Vincent Gaudet, *Microelectronic Circuits*, 8th international edition, NY: Oxford University Press, 2021
2. G. Rizzoni and James Kearns, *Principles and Applications of Electrical Engineering*, 6th ed., New York: McGraw-Hill, 2016.
3. W.H. Hayt, J.E. Kemmerly and S.M. Durbin, *Engineering Circuit Analysis,* 9th ed., New York: McGraw-Hill, 2018.
4. A.H. Robbins and W.C. Miller, *Circuit Analysis: Theory and Practice*, Thomson Learning, 5th ed., 2013.