GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Biomedical Engineering
Subject Code: BE03003041
Subject Name: Advanced Electronics

w. e. f. Academic Year:	2024-25
Semester:	3
Category of the Course:	PCC

Prerequisite:	Basics of Electrical Engineering, Digital Fabrication Workshop, Basic Electronics
Rationale:	This course will provide knowledge to students about fundamentals of op-amp, op-amp applications, 555 timer & applications, power supply design and basics of Relay. Students will be able to analyze, design and create various electronic circuits based on op-amp, 555 timer and power supply.

Course Outcome:

After Completion of the Course, Student will able to:

No		
01	Study and understand the Operational amplifier, Electrical parameters and its open-loop & close-loop configurations.	R/U
02	Study, analyze and design various linear applications of Op-amp.	U/A/N/E/C
03	Study, analyze and design active filter circuits to remove the noise in the signal.	R/U/A/N/E/C
04	Study, analyze and design op-amp based Oscillators, Comparators and 555 Timer-based circuits.	U/A/N/E/C
05	Study and understand Power supply & Relay, and design Power Supply.	R/U/A/C

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	TH		ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
60	0	30	30	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Op-Amp:** ICs, Classification, Package types, Op-Amp, Block-diagram, Symbol, 741 Op-amp pin diagram, Features of 741 Op-amp, Multi-opamp IC pin diagram (LM318, LM358, LM324), Electrical Parameters of Op-amp, Ideal Op-amp characteristics, Equivalent circuit of op-amp, Virtual Ground concept, Open loop Op-amp configurations: Inverting Amplifier, Non-inverting Amplifier, Differential Amplifier, Op-amp with feedback, Types of feedback, Negative feedback Close loop Op-amp configurations: Inverting Amplifier, Non-inverting Amplifier, Differential Amplifier.	10	20
2.	**Linear Applications of Op-amp:** Voltage Follower, Inverting Configuration: Summing, Scaling & Averaging amplifier, Non-inverting configuration: Averaging & Summing amplifier, Differential configuration: Subtractor & Summing amplifier, Instrumentation Amplifier, Instrumentation Amplifier IC INA823, Voltage to Current convertor with grounded load, Current to Voltage converter, Integrator, Differentiator.	13	22
3.	**Op-amp Active Filters:** Introduction to Filters & its need, Active filters, Types, Ideal & Practical frequency response of Filters, 1st & 2nd order Low-pass Butterworth filter, 1st & 2nd order High-pass Butterworth filter, Wide Band-pass filter, Narrow Band-pass filter, Wide Band-reject filter, Narrow Band-reject filter, All-pass Filter, Universal Active Filter IC FLT-U2.	13	20
4.	**Oscillators, Comparators & 555 Timer:** Oscillator principle, Types, Phase-shift oscillator, Wien-bridge oscillator, Square-wave generator, Triangular-wave generator, Comparator, Basic non-inverting & Inverting comparator, Zero-crossing detector, Schmitt trigger, Peak detector, Sample & Hold circuit, 555 Timer pin diagram, 555 as Monostable & Astable multivibrator.	14	22
5.	**DC Power Supply & Relay:** **DC Power Supply:** Block diagram, Components, IC voltage regulators: Fixed Positive & Negative, Adjustable Positive & Negative, Fixed voltage Power supply design, Adjustable voltage Power supply design. **Relay:** Introduction, Applications, Types of Relay: Electromagnetic, Solid-state & Hybrid Relay.	10	16
	Total	**60**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**25**	**20**	**10**	**10**	**15**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, Pearson.
2. Operational Amplifiers and Linear Integrated Circuits, Robert F. Coughlin, Frederick F. Driscoll, PHI.
3. Practical Electronics for Inventors, Paul Scherz, Simon Monk.
4. Op Amps for Everyone by Ron Mancini.

Suggested Course Practical List:

1. Introduction to Electrical circuit simulator software CircuitLab/KiCad/eSim/Proteus/Multisim.
2. To design close-loop Inverting and Non-inverting amplifier using op-amp.
3. To design close-loop Differential amplifier using op-amp.
4. To design Summing amplifier, Scaling amplifier and Averaging amplifier using inverting configuration.
5. To design Instrumentation amplifier using 3 op-amp configuration.
6. To design a Differentiator circuit using an op-amp.
7. To design 2nd order Low-pass butterworth filter using op-amp and verify its frequency response.
8. To design 2nd order High-pass butterworth filter using op-amp and verify its frequency response.
9. To design 50Hz Notch filter using op-amp and verify its frequency response.
10. To design Wein bridge oscillator circuit using an op-amp.
11. To design basic non-inverting & inverting Comparator using op-amp.
12. To design Astable multivibrator using 555 timer IC.

List of Laboratory/Learning Resources Required:

Op-Amp trainer kit/Electronic components, Power Supply, CRO/DSO, Function Generator, Electronic Workbench.

Suggested Project List:

1. Any real-life project can be given to students individually/in group with the use of Op-Amp, 555 Timer, Relay and other electronic components.
2. Design Fixed Positive & Negative/Adjustable Positive & Negative Power supply individually/in group.

Suggested Activities for Students:

1. Students should be given a task individually/in group to design charts of different op-amp applications, 555 Timer applications, Relays, Power semiconductor devices.
2. Students should be given a task individually/in group to design different op-amp applications, 555 Timer applications, Power supply, Relay applications in any Circuit Simulator/Software.

- **List of suggested activities for Problem Based Learning:**

Sr. No.	Name of the activity	No. of hours per activity	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding-based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model	Working = 12 h	Based on inter

	on technical topics	Non- working = 8 h	department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software
15	Online Technical Quizzes/Simulations	Multiple quizzes summing up to 10h	Based on quiz scores and reflection report after each quiz.
16	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:

1. All the suggested activity should be related to the subject.
2. Subject coordinator shall identify activities from above list as per the subject needs, they also declare list of activities wise hours, evaluation scheme and rubrics to students at the start of semester.
3. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
4. All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
5. Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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