GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

MEDICAL ELECTRONICS
(Code: 3330303)

Diploma Programmes in which this course is offered	Semester in which offered
Biomedical Engineering	Third

1. RATIONALE

Medical electronics is a very important subject since the growth of biomedical industry depends upon electronics to a great extent. This course contains operational amplifier with positive and negative feedback, various operational amplifier applications used at various level of instrumentation for biomedical field. Skills acquired through course will help the student to troubleshoot medical equipments.

2. COMPETENCY('Programme Outcome' according to NBA Terminology)

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Maintain/calibrate electronic parts of the medical equipment.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit **ESE** - End Semester Examination; **PA** - Progressive Assessment.

4. COURSE DETAILS

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Introduction to Operational Amplifiers	1a. Describe the working of an operational amplifier with block diagrams 1b. Distinguish working of different types of open loop configurations. 1c. Differentiate between inverting and non-inverting amplifiers	3.1. Operational amplifier: block diagram, schematic symbol schematic symbol, Op-Amp: characteristics of ideal op-amp, equivalent circuit, Open loop configuration: inverting, non-inverting, differential
	1d. Define various parameters of op-amps.	3.2. Op-amps' Parameters: input offset voltage, input offset, current, input bias current, differential input, resistance, input capacitance, offset voltage, adjustment range, input voltage range, common mode rejection ratio, supply voltage rejection ratio, large signal voltage gain, output voltage swing, output resistance, output short circuit current, supply current, power consumption, transient response, slew rate, gain bandwidth product, average temperature coefficient of input offset voltage and current, noise
Unit– II Op-Amp with Negative Feedback	2a. Distinguish between various feedback configurations. 2b. Explain the voltage follower Circuit. 2c. Explain the working of differential amplifier with one op- amp.	2.1 Different feedback configuration: voltage-series feedback, voltage-shunt feedback, current-series feedback and current-shunt feedback. 2.2 voltage follower 2.3 Differential amplifier with one opamp
Unit– III General Linear Applications of Op-Amp	3a. Explain the working of a general AC amplifier with a single supply. 3b. Describe different summing, scaling and averaging amplifier.	3.1 AC amplifiers with a single supply, summing, scaling and averaging amplifiers.
	3c. Describe the working of instrumentation amplifier with three Op-Amps with sketches. 3d. Differentiate the difference between the Integrator and Differentiator using amps	3.2 Instrumentation amplifier differential amplifier with three op-amp 3.3 Integrator using op-amp Differentiator using op-amp
Unit – IV Active Filter, Oscillators, Comparators and	4a. Describe the working of active filters. 4b. Explain the working principle of oscillators. 4c. Differentiate the working of a phase shift oscillator and Wein bridge	4.1. Active filters- first order low pass Butterworth filter, first order high pass Butterworth filter, 4.2. Band pass filter, band reject filter, all pass filter

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Converters using Op-Amp	oscillator with sketches 4d. Distinguish between the working of square wave and saw tooth generator with sketches	4.3. Oscillators- oscillator principles, phase shift oscillator, wein bridge oscillator 4.4. Square wave generator 4.5. Saw tooth wave generator
	4e. Explain comparator and schmitt trigger. 4f. Explain the working of digital to analog converter. 4g. Describe the working of successive approximation	4.6. Comparators and Schmitt Trigger 4.7. Converters- D/A converter with binary 4.8. weighted resistors, successive approximation A/D converter
Unit – V Bio-potential Amplifiers.	5a. Explain working of electrocardiograph amplifier with sketches 5b. Describe the block diagram of cardiac monitors.	5.1 Electrocardiograph amplifier 5.2 Cardiac monitors

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Operational amplifiers	6	4	4	-	08
II	Op-Amp with negative feedback	12	2	6	4	12
III	General Linear applications of Op-Amp	12	-	20	-	20
IV	Active Filter , Oscillators, comparators and converters using Op-Amp	14	-	20	-	20
V	Bio-potential amplifiers	12	-	-	10	10
	Total	**56**	**6**	**50**	**14**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills **(Course Outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

Note: Here only course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in *affective domain*** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

Sr. No.	Unit No.	Practical Exercises ('Course Outcomes' in Psychomotor Domain according to NBA terminology)	Hrs. required
1	I	Test open loop inverting amplifier.	2
2	I	Test open loop non inverting amplifier.	2
3	I	Test open loop differential amplifier.	2
4	II	Build/test closed loop inverting amplifier.	4
5	II	Build/test closed loop non-inverting amplifier.	4
6	II	Build/test differential amplifier using one op-amp.	4
7	II	Build/test voltage follower using op-amp.	4
8	III	Build/test differential amplifier using two op-amp.	4
9	III	Build/test AC amplifier using single supply.	4
10	III	Build/test summing amplifier using inverting and non-inverting configuration.	4
11	III	Build/test averaging amplifier using inverting and non-inverting configuration.	4
12	III	Test the Integrator circuit.	2
13	III	Build/test Differentiator circuit.	4
14	IV	Build/test oscillator circuit.	4
15	IV	Build/test comparator circuit.	4
16	IV	Build/test square wave generator circuit.	4
17	IV	Build/test saw tooth generator circuit.	4
18	IV	Build/test schmitt trigger circuit using op-amp.	4
19	IV	Build/test D-A converter using op-amp.	2
20	IV	Build/test A-D converter using op-amp.	2
21	V	Record an ECG using trainer kit.	2
		Total	**70**

Note: Ask students to perform enough number of practical such that all the units are covered within 56 hours. (Different students may be asked to do different practical)

7. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Collect different datasheet of op-amp and list the different parameter values that are affecting the operation of op-amp while operating.
ii. Observe the output parameter as well waveform using simulation and compare it with practical results.
iii. Make a comparative table of prices of various op-amps.

8. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Demonstrations during lectures using models, animation and video films.
ii. Practical exercises.
iii. Mini projects

9. SUGGESTED LEARNING RESOURCES

A) List of Books

Sr. No.	Title of Book	Author	Publication
1	Biomedical Instrumentation and Measurements	Cromwell, Leslie, Weibell, Fred J. and Pfeiffer, Erich A.	PHI Learning, New Delhi, 2010 of latest
2	Medical Instrumentation Application and Design	Webster John G., Editor	WILEY India, New Delhi 2011 of latest
3	Linear Integrated Circuits Op-Amp.	Ramakant A. Gayakwad	PHI Learning, 2000 of latest

B) List of Major Equipment/ Instruments with Broad Specifications

i. Digital multimeter (3 1/2 digit)
ii. Oscilloscope (2 channel, preferably digital)
iii. Function Generator
iv. DC power supply(-30V-0-30V)
v. AC power supply(-30V-0-30V)
vi. Differential Amplifier trainer kit
vii. Inverting and Non-inverting Amplifier trainer kit
viii. Integrator and Differentiator Trainer Kit
ix. Square wave generator Trainer Kit
x. Saw tooth wave generator Trainer Kit
xi. Schmitt trigger Trainer Kit
xii. Instrumentation Amplifier Trainer kit

C) List of Software/Learning Websites

i. Circuit simulator for op-amp.
ii. www.efymag.com
iii. www.electronicsforu.com
iv. www.gpgbiomedical.hpage.com

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. A. K. Bula** , Lecturer , Dept of Instrumentation Engineering, G. P. Gandhinagar
- **Prof. N. D. Makwana**, Lecturer, Dept of Biomedical Engineering, G. P. Gandhinagar
- **Prof. S. S. Malkan** , Lecturer , Dept of Biomedical Engineering, G. G. P. Ahmedabad
- **Prof. M. H. Dave** , Lecturer, Dept of Biomedical Engineering, G. P. Gandhinagar

Coordinators and Faculty Members from NITTTR Bhopal

- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Department of Electrical and Electronics Engineering
- **Dr. (Mrs.) Anjali Potnis,** Assistant Professor, Department of Electrical and Electronics Engineering.