Program Name	: **Diploma in Medical Electronics**
Program Code	: **MU**
Semester	: **Fourth**
Course Title	: **Electronic Communication Techniques**
Course Code	: **22437**

1.   RATIONALE

Biotelemetry and telemedicine are emerging fields in medical electronics. These new technologies have been used for remote measurement of the physiological signals like electrocardiogram (ECG), electroencephalogram (EEG), and electromyogram (EMG). Skills to use modulation, demodulation and data communication techniques is essential for the diploma engineering pass out to work in any medical electronic Industry as s/he will have to use and maintain electronic communication equipment and circuits related to this area. This course will help the student to develop them.

2.   COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
- **Use different electronics communication systems.**

3.   COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:
  a. Use modulation and demodulation techniques.
  b. Apply pulse code modulation.
  c. Use multiplexing techniques for various applications.
  d. Select relevant data communication protocol for medical applications.
  e. Maintain telemetry and telemedicine system.

4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Paper Hrs.	Theory						Practical					
L	T	P			ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.
Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5.   COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course. in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.
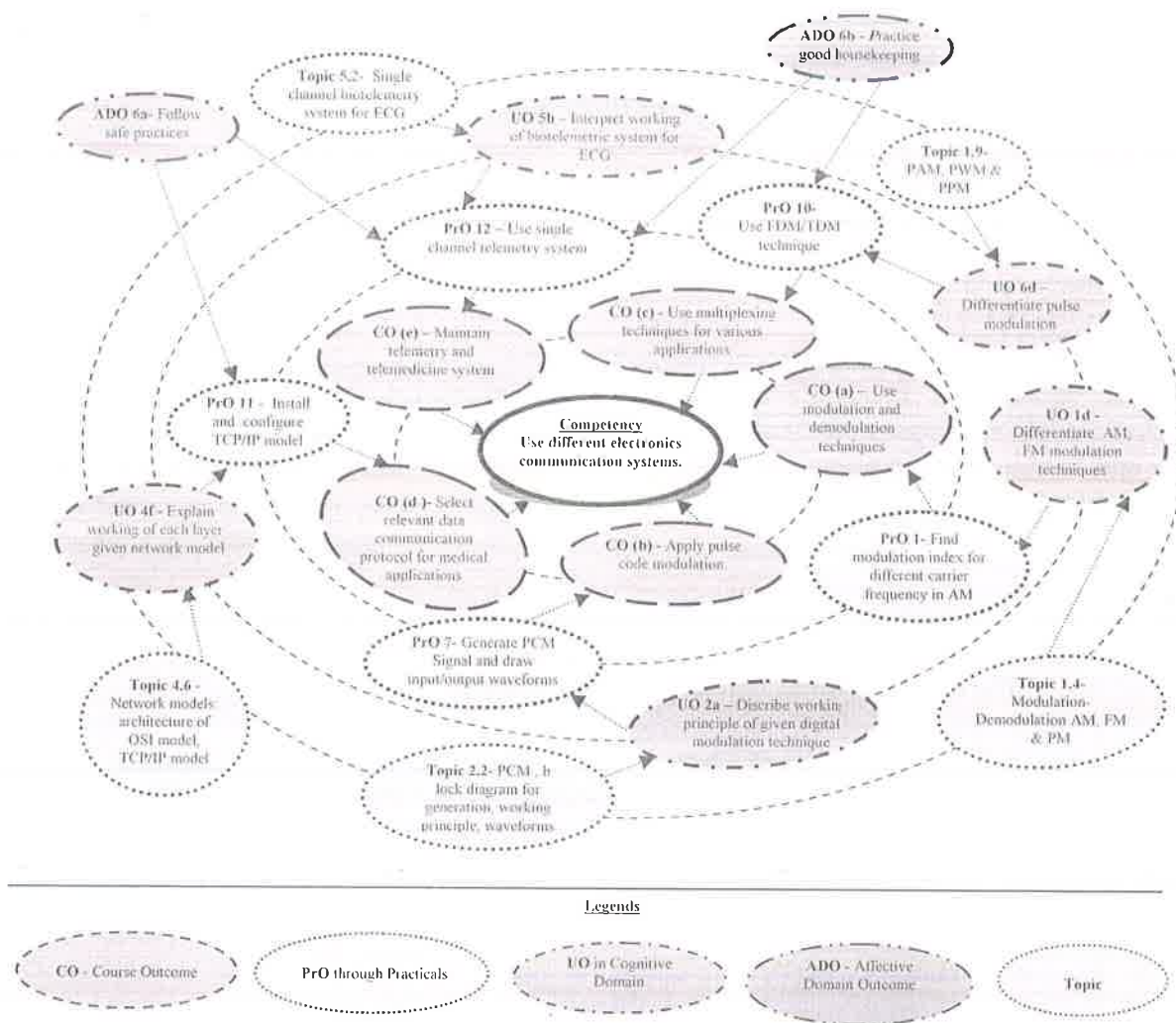

Figure 1 - Course Map

6.   SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Find modulation index for different carrier frequency in AM. Part – I	I	02*
2	Find modulation index for different carrier frequency in AM. Part – II	I	02
3	Measure the modulation index of the frequency modulated wave. Part – I	I	02
4	Measure the modulation index of the frequency modulated wave. Part – II	I	02
5	Use Germanium diode for AM demodulation.	I	
6	Use balance slope detector for FM demodulation.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Use superheterodyne principle for AM receiver.	I	04
8	Measure the parameters of PAM .	I	02
9	Measure the parameters of PWM and PPM waveforms.	I	02
10	Generate PCM Signal and draw input and output waveforms.	II	02*
11	Measure the parameters of ASK and FSK waveforms.	II	02
12	Use FDM/TDM technique.	III	02*
13	Install and configure TCP/IP model. Part – I	IV	02
14	Install and configure TCP/IP model. Part – II	IV	02
15	Use single channel telemetry system. Part – I	V	02*
16	Use single channel telemetry system. Part – II	V	02*
	Total		**32**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

    a. Follow safe practices
    b. Practice good housekeeping
    c. Practice energy conservation
    d. Demonstrate working as a leader/a team member
    e. Maintain tools and equipment
    f. Follow ethical practices

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

    • 'Valuing Level' in 1st year
    • 'Organising Level' in 2nd year

* 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO No.
1	AM Radio section: tuning range : 520 KHz – 1620 KHz, IF frequency : 455 KHZ, tracking : + - 3 db from 700 KHz to 1400 KHz' 10 db signal to noise at 200 microvolt typical.	1 and 3
2	FM Radio Section: tuning Range : 88 MHz – 108 MHz, IF frequency : 10.7 MHZ, tracking : + - 5 db from 90 MHz to 106 MHz detector.	2,4
3	PAM,PWM,PPM modulation and demodulation: Sine waveform output of 250Hz, 500Hz, 1 KHz, and 2 KHz; selectable sampling clock of 4, 8, 16, 32 KHz; analog sample circuit/output, sample and hold circuit/output, flat top circuit/Output PAM/PWM/PPM modulation and demodulation.	5
4	Analog sampling reconstruction : Synchronized sine waveform output of frequency 1 KHz and 2 KHz. Selectable sampling frequency of 2,4,8,16,32 KHz. Sample circuit/output, sample and hold circuit/output switch selectable sampling duty cycle of 0-90% in steps, 2nd order low pass filter.	6
5	Pulse code modulation: Sine waveform output of 500Hz, 1 KHz, two nos. of variable DC source with amplitude adjustments, fast (240 KHz/channel approx)	8
6	LAN: 1Mbps coax cable or 10BaseT twisted pair, 100Mbps, 100Base TX twisted pair or 100 Base FX fiber optic.	10,11
7	Single channel telemetry trainer kit	12

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Analog communication	1a. Classify given frequency signals with justification. 1b. Identify RF and microwave frequency ranges from the given eletromagnetic spectrum. 1c. Interpret importance of the given modulation techniques. 1d. Differentiate AM and FM modulation techniques for the specified aspect. 1e. Select the specific diode circuit for given demodulation with justificaion . 1f. Explain with sketches the working of the given receiver. 1g. Explain with sketches the	1.1 Communication system, Information, transmitter, channel, receiver,noise 1.2 Electromagnetic spectrum 1.3 Signal to noise ratio 1.4 Modulation AM, FM and PM 1.5 Modulation index AM/FM 1.6 AM transmitter 1.7 Demodulation- Amplitude demodulation by germanium diode Detector, frequency demodulation sing balance detector 1.8 Superheterodyne receiver 1.9 PAM, PWM and PPM

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	working of the specified pulse modulation technique.	
Unit-II Digital Communications	2a. Explain with sketches the working of the given digital modulation technique. 2b. Describe the Strengths and limitations of the given type of digital modulation. 2c. Select the relevant digital modulation technique for specific application wih justification. 2d. Describe with sketches the functions of specified block of a typical block diagram of digital communication system. 2e. Describe the strengths, limitations and applications of given shift keying technique.	2.1 Sampling theorem 2.2 PCM: block diagram for generation, working principle, waveforms. 2.3 Strengths and limitations of PCM 2.4 Delta modulation, Strengths and limitations and applications 2.5 Typical block diagram of digital communication system. 2.6 ASK, FSK, PSK 2.7 BPSK, QPSK, DPSK
Unit– III Multiplexing Techniques	3a. Describe the need of given multiplexing technique. 3b. Explain with sketches the working of the multiplexing techniques. 3c. List Strengths and limitations of given multiplexing technique. 3d. Explain with sketches the working of the specified multiple access technique.	3.1 Multiplexing definition, Schematic diagram, principle, application 3.2 TDM, FDM and WDM 3.3 FDM transmitter and receiver 3.4 TDM transmitter and receiver 3.5 Strengths and limitations of TDM, FDM and WDM 3.6 Working principle, Strengths and limitations of TDMA, FDMA, CDMA
Unit– IV Data Communication	4a. Explain with sketches the working of the specified block of data communication system. 4b. Compare the features of the given two given data communication protocols. 4c. Describe the importance of given data transmission. 4d. Explain the specified mode used for transmitting data. 4e. Describe the functions of specified signal used in RS232. 4f. Explain with sketches the working of the each layer of given network models. 4g. Explain with sketches the working	4.1 Block diagram of data communication circuit. 4.2 Data communication protocols, connection oriented protocols and connectionless protocols. 4.3 Types of data transmission serial, parallel, synchronous, asynchronous 4.4 Transmission modes: simplex, half duplex, full duplex. 4.5 Serial interface standard, RS232 4.6 Network models: Architecture of OSI model, TCP/IP model 4.7 Data encoding techniques: Unipolar NRZ, polar NRZ, RZ Biphase Manchester and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of the given data encoding technique.	differential Manchester
Unit –V Biotelemetry and Telemedicine	5a. Interpret the working of the given biotelemetric system for ECG. 5b. Describe procedure for measurment of pulse rate using the given biotelemetry system. 5c. Explain with sketches the use of the given biotelemetry instrument to measure body temperature. 5d. Explain with sketches the working of the given types telemedicine techniques. 5e. Explain with sketches the working of the given aspect of internet medical services.	5.1 Biotelemetry transmitter and receiver 5.2 Single channel biotelemetry system for ECG 5.3 Multi channel biotelemetry system 5.4 Sports physiology studies through telemetry 5.5 Telemedicine parameters, Strengths and limitations and applications 5.6 Teleradiology 5.7 Concept of tele-psychiatry. tele-dermatology, tele-surgery 5.8 Ethical and legal aspect of internet medical services

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9.   SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Analog Communication	14	04	08	04	16
II	Digital Communication	12	04	08	04	16
III	Multiplexing Techniques	06	02	04	04	10
IV	Data Communication	10	04	08	04	16
V	Biotelemetry and Telemedicine	06	04	06	02	12
Total		**48**	**18**	**34**	**18**	**70**

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)
Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10.   SUGGESTED STUDENT ACTIVITIES
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:
  a. Prepare journals based on practical performed in laboratory.
  b. Follow the safety precautions.
  c. Use CRO/DSO to test communication circuits.

d. Library / Internet survey of communication circuits.

e. Prepare power point presentation or animation for understanding different circuits behavior.

11.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.

b. *'L' in item No. 4* does not mean only the tradinal lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.

c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.

e. Use Flash/Animations to explain various electronic communication techniques.

f. Guide student(s) in undertaking micro-projects.

12.   SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three.*

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. **AM modulator Circuit:** Build AM modulator circuit using transistor on breadboard first, and then build using PCB. Measure the amplitude and frequency and draw waveforms. Write report on same.

b. **AM demodulator circuit:** Build AM demodulator circuit using germanium diode on breadboard first, and then build using PCB. Measure the amplitude and frequency and draw waveform. Write report on same.

c. **FM transreceiver circuit**: Build FM transmitter and receiver circuit using PCB. Measure FM signal parameter and draw waveform. Write report on same.

d. **FSK modulator circuit**: Build FSK modulator using IC555 on PCB. Measure FSK signal parameter and draw waveform. Write report on same.

e. **FSK demodulator circuit**: Build FSK demodulator using NE-SE 565 IC on PCB. Measure FSK signal parameter and draw waveform. Write report on same.

f. **Binaryhase Shift Keying (BPSK) modulation circuit**: Build BPSK modulator using CD4016 and 741 Op amp on PCB. Measure BPSK signal parameter and draw waveform. Write report on same.

g. **PWM/PPM circuit**: Build/test PWM/PPM circuit using IC555.

h. **Telemetric system**: Make survey of different kinds of telemetric system. Write report on same.

i. **Telemedicine system:** Make survey of different kinds of telemetric system. Write report on same.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Communication System	Kennedy, G.	McGraw-Hill Education (India) Ltd., New Delhi, 2014, ISBN: 9780074636824
2	Electronic Communication	Roddy, D.; Coolen, J.	PHI learning, New Delhi. 2014. ISBN: 9780133120837
3	Communication Systems	Chandra Sekar, V.	Oxford University Press, New Delhi. 2014. ISBN: 9780198078050
4	Biomedical Instrument and Measuremen	Cromwell Leslie; Weibell Fred, J.; Pfeiffer Erich, A.	PHI learning Pvt. Ltd. New Delhi. 2014, ISBN: 978-0130764485
5	Principles of Electronic Communication Systems	Frenzel Louis E.	McGraw-Hill Education (India) Ltd., New Delhi, 2014, ISBN: 9780070667556
6	Data Communication and Networking	Behrouz A. Forouzan	McGraw-Hill Education (India) Ltd., New Delhi, 2014, ISBN: 9781259064753
7	Hand book of Biomedical Instrumentation	Khandpur, R. S.	McGraw-Hill Education (India) Ltd., New Delhi, ISBN: 978-9339205430

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://en.m.wikipedia.org/wiki/Data_transmission

b. www.tutorialspoint.com/data_communication_computer_network/physical_layer_multiplexing.htm

c. https://www.youtube.com/watch?v=0237PiujAgo

d. Files.teceee-in.webnode.in>biotelemetry

e. http://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Cardiac_Telemetry/