Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Medical Electronics

Program Code : MU **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters **Duration : 16 Weeks**

Semester : Fourth **Scheme : I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory							Practical					
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Analog Circuits	ACI	22433	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
2	Microcontroller and Embedded System	MES	22434	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
3	Analytical Equipment	AEQ	22435	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Diagnostic Equipment	DEQ	22436	3	2	2	7	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
5	Electronic Communication Techniques	ECT	22437	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Simulation Software	SSO	22038	-	-	4	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	100
7	Technical Writing and Soft Skill	TWS	22039	-	-	2	2	--	--	--	--	--	--	--	25@	10	25~	10	50	20	50
			Total	**16**	**2**	**16**	**34**	--	**350**	--	**150**	--	**500**	--	**200**	--	**200**	--	**400**	--	900

Student Contact Hours Per Week: **34 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **900**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* 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 LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Fourth**

Course Title : **Simulation Software**

Course Code : 22038

1. RATIONALE

Recent development in technology has put a lot of emphasis on awareness of available analytical tools. Number of application software as analytical tools are available which are helpful in designing, testing and simulating electronic circuits with ease. The ready to use library functions available in different simulation software enable the user to design circuits without knowing the complex mathematical details. Under this course students will be taught use of software like Scilab/MATLAB and LabVIEW that are commonly used by electronics engineers, worldwide. This practical only course uses the concepts and other details learnt in other courses of earlier semesters.

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 simulation tools for relevant medical applications.**

3. COURSE OUTCOMES (COs)

The 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 various library functions available in the software.
b. Construct given circuit diagram using these library functions.
c. Simulate the circuit and observe its working for various inputs.
d. Simulate various biomedical systems to analyze medical parameters.
e. Perform simulation of different waveforms using software tools.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
--	--	4	4	--	--	--	--	--	--	--	50@	20	50~	20	100	40	

*(~): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment, **'#':** No Theory Examination*

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.

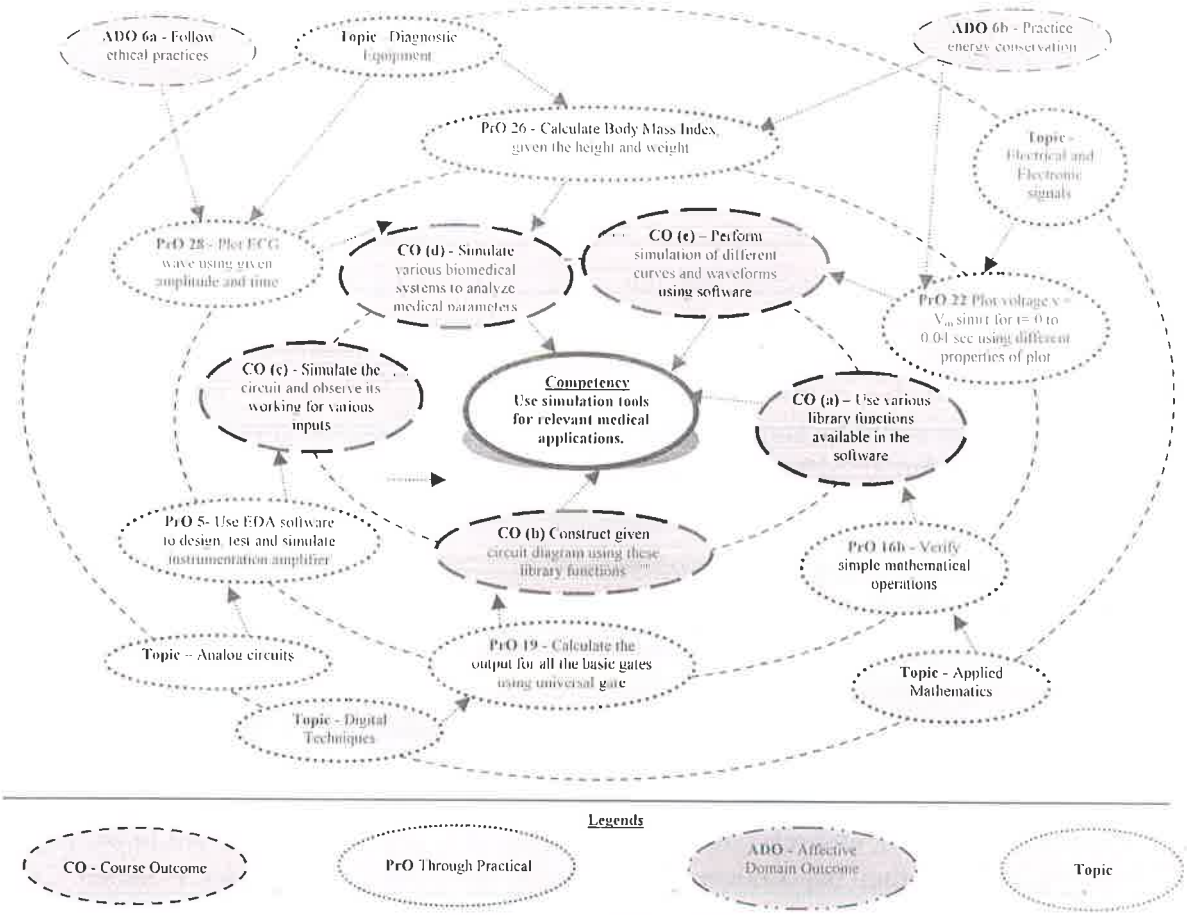

Figure 1 - Course Map

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)	Approx. Hrs. Required
1	Identify the various components and facilities available in the simulation software.	02
2	Use the library functions of available simulation software.	02*
3	Use EDA software to test and simulate half wave rectifier (HWR).	02
4	Use EDA software to design, test and simulate full wave rectifier (FWR) and bridge rectifier.	02
5	Use EDA software to design, test and simulate capacitor filter and π filter.	02*
6	Use EDA software to design, test and simulate clipper and clamper circuit.	02
7	Use EDA software to design, test and simulate high pass filter. Observe waveform on CRO.	02
8	Use EDA software to design, test and simulate instrumentation amplifier using opamp.	02*
9	Use EDA software to design, test and simulate Counter.	02
10	Use EDA software to assemble astable multivibrator using IC 555.	02

S. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
	Observe waveform on CRO.	
11	Use EDA software to design, test and simulate 1:8 multiplexer.	02
12	Use EDA software to design, test and simulate 8:1 de-multiplexer by using 4:1 de-multiplexer.	02
13	Use EDA software to test Kirchhoff's voltage law and Kirchhoff's current law.	02*
14	Use EDA software to test maximum power transfer theorem.	02
15	Use EDA software to find the equivalent resistance current, voltage using thevenins theorem Verify the same using Norton's theorem.	02
16	a. Find the determinant, inverse and transpose of the given 2 X 2 matrix. b. Verify following simple mathematical operations of all elements in row/column vector using Scilab/MATLAB. a. Sum b. Mean c. Length d. Max e. Min f. Prod g. Sign h. Round i. Sort j. Fix 2	02*
17	Use commands to (for any two of the following) a. Convert Centigrade to Fahrenheit. b. Convert Kilograms to Pounds. c. Convert Meter to Feet. d. Given the radius of circle. Find the circumference and its area.	02
18	Write a Scilab/ MATLAB program to specify the resistance values and tolerance using given colour codes.	02*
19	a. Calculate the output for all the basic gates using universal gate. OR b. Calculate the output for all condition of A, B, C, for decade counter.	02
20	Calculate the natural frequency of oscillators for the given RLC circuit. Assume L=0.01mH, R=100Ω and C varying from 0.1 to 0.5 in steps of 0.1 μf using following equation. $F = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4C^2}}$	02
21	A series R-L-C circuit connected across 100V peak, 50 Hz supply, consists of R=10Ω, L=0.2H, C=100μF. Write a Scilab/MATLAB script to determine the resonant frequency and current at resonance. Hint: $F = \frac{1}{2\pi\sqrt{LC}}$, $I = \frac{V}{R}$, $Vrms = \frac{Vpp}{\sqrt{2}}$	02*
22	Plot voltage v = V_m sinwt for t= 0 to 0.04 sec using different properties of plot.	02
23	Plot the voltage v = 5sinwt and current i = 2sin(wt-ϕ) flowing through circuit on the common axis X.	02

S. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
24	a. Perform simulation of amplitude modulation for different modulation index. b. Perform simulation of frequency modulation for different modulation index.	02*
25	Design a low pass filter with R= 1 KΩ and C = 0.1 μF and calculate the cut off frequency.	02
26	Calculate Body Mass Index (BMI), given the height and weight.	02
27	Given the Heart Rate and display whether the person is having tachycardia and bradycardia.	02
28	Plot ECG wave using given amplitude and time. Part - I	02*
29	Create a VI that produces a sine wave with a specified frequency and displays the data on a waveform chart until stopped by the user. Part - II	02*
30	Create a VI that produces a sine wave with a specified frequency and displays the data on a waveform chart until stopped by the user. Part - I	02*
31	Create a VI that produces a sine wave with a specified frequency and displays the data on a waveform chart until stopped by the user. Part - II	02*
32	Create a VI to connect three sine wave sources of given amplitude and frequency but with a phase shift of 0, $2\pi/3$, and - $2\pi/3$ to a 3X1 multiplexer and observe the waveforms on scope. Also, demultiplex these waveforms and observe on the scope.	02
	Total	**64**

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 24 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	Write algorithm and draw flow chart.	20
2	Use Scilab/MATLAB software tool for programming to create, edit and compile the programs/applications.	40
3	Debug, test and execute the programs/applications.	20
4	Able to answer oral questions.	10
5	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. Demonstrate working as a leader/a team member
b. Maintain software tools and equipment.
c. Handle console/command environment.
d. Follow ethical practices.
e. Practice energy conservation.

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 and
- '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. S. No.
1	Hardware: Personal computer, (i3-i5 preferable), RAM minimum 2 GB onwards.	For all Practicals
2	Operating system: Windows XP/Windows 7/LINUX onwards.	For all Practicals
3	Software: Scilab /MATLAB/ LabVIEW. Any other equivalent open source software can also be used.	14 to 28
4	Software: MultiSIM /TINA/iCircuit , Any other equivalent open source software can also be used.	1 to 13

8. UNDERPINNING THEORY COMPONENTS

-Not applicable-

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

-Not applicable-

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. Give seminar on relevant topic.
c. Library/E-Book survey regarding use of different 'simulation software' in biomedical field.
d. Prepare power point presentation or animation for showing different applications of simulation software.
e. Visit a hospital/diagnostic scan centers to learn about various image grabbing software and prepare a report.
f. Undertake a market survey of different 'simulation software' and compare with respect to following points.
   i. Available applications.
   ii. Application profile.

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. 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 LOs/COs through classroom presentations (see implementation guideline for details).
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. Guide student(s) in undertaking micro-projects.
e. No. of practical's selection to be performed should cover all units.

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. Design a scope for patient monitoring with at least four different parameters and observe the waveform by changing these parameters.
b. Simulate pre-amplifier circuit for ECG.
c. Simulate pre-amplifier circuit for EEG.
d. Simulate bio-potential amplifier.
e. Simulate electroencephalogram signal.
f. Simulate electromyogram signal.
g. Generate waveform of spirogram for different pressure.
h. Simulate cardiac acoustic mapping system which displays phonocardiogram.
i. Simulate ECG pulse missing detector.

13. SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Programming in Scilab 4.1	Das, Vinu V.	New Age Publication, New Delhi, 2014, ISBN: 9788122424713
2	Modeling and Simulation using MATLAB	Jain, Shailendra	Wiley India Pvt. Ltd., New Delhi, 2014, ISBN: 9788126551972
3	Virtual Instrumentation LabVIEW	Gupta, Sanjay; John, Joseph	Mc Graw Hill Education, New Delhi, 2014, ISBN: 9780070700284
4	Virtual Instrumentation	Jerome, Jovitha	PHI Learning New Delhi, 2014;

S.No.	Title of Book	Author	Publication
	Using LabVIEW		ISBN: 9788120340305

14. SUGGESTED SOFTWARE/LEARNING WEBSITE

a. http://www.mathworks.com
b. http://coep.vlab.co.in/?sub=25
c. http://scilab.in/lab_migration_run/download_code
d. http://www.ni.com/download-labview/
e. http://www.ti.com/tool/tina-ti/
f. http://www.ni.com/multisim/


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Medical Electronics

Program Code : MU | **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters | **Duration : 16 Weeks**

Semester : Second | **Scheme : I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Applied Mathematics	AME	22210	4	2	--	6	3	70	28	30*	00	100	40	--	--	--	--	--	--	100
2	Applications of Biomaterials	ABI	22219	3	--	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Fundamentals of Medical Electronics	FME	22220	4	--	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
4	Basic Electrical Engineering	BEM	22221	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Business Communication Using Computers	BCC	22009	--	--	2	2	--	--	--	--	--	--	--	35@^	14	15~	06	50	20	50
6	Medical Electronics Workshop	MEE	22019	--	--	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
7	Programming in 'C'	PIC	22020	2	--	2	4	--	--	--	--	--	--	--	25@	10	25~	10	50	20	50
			Total	16	4	14	34	--	280	--	120	--	400	--	185	--	165	--	350	--	750

Student Contact Hours Per Week: **34 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **750**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment (5 marks each for Physics and Chemistry) 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 LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Electrical Engineering Program Group & Electronics Engineering Program Group**

Program Code : **DE/EE/EJ/IE/IS/MU**

Semester : **Second**

Course Title : **Applied Mathematics**

Course Code : **22210**

1. RATIONALE

The core technological studies can be understood with the help of potential of applied mathematics. This course is an extension of Basic Mathematics of first semester which is designed for its applications in engineering and technology using the techniques of calculus, differentiation, integration, differential equations and in particular complex numbers and Laplace transform. Derivatives are useful to find slope of the curve, maxima and minima of the function, radius of curvature. Integral calculus helps in finding the area. In analog to digital converter and modulation system integration is important. Differential equation is used in finding the curve and its related applications for various engineering models like LCR circuits. This course further develops the skills and understanding of mathematical concepts which underpin the investigative tools used in engineering.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Solve electrical and electronics engineering related broad-based problems using the principles of applied mathematics.**

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. Calculate the equation of tangent, maxima,minima,radius of curvature by differentiation.
b. Solve the given problem(s) of integration using suitable methods.
c. Apply the concepts of integration to find the area and volume.
d. Solve the differential equation of first order and first degree using suitable methods.
e. Use Laplace transform to solve first order first degree differential equations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	2	--	6	3	70	28	30*	00	100	40	--	--	--	--	--	--

(*): 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 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, Unit Outcomes i.e. UOs 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.

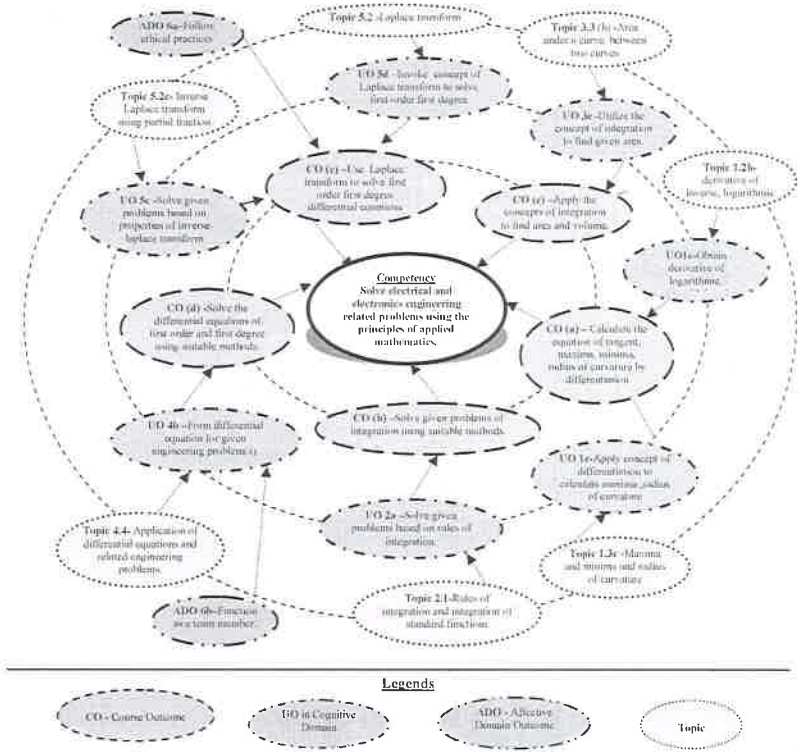

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The tutorials in this section are sub-components of the COs to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	Tutorials	Unit No.	Approx. Hrs. Required
1	Solve problems based on finding value of the function at different points.	I	2
2	Solve problems to find derivatives of implicit function and parametric function	I	2
3	Solve problems to find derivative of logarithmic and exponential functions.	I	2
4	Solve problems based on finding equation of tangent and normal.	I	2
5	Solveproblems based on finding maxima, minima of function and radius of curvature at a given point.	I	2
6	Solve the problems based on standard formulae of integration.	II	2
7	Solve problems based on methods of integration, substitution, partial fractions.	II	2
8	Solve problems based on integration by parts.	II	2
9	Solve practice problems based on properties of definite integration.	III	2
10	Solve practice problems based on finding area under curve, area between two curves and volume of revolutions.	III	2
11	Solve the problems based on formation, order and degree of differential equations.	IV	2
12	Develop a model using variable separable method to related engineering problem.	IV	2
13	Develop a model using the concept of linear differential equation to related engineering problem.	IV	2
14	Solve problems based on algebra of complex numbers.	V	2
15	FindLaplace transform and inverse Laplace transformusing related properties.	V	2
16	Make use of concept of Laplace transform to solve first order first degree differential equation.	V	2
			32

Note: The above tutorial sessions are for guideline only. The remaining tutorial hours are for revision and practice.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

- Not applicable -

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Differential Calculus	1a. Solve the given simple problems based on functions. 1b. Solve the given simple problems based on rules of differentiation. 1c. Obtain the derivatives of logarithmic,exponential functions. 1d. Apply the concept of differentiation to find equation of tangent and normal. 1e. Apply the concept of differentiation to calculate maxima and minima and radius of curvature of given problem.	1.1 Functions and Limits : a) Concept of function and simple examples b) Concept of limits without examples. 1.2 Derivatives : a) Rules of derivatives such as sum, product, quotient of functions. b) Derivative of composite functions (chain Rule), implicit and parametric functions. c) Derivatives of inverse, logarithmic and exponential functions. 1.3 Applications of derivative : a) Second order derivative without examples. b) Equation of tangent and normal c) Maxima and minima d) Radius of curvature
Unit– II Integral Calculus	2a. Solve the given problem(s) based on rules of integration. 2b. Obtain the given simple integral(s) using substitution method. 2c. Integrate given simple functions using the integration by parts. 2d. Evaluate the given simple integral by partial fractions.	2.1 Simple Integration: Rules of integration and integration of standard functions. 2.2 Methods of Integration: a) Integration by substitution. b) Integration by parts c) Integration by partial fractions.
Unit– III Applications of Definite Integration	3a. Solve given simple problems based on properties of definite integration. 3b. Apply the concept of definite integration to find the area under the given curve(s). 3c. Utilize the concept of definite integration to find area between given two curves. 3d. Invoke the concept of definite integration to find the volume of revolution of given surface.	3.1 Definite Integration: a) Simple examples b) Properties of definite integral (without proof) and simple examples. 3.2 Applications of integration : a) Area under the curve. b) Area between two curves. c) Volume of revolution.
Unit-IV First Order First Degree Differential Equations	4a. Find the order and degree of given differential equations. 4b. Form simple differential equations for given engineering problem(s). 4c. Solve the given differential equations using the method of variable separable. 4d. Solve the given problems based on linear differential equations.	4.1 Concept of differential equation 4.2 Order, degree and formation of differential equation. 4.3 Solution of differential equation a. Variable separable form. b. Linear differential equation. 4.4 Application of differential equations and related engineering problems.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Complex Numbers and Laplace transform.	5a. Solve given problems based on algebra of complex numbers. 5b. Solvethe given problems based on properties of Laplace transform 5c. Solve the given problems based on properties of inverse Laplace transform. 5d. Invoke the concept of Laplace transform to solve first order first degree differential equations.	5.1 Complex numbers: a. Cartesian, polar and exponential form of a complex number. b. Algebra of complex numbers. 5.2 Laplace transform: a. Laplace transform of standard functions (without proof). b. Properties of Laplace transform such as linearity, first and second shifting properties (without proof). c. Inverse Laplace transform using partial fraction method, linearity and first shifting property. d. Laplace transform of derivatives and solution of first order first degree differential equations.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above 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	Differential calculus	20	04	08	12	24
II	Integral calculus	14	02	06	08	16
III	Applications of Definite Integration	10	02	02	04	08
IV	First Order First Degree Differential Equations	08	02	02	04	08
V	Complex numbers and Laplace transform	12	02	05	07	14
Total		**64**	**12**	**23**	**35**	**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 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:

a. Identify engineering problems based on real world problems and solve with the use of free tutorials available on the internet.
b. Use graphical software's: EXCEL, DPLOT, and GRAPH for related topics.
c. Use Mathcad as Mathematical Tools and solve the problems of Calculus.

d. Identify problems based on applications of differential equations and solve these problems.
e. Prepare models to explain different concepts of applied mathematics.
f. Prepare a seminar on any relevant topic based on applications of integration.
g. Prepare a seminar on any relevant topic based on applications of Laplace transform to related engineering problems.

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 traditional 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. Guide student(s) in undertaking micro-projects.
f. Apply the mathematical concepts learnt in this course to branch specific problems.
g. Use different instructional strategies in classroom teaching.
h. Use video programs available on the internet to teach abstract topics.

12. SUGGESTED MICRO-PROJECTS

Only ***one micro-project*** is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare models using the concept of tangent and normal to bending of roads in case of sliding of a vehicle.
b. Prepare models using the concept of radius of curvature to bending of railway track.
c. Prepare charts displaying the area of irregular shapes using the concept of integration.
d. Prepare charts displaying volume of irregular shapes using concept of integration.
e. Prepare models using the concept of differential equations for mixing problem.
f. Prepare models using the concept of differential equations for radio carbon decay.
g. Prepare models using the concept of differential equations for population growth.
h. Prepare models using the concept of differential equations for thermal cooling.
i. Prepare models using the concept of Laplace transform to solve linear differential equations.

j. Prepare models using the concept of Laplace transform to solve initial value problem of first order and first degree.
k. Prepare charts displaying various algebraic operations of complex numbers in complex plane.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Higher Engineering Mathematics	Grewal, B.S.	Khanna publications, New Delhi , 2013 ISBN- 8174091955
2	Advanced Engineering Mathematics	Krezig, Ervin	Wiley Publications, New Delhi, 2016 ISBN:978-81-265-5423-2,
3	Advanced Engineering Mathematics	Das, H.K.	S. Chand Publications, New Delhi, 2008, ISBN-9788121903455
4	Engineering Mathematics. Volume 1 (4th edition)	Sastry, S.S.	PHI Learning, New Delhi, 2009 ISBN-978-81-203-3616-2,
5	Getting Started with MATLAB-7	Pratap, Rudra	Oxford University Press. New Delhi,2009 ISBN- 0199731241
6	Engineering Mathematics (third edition)	Croft, Anthony	Pearson Education, New Delhi,2010 ISBN 978-81-317-2605-1

14. SOFTWARE/LEARNING WEBSITES

a. www.scilab.org/ - SCI Lab
b. www.mathworks.com/products/matlab/ - MATLAB
c. Spreadsheet applications
d. www.dplot.com/ - DPlot
e. www.allmathcad.com/ - MathCAD
f. www.wolfram.com/mathematica/ - Mathematica
g. http://fossee.in/
h. https://www.khanacademy.org/math?gclid=CNqHuabCys4CFdOJaAoddHoPig
i. www.easycalculation.com
j. www.math-magic.com

Program Name : **Diploma in Medical Electronics**
Program Code : **MU**
Semester : **Second**
Course Title : **Application of Biomaterials**
Course Code : **22219**

1. RATIONALE

Biomaterials are a vital ingredient to the medical industry. They are used for implant manufacturing and have found applications in various kinds of medical devices that have been used in repairing skeletal systems, returning cardiovascular functionality, repairing and restoring the function of traumatized or degenerated tissues or organs, and thus improving the quality of life of the patients. Metals and their alloys, polymers, ceramics and composites are the commonly used biomaterials. This course curriculum is important for a diploma biomedical engineer to understand the concepts underlying the selection of specific materials used in orthotic and prosthetic implants for the human body.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Select relevant biomaterials and implants for the specified requirements.**

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. Justify the biocompatibility of biomaterials with the living system.
b. Identify the metal to be used for different medical applications.
c. Identify the ceramic/polymer to be used for different medical applications.
d. Identify the biomaterial to be used for various implants.
e. Select the material for various dental/orthopedic implants.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			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.

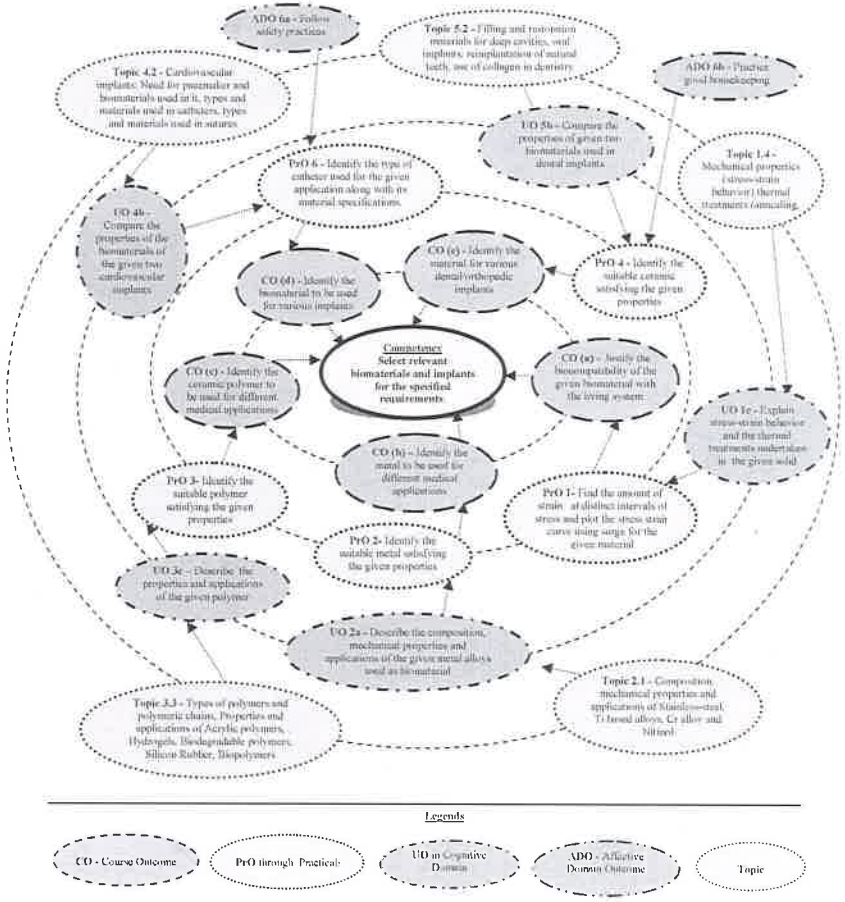

Figure 1 - Course Map

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Find the amount of strain at distinct intervals of stress and plot the stress strain curve using surge for the given material.	I	02
2	Identify the suitable metal satisfying the given properties.	II	02
3	Identify the suitable polymer satisfying the given properties.	III	02
4	Identify the suitable ceramic satisfying the given properties.	III	02
5	Identify the type of suture along with its composition.	IV	02
6	Identify the type of catheter used for the given application along with its material specifications.	IV	02
7	Identify the various biomaterials used in different parts of pacemaker.	IV	02
8	Identify the dental implant type along with its material specifications.	V	04
9	Identify the fixation devices based in their applications.	V	04
10	Identify the types of total hip replacement devices along with its material specifications.	V	04
	Total		**26**

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

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, acquisition of the ADOs takes place gradually in the student when s/he undertakes a series

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	Exp. S. No.
1	Surge equipment, wooden block (clamp), wires, rotary motor sensor	1
2	Dental implants (Example: microvent, crovent, screw-vent)	8
3	Fixation devices (screws, plates, intramadullary nails, pins, wires)	9
4	Hip replacement devices (Thompson 316L, Austin Moore 316L, Biopolar 16L, Co-Cr head)	10
5	Sutures (Absorbable and Non-absorbable)	5
6	Different types of catheters	6

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Overview of Biomaterials	1a. Describe the structure of the given solid. 1b. Compare the properties of the given two biomaterials. 1c. Explain the concept of biocompatibility in the given two biomaterials. 1d. Describe the method for analyzing the surface properties of the given solid. 1e. Explain stress-strain behavior and the thermal treatments undertaken in the given solid. 1f. Explain the testing method of the given biomaterial.	1.1 Historical developments, atomic and molecular bonds, types of solids, crystal structure of solids 1.2 Types of biomaterials, concept of biocompatibility 1.3 Surface properties (surface energy, contact angle method, electrokinetic theory) 1.4 Mechanical properties (stress-strain behavior), thermal treatments (annealing, forging, tempering), sterilization 1.5 Testing of biomaterials (invitro-invivo test and types), forms of corrosion (uniform, galvanic, stress, pitting, crevice corrosion), electrochemical corrosion testing, wear and its types
Unit– II Metals	2a. Describe the composition and mechanical properties of the given metal alloy used as biomaterial.	2.1 Composition, mechanical properties and applications of Stainless-steel, Ti based alloys,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2b. Identify the applications of the given metal alloy with justification. 2c. Explain the method of the measurement of rate of corrosion of the given implant metal. 2d. Explain the biological tolerance of the given implant metal in human body.	Cr alloy and Nitinol 2.2 Corrosion rate measurement, biological tolerance of implant metal
Unit– III Ceramics and Polymers	3a. Identify the properties of ceramic used in the implant manufacturing for the given case with justification. 3b. Identify the method(s) used for surface characterization of the given biomaterial with justification. 3c. Describe the properties and applications of the given polymer. 3d. Describe the properties and applications of the given acrylic polymer.	3.1 Properties and applications of carbon, alumina, zirconia resorbable ceramics, composites 3.2 Methods used for biomaterial surfaces characterization 3.3 Types of polymers and polymeric chains, 3.4 Properties and applications of acrylic polymers, hydrogels, biodegradable polymers, silicon rubber, biopolymers
Unit-IV Overview of Implants	4a. Describe the concept and need of the specified type of tissue grafting. 4b. Compare the properties of the biomaterials of the given two cardiovascular implants. 4c. Describe the properties of the given biomaterial used in ophthalmic implants. 4d. Describe the properties of the given biomaterial used in dental implants. 4e. Describe the properties of the given biomaterial used in orthopedic implants.	4.1 Tissue grafting: concept and types (biological and artificial) of grafting 4.2 Cardiovascular implants: need for pacemaker and biomaterials used in it, types and materials used in catheters, types and materials used in sutures 4.3 Ophthalmic implants: concept and materials used in contact lenses 4.4 Dental implants: overview 4.5 Orthopedic implants: overview
Unit –V Dental and Orthopedic Implants	5a. Describe the mechanical properties of given type of teeth. 5b. Compare the properties of given two biomaterials used in dental implants. 5c. Describe the testing and evaluation process for the given dental implant. 5d. Describe the given stage in bone healing process. 5e. Explain the process of the given type of joint replacement.	5.1 Teeth composition with its mechanical properties 5.2 Filling and restoration materials for deep cavities, oral implants, reimplantation of natural teeth, use of collagen in dentistry 5.3 Testing and evaluation of dental implants 5.4 Bone composition (structure of typical long bone), factors affecting bone formation and resorption, mechanical properties of bone, bone healing 5.5 Joint replacement (total hip replacement), knee joint repair, total knee replacement.

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	Overview of Biomaterials	12	06	06	06	18
II	Metals	07	02	04	04	10
III	Ceramics and polymers	09	04	04	06	14
IV	Overview of Implants	08	04	04	02	10
V	Dental and Orthopedic implants	12	04	06	08	18
Total		48	**20**	**24**	**26**	**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:

a. One group will prepare questionnaire on the composition, properties and applications of the following topics and ask those to others by conducting a quiz:
   i. Metals
   ii. Ceramics
   iii. Polymers
b. Undertake a market survey of any one of metal alloy, ceramic or polymer on the basis of following points:
   i. Composition
   ii. Properties
   iii. Applications

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. Use MOOCs (Massive Open Online Courses) to teach various topics and sub-topics.

b. Guide student(s) in undertaking interesting micro-projects.
c. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
d. 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).
e. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f. Use Flash/Animations to demonstrate the surgeries undertaken for implant fixation.

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. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. Each group will prepare chart on either of the following topics:
   i. Classification of Biomaterials
   ii. Historical developments of biomaterials
   iii. Polymeric chain
b. Each group will prepare a model on:
   i. Orthopedic implant
   ii. Dental implant
   iii. Crystal structure
c. Visit a dental hospital and make a report on dental implants that you came across in the hospital.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Biomaterials	Bhatt, Sujata V.	Narosa Publishing House, New Delhi, 2010 (2nd edition), ISBN: 978-8173196263
2	Biomaterials	Temenoff, J.; Mikos, A.	Pearson Publication, New Delhi, 2009, ISBN : 978-8131727423
3	Biomaterial Science and Engineering	Park, J. V.	Pearson Publication, New Delhi, ISBN : 978-1461327691
4	Encyclopedia of Medical Devices and Instrumentation	Webster, John	Volume I, II, III, IV, Marcel Publication, ISBN: 978-0471829362
5	Biological Performance of Materials : Fundamentals of Biocompatibility	Black, Jonathan; Dekker, Marcel	CRC Press, New York, (4th edition), ISBN : 978-0849339592
6	Fundaments of Biomedical Engineering	Sawhney, G. S.	New Age International Publication, New Delhi, ISBN: 978-8122421026
7	Biomaterial Science - An introduction to materials in medicine	Ratner, Buddy D.; Hoffman, Ailan S.; Schoen, Fredrick J.; Lemons, Jack E.	Academic Press Limited Publication, New Delhi, 2013, (3rd edition), ISBN: 978-0123746269

14. SOFTWARE/LEARNING WEBSITES

a. www.biopolymer.net
b. www.biomatnet.org
c. www.biomaterials.org
d. www.othoapospl.com
e. www.massdevice.com
f. www.dolphinsutures.com

Program Name : Diploma in Medical Electronics

Program Code : MU

Semester : Second

Course Title : Fundamentals of Medical Electronics

Course Code : 22220

1. RATIONALE

A large number of electronic equipment are being used in hospitals for patient care, diagnosis and to carry out surgeries. Diploma engineers have to deal with the various electronic components and circuits while maintaining such electronic equipment. This course will enable the students to learn the basics of medical electronics and build electronics/biomedical circuits applicable in biomedical field that will enable them to develop the troubleshooting skills. Further this course will also provide an overview of various types of medical instruments, the details of which will be included in later semesters.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain electronic circuits of medical electronic equipment comprising of discrete electronic components.**

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. Test active and passive electronic components.
b. Identify different types of passive electronic components.
c. Use passive electronic component for different applications.
d. Use diode in different applications.
e. Interpret the performance of rectifiers and filters.
f. Identify the medical instruments and their types for different applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	--	2	6	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 LOs 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.

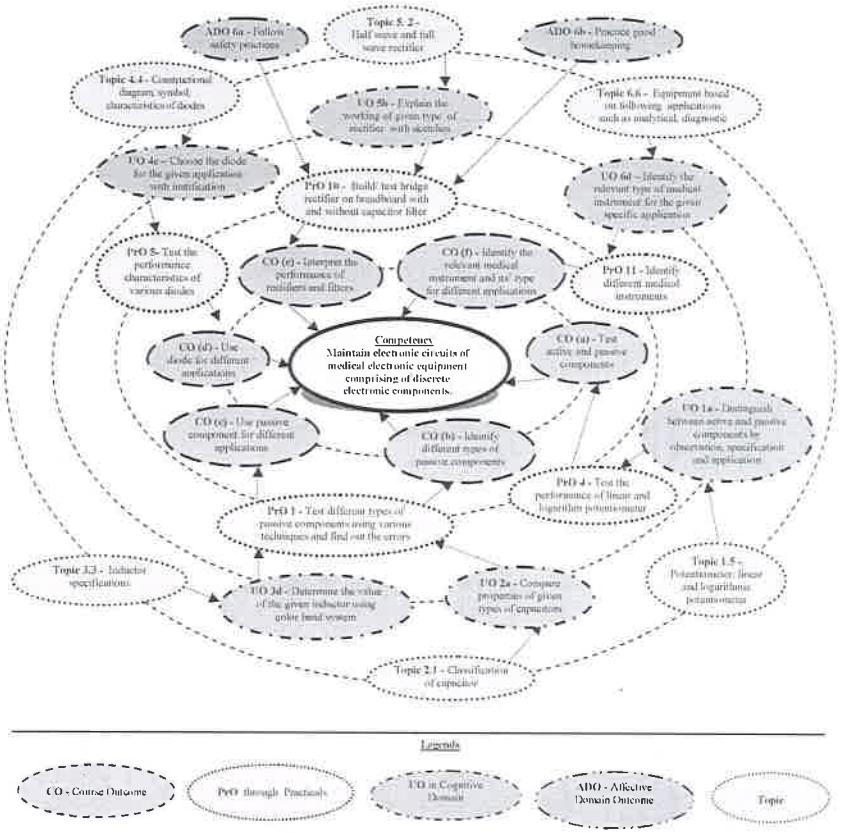

Figure 1 - Course Map

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	Test different types of passive components using various techniques and find out the errors. Part I	I,II,III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
2	Test different types of passive components using various techniques and find out the errors. Part II	I,II,III	02
3	Test the performance of LDR.	I	02
4	Test the performance of linear and logarithmic potentiometer.	I	02
5	Test different types of active components.	IV	02*
6	Test the performance of photo diode by varying the light intensity and distance.	IV	02
7	Test the performance of PN junction diode.	IV	02
8	Test the performance of zener diode.	IV	02
9	Build/test half wave rectifier on breadboard.	V	02*
10	Build/ test full wave rectifier on breadboard using two diodes.	V	02
11	Build/ test bridge rectifier on breadboard with capacitor filter.	V	02
12	Build/ test bridge rectifier on breadboard without capacitor filter.	V	02
13	Build/test low pass filter.	V	02
14	Build/test high pass filter.	V	02
15	Identify different types of medical equipment.	VI	02*
16	Find out the technical specifications of ECG and EEG machine of different manufacturers.	VI	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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.

d. Maintain tools and equipment.
e. 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 administrators.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Digital multimeter: 3 1/2 digit display, 9999 counts, measures: V_{ac}, V_{cc} (1000V max) , A_{dc}, A_{ac} (10 amp max) , Hz , resistance (0 - 100 MΩ) , capacitance and temperature	1 to 10
2	Variable DC power supply 0- 30V, 2A, short circuit protection, display for voltage and current	2 to 10
3	Cathode Ray Oscilloscope: Dual Trace 20 MHz, 1 megohm input impedance	8 to 11
4	Lux meter: 3000 Lumen, battery operated hand held type	3
5	Function Generator: 0-2 MHz with sine, square and triangular output with variable frequency and voltage	12
6	Electronic Test Bench: Bread Board 840 -1000 contact points, positive and negative power rails on opposite side of the board, 0-30 V, 2 Amp variable DC power supply, Function Generator 0-2 MHz, CRO 0-30 MHz, digital multimeter	1 to 11

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Resistors	1a. Distinguish between the specified active and passive components by observation, specification and application. 1b. Explain the construction of the given type of the resistor. 1c. Describe the construction and working principle of the given type of	1.1 Types of components: discrete, active, passive, parasitic components 1.2 Classification of resistors, materials used, specifications construction and applications of different types of resistors: carbon film resistors, standard wire-wound resistors, SMD resistor, colour coding: with three, four and five bands, Light dependant resistor (LDR) and temperature dependent resistor (TDR) 1.3 Potentiometer: linear and logarithmic

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	potentiometer. 1d. Select the passive component for the specified simple application with justification.	potentiometer 1.4 Potentiometer and trimmer
Unit – II Capacitors	2a. Compare properties of the given types of capacitors. 2b. Identify the material used for the construction of the given type of capacitor with justification. 2c. Select relevant capacitor for the given application with justification. 2d. Find the value of given capacitor based on colour coding system.	2.1 Classification of capacitor, materials used for capacitors, capacitor specifications, types of capacitor 2.2 Fixed capacitor: construction, specifications and applications 2.3 Electrolytic capacitor: constructional diagram, specifications and applications 2.4 Variable capacitors: requirement of variable capacitor, construction, working, specification of air gang, PVC gang capacitor, trimmer capacitor. 2.5 SMD Capacitor 2.6 Coding of capacitors using numerals, colour band system
Unit – III Inductors	3a. Describe properties of the given type of magnetic material with their B-H characteristics. 3b. Explain laws related to the specified laws of electromagnetic induction. 3c. Explain the construction of the given type of inductor with their applications. 3d. Find the value of the given inductor using colour band system.	3.1 Magnetic materials - ferromagnetic and ferromagnetic, B-H curve, Hard and soft Magnetic materials, hysteresis , permeability, coercivity, reluctivity and losses of magnetic materials 3.2 Faraday's laws of electromagnetic induction, self and mutual induced emf. 3.3 Inductor specifications - self inductance, mutual inductance coefficient of coupling, operation at low and high frequency, Q factor 3.4 Construction and application of air core, iron core, ferrite core inductor, frequency range inductors - A.F., R.F., I.F., toroidal inductor, slug tuned inductor 3.5 Colour coding of inductor using colour band system
Unit – IV Semiconductor Diodes	4a. Explain the construction of the given type of diode with sketches. 4b. Explain the working of the given type of diode with sketches. 4c. Choose the diode for the given application with	4.1 Semiconductor - intrinsic and extrinsic 4.2 P.N. junction diodes, V-I characteristic of p-n junction diode, static and dynamic resistance 4.3 Specifications of junction diode 4.4 Types of diodes, constructional diagram, symbol, circuit diagram, specifications and characteristics of zener diode, PIN diode,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	justification. 4d. Write the broad specifications of the given diode.	schottky diode, tunnel diode, photodiode, laser diode, LED, IRLED
Unit– V Rectifiers and Filters	5a. Describe the construction of the given rectifier with its application. 5b. Explain the working of given type of rectifier with sketches. 5c. Explain the working of given type of filter with sketches. 5d. Solve given simple numerical examples based on parameters of rectifiers.	5.1 Rectifiers, need and types of rectifiers 5.2 Half wave and full wave rectifier (bridge and centre tap) - circuit operation, I/O waveforms for voltage and current 5.3 Parameters of rectifier (without derivation): average DC value of current and voltage, ripple factor, ripple frequency, PIV of diode, TUF, efficiency of rectifier 5.4 Filters, need of filters, low pass filter, high pass filter 5.5 Input-output waveforms of shunt capacitor, series inductor, 5.6 Numerical problems on average DC value of current and voltage, ripple factor, ripple frequency, PIV of diode, TUF, efficiency of rectifier
Unit-VI Fundamentals of Medical Electronics	6a. Describe primary signal characteristic of the given device 6b. Identify the required biomedical signal for the given application. 6c. Describe the function of the specified medical equipment. 6d. Identify the relevant type of medical instrument for the given specific application.	6.1 Role of technology in medicine and role of engineers in healthcare industry 6.2 Origin of bioelectric signals - polarization, depolarization, repolarization, a typical cell potential waveform 6.3 Primary signal characteristics of ECG, EEG,EMG, ERG, EOG 6.4 Sources of biomedical signals: bioelectric, bioacoustics, biomechanical, biochemical, biomagnetic, biooptical, bioimpedance signal 6.5 Basic medical instrumentation system and its objectives 6.6 Equipment classification based on: analytical equipment, diagnostic equipment, intensive care equipment, therapeutic equipment, medical imaging equipment

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	Resistors	10	04	04	04	12
II	Capacitors	10	04	04	02	10
III	Inductors	10	04	04	02	10
IV	Semiconductor Diodes	12	04	04	06	14
V	Rectifiers and Filters	10	02	04	04	10
VI	Fundamentals of Medical Electronics	12	04	04	06	14
Total		**64**	**22**	**24**	**24**	**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:

a. Prepare journals/manuals based on practical performed in laboratory.
b. Prepare a chart of different electronic components based on their construction, working, specifications and application.
c. Collect information from different periodicals related to medical equipment.
d. Collect and understand datasheets of different types of resistors, capacitors, inductors and diodes.

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 traditional 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. Guide student(s) in undertaking interesting micro-projects.
f. Use flash/animations to explain the construction and working of discrete components.

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. S/he ought to submit it by the end of the semester to in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application develop the industry oriented COs. Each micro-project should encompass two or more COs which are based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Diode**: Build a positive clipper circuit and prepare the report.
b. **Diode:** Build a positive clamper circuit and prepare the report.
c. Build a circuit on bread board to clamp a waveform at 2.0 V using diode and passive components.
d. **Rectifier**: Build a half wave rectifier for 6 V, 500 mA output current on general purpose PCB.
e. **Rectifier**: Build a full wave bridge rectifier with capacitor filter for 6 V, 500 mA output current on general purpose PCB.
f. Build a smoke detector/burglar's alarm circuit on general purpose PCB by using photo diode and prepare a report.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	A Textbook of Applied Electronics	Sedha, R.S.	S .Chand and Company Ltd., New Delhi, 2014, ISBN: 978-8121927833
2	A Handbook of Biomedical Instrumentation	Khandpur, R.S.	Mc GrawHill Education, New Delhi, ISBN: 978-9339205430
3	Basic Electronic Engineering	Baru, V.; Kaduskar, R.; Gaikwad, S.T.	DreamTech Press, New Delhi, 2015 ISBN: 978-9350040126
4	Fundamental of Electronic Devices and Circuits	Bell, David	Oxford University Press, New Delhi, 2015, ISBN: 978-0195425239

14. SOFTWARE/LEARNING WEBSITES

a. http://www.electronics-tutorials.ws/resistor/res_1
b. http://www.electronics-tutorials.ws/capacitor/cap_1.html
c. http://www.digikey.com
d. https://cds.cern.ch/record/987551/files/p133.pdf
e. www.datasheetcafe.com
f. www.who.int/medical_devices/innovation/core_equipment/en/

Program Name : **Diploma in Medical Electronics**
Program Code : **MU**
Semester : **Second**
Course Title : **Basic Electrical Engineering**
Course Code : **22221**

1. RATIONALE

Medical electronics diploma holders are expected to have basic knowledge of electrical engineering. Also they have to deal with various types of electrical machines and equipment in any health care industry. This course is intended to help the students to comprehend basic fundamentals of electrical engineering and working principles of commonly used AC and DC motors and their characteristics. Acquiring the practical skills and cognitive skills of basic electrical engineering will go a long way in maintaining many of the biomedical equipment and instrumentation system ensuring safety practices. Further, the basic concepts of electrical engineering learnt in this course will be very useful for understanding of other higher level courses during the further stages of study.

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 electrical systems employed in the field of medical instrumentation.**

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. Interpret electric and magnetic circuits.
b. Use the principles of AC circuits for maintaining medical equipment.
c. Use transformers for specific requirements.
d. Connect three phase induction motors and DC motors safely.
e. Use FHP motors for medical applications.
f. Select switchgears for specific requirement in medical applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	2	2	7	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 LOs 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	Determine branch currents of a given circuit applying Kirchhoff's laws.	I	02*
2	Determine the permeability of magnetic material by plotting its B-	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	H curve.		
3	Determine the direction of induced current by applying Fleming's right hand rule in given circuit.	I	02
4	Determine frequency, time period, peak value, rms value, peak factor and form factor of a sinusoidal A.C. waveform by observing it on C.R.O.	II	02*
5	Determine the phase difference between voltage and current by observing their waveforms on C.R.O. for resistive, inductive and capacitive circuits.	II	02
6	Determine the relation between line and phase values of voltages and currents for balanced star and delta connected load.	III	02*
7	Determine the relation between line and phase values of voltages and currents for unbalanced star and delta connected load.	III	02
8	Determine voltage and current ratio of single phase transformer.	III	02
9	Calculate percentage efficiency and regulation of single phase transformer by direct loading method.	III	02
10	Determine the direction of force on a current carrying conductor by applying Fleming's left hand rule.	III	02
11	Control the speed of DC shunt motor by armature voltage and field current control method.	III	02
12	Reverse the direction of rotation of single phase induction motor.	IV	02
13	Reverse the direction of rotation of three phase induction motor.	III	02
14	Reverse the direction of rotation of Universal motor.	IV	02*
15	Identify switches, fuses, switch fuse and fuse switch units, MCB, MCCB and ELCB.	V	02*
16	Test circuit using series lamp and multimeter.	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	Selection of suitable component, apparatus/instrument	20
2	Preparation of experimental set up	10
3	Setting and operation	10
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. 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 administrators.

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
1	Single Phase Transformer: 1kVA, single-phase, 230/115 V, air cooled, enclosed type.	1,6,7
2	Single phase auto transformer (Dimmerstat): Single-phase, air cooled, enclosed model, Input: 0 ~ 230 V, 10A, Output: 0 ~ 270 V	1,3,4,6,7,8
3	CRO – 20 MHz, Dual channel	3,4,5
4	Three phase auto transformer: 15 kVA, Input 415 V, 3 phase, 50 Hz, Output 0-415 V, 30 A per line, cooling air natural	6
5	Loading Rheostat: 7.5 kW, 230V, 3 phase, 4 wire, and balanced load. (Each branch having equal load), Load: Wire wound fixed resistors	5,8
6	Lamp Load Bank: 230 V, 0-20 A	6, 7
7	DC shunt motor coupled with DC shunt Generator	10
8	Single phase Induction motor: ½ HP, 230 V, 50 Hz, AC supply	12
9	Three phase Induction motor: 5 HP, 440 V, 50 Hz, AC supply	12
10	Universal motor: 1/4 Hp	13
11	Galvanometer: 30-0-30 μA	2
12	Watt meters: Single Phase, 2.5/5 Amp, 150/300 V, unity power factor	8
13	Digital Multimeter: 3 1/2 digit	10,13, 14, 15
14	DC and AC Ammeters: 0-5-10 Amp	1,3
15	DC and AC Voltmeters: 0-150-300 V	6,7,8,10
16	Tachometer: Non contact type, 0-10000 rpm	11, 12, 13
17	Rectifier: Solid state, Input -415 V, 3-Phase AC, Output- 230 V DC regulated, 20 Amp	13

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Electric and Magnetic Circuits	1a. Determine branch current of the given two loop circuit applying Kirchhoff's laws. 1b. Compare the characteristics of the given electric and magnetic circuits. 1c. Explain the features of the B-H curve and hysteresis loop of the given material. 1d. Apply Fleming's left hand rule and Lenz's law for determination of direction of induced emf in the given circuit.	1.1 Kirchhoff's laws, Electric and magnetic circuits. 1.2 Mesh analysis 1.3 Magnetic flux, flux density, magneto motive force, magnetic field strength, permeability, reluctance, Series and parallel magnetic circuits 1.4 B-H curve and hysteresis, hysteresis loop and hysteresis loss 1.5 Faraday's laws of electromagnetic induction, Fleming's right hand rule, Lenz's law 1.6 Dynamically and statically induced emf, self and mutual inductance
Unit– II AC Fundamentals	2a. Compare the features of the given type of electric power supply systems 2b. Calculate amplitude, time period, frequency, RMS value, average value, form factor and peak factor of the given AC quantity. 2c. Represent the given AC quantities by phasors, waveforms and mathematical equations. 2d. Explain the response of AC circuit in the given condition. 2e. Calculate impedance, current, power factor and power of the given AC series circuit.	2.1 AC and DC quantity, Single phase AC 2.2 Sinusoidal AC waveform: instantaneous value, cycle, amplitude, time period, frequency, angular frequency, R.M.S. value, average value, form factor, peak factor 2.3 Vector representation of sinusoidal AC quantity, Phase angle, phase difference, concept of lagging and leading 2.4 Pure resistance, inductance and capacitance in AC circuit 2.5 R-L and R-C series circuits 2.6 Impedance and impedance triangle 2.7 Power – active, reactive and apparent, power triangle 2.8 Power factor and its significance
Unit– III Polyphase AC Circuits and Transformers	3a. Explain the features of the given type of power supply system. 3b. Calculate the current and power in the given three phase balanced system. 3c. Explain the working principle of the given type of transformer. 3d. Compare the applications of the given type of transformer with the auto-transformer.	3.1 3-phase emf generation and its wave form, Current, power, power factor in a 3 phase balanced system 3.2 Phase and line current, phase and line voltage in star connected and delta connected balanced system 3.3 Phase sequence, balanced and unbalanced load 3.4 Working principle, classification, emf equation, Voltage ratio, current ratio and transformation ratio, high efficiency and low regulation in

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		transformer. 3.5 Two winding transformer and auto-transformer
Unit-IV Three phase Induction Motors and DC Motors	4a. Explain the construction of the given type of electric motor. 4b. Explain the working principle of the given type of electric motor. 4c. Describe the procedure for reversal of rotation of the given type of electric motor. 4d. Select suitable type of motor for the given application with justification. 4e. Describe the procedure to control the speed of the given type of electric motor with sketches.	4.1 Construction and principle of working of three phase induction motor, Reversal of rotation of 3-phase induction motor, Starters for three phase induction motors 4.2 Types – Squirrel cage and slip ring, applications of 3-phase induction motors 4.3 DC motor construction and material used, Principle of operation (no equations) 4.4 DC shunt, series and compound motors: schematic diagram and applications, Speed control methods of D.C shunt motor
Unit-V Fractional Horse Power (FHP) Motors	5a. Explain the construction of the principle of given type of FHP motor. 5b. Explain the working principle the given type of FHP motor with sketches. 5c. Describe the testing procedure of the given type of FHP motor. 5d. Describe the maintenance procedure of the given type of FHP motor. 5e. Select relevant FHP motor for the given application with justification.	5.1 Split phase Induction motor, capacitor start induction run, capacitor start capacitor run and permanent capacitor motors, shaded pole motors: Schematic representation, principle of operation and applications 5.2 Universal motor: Basic principle of operation, reversal of rotation and applications 5.3 Stepper motor: Types, basic principle of working and applications 5.4 Brushless DC motor: Basic principle of operation and applications 5.5 Servo motor: Types, basic principle of working and applications 5.6 Maintenance procedure of the FHP motors.
Unit-VI Switching and Protective Devices	6a. Describe the given type of switching or protective device. 6b. Compare the salient features of the given types of earthing systems. 6c. State the I.E. rule related to be applied for the given type of earthing with justification 6d. Select the suitable switchgear for the given situation with	6.1 Fuse: Operation, types 6.2 Switch fuse unit and fuse switch unit: Comparison 6.3 MCB, MCCB and ELCB: Operation and general specifications 6.4 Concept of limit switch, float switch, proximity switch 6.5 Earthing: Purpose of earthing, types of earthing - pipe earthing, plate earthing (installation only)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	justification.	6.6 Methods of reducing earth resistance, I.E rules relevant to earthing

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	Electric and Magnetic Circuits	08	04	04	02	10
II	AC Fundamentals	10	04	04	06	14
III	Polyphase AC Circuits and Transformer	08	02	04	06	12
IV	Three phase Induction Motor and DC Motor	08	04	04	04	12
V	Fractional Horse Power Motors	08	04	04	04	12
VI	Switching and Protective Devices	06	02	04	04	10
Total		**48**	**20**	**24**	**26**	**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:

a. Market survey regarding commonly used electrical equipment which are not covered in the curriculum.
b. Prepare power point presentation or animation for showing working of transformer and DC motors.
c. Undertake a market survey of different switchgears based on the following points.
   i. Manufacturers
   ii. Specifications/ratings
   iii. Salient features
   iv. Applications.

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 traditional 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. Guide student(s) in undertaking micro-projects.
f. Use animations to explain the construction and working of electrical machines.
g. Use video programmes available on the internet to teach some topics.
h. In respect of item no.10 above, the teachers need to create opportunities and pursue students for the effectiveness of such co-curricular activities.

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. S/he ought to submit it by the end of the semester to in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application develop the industry oriented COs. Each micro-project should encompass two or more COs which are based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Electric and Magnetic circuits:** Each batch will collect B-H curves and hysteresis loops for various types magnetic and non magnetic materials from internet. Based on the permeability and shapes of the curves, each student will decide the suitability of each material for different applications.
b. **Electric and Magnetic circuits:** Each batch will prepare a coil without core. Students will note the deflection of galvanometer connected across the coil for: movement of the north pole of permanent magnet towards and away from the coil (slow and fast movement), movement of the south pole of permanent magnet towards and away from the coil (slow and fast movement). Students will demonstrate and prepare a report based on their observations.
c. **AC fundamentals**: Each batch will visit a nearby sub-station or industry and observe the arrangement for power factor correction/improvement. Each batch will prepare a report based on their observation.
d. **Transformer:** Each batch will visit nearby pole mounted sub-station and prepare a report based on the following points:
   i. Rating: kVA rating, primary and secondary voltage, connections
   ii. Different parts and their functions
   iii. Earthing arrangement
   iv. Protective devices.
e. **Fractional horse power motor**: Each batch will select a FHP motor for a particular application (assume suitable rating). They will visit local electrical market (if the market is not nearby you may use the Internet) and prepare a report based on the following points:

i. Manufacturers
ii. Technical specifications
iii. Features offered by different manufacturers
iv. Price range

Then select the motor which you would like to purchase. Give justification for your selection in short.

f. Each batch will visit Institute workshop and prepare a report which includes the following points:
   i. Different types of prime movers used, their specifications and manufacturers
   ii. Method of starting and speed control
   iii. Different protective and safety devices used
   iv. Maintenance.

Each batch will select any one electrical device/equipment which is not included in the curriculum and prepare a short power point presentation for the class based on the following points: construction, working, salient features, cost, merits, demerits, applications, manufacturers.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical Technology Vol – I & Vol - II	Theraja, B. L.	S. Chand publications, New Delhi, latest edition ISBN: 978-8121924405 ISBN: 978-8121924375
2	Basic Electrical Engineering	Mittle, V, N. and Mittal Arvind	McGraw Hill publications, New Delhi, ISBN : 978-0070593572
3	Fundamentals of Electrical Engineering	Seksena, Subodh Behari Lal	Cambridge University Press, New Delhi latest edition, ISBN : 978-1107464353
4	Basic Electrical and Electronics Engineering	Jegathesan, V.	Wiley India, New Delhi latest edition ISBN : 978-81236529513

14. SOFTWARE/LEARNING WEBSITES

a. Electronics Workbench
b. Scilab
c. http://www.nptelvideos.in/2012/11/basic-electrical-technology.html
d. www.onlinelibrary.wiley.com
e. http://xiendianqi.en.made-in-china.com/
f. http://ewh.ieee.org/soc/es/
g. http://www.electrical-technologies.com/
h. http://www.howstuffworks.com/search.php?terms=Electrical+

Program Name: All Branches of Diploma in Engineering and Technology.

Program Code: CE/CR/CS/CH/PS/CM/CO/IF/CW/DE/EJ/EN/EQ/ET/EX/IE/MU/EE/ EP/EU/IS/IC/AE /FG/ME/PG/PT/DC/TX/TC

Semester : Second

Course Title : Business Communication Using Computers

Course Code : 22009

1. RATIONALE

Communication is the key factor for smooth and efficient functioning of any industry or business activity. Effective business communication is the lifeblood of any organization and is required to maintain quality and progress. The efficacy of business communication skills are essential for engineering professionals for instructing, guiding and motivating subordinates to achieve desired goals at work place. It is very crucial for an entrepreneur to run organization successfully by communicating effectively and skillfully with employees, customers and investors. Thus this course has been designed to enhance the skills to '*Communicate effectively and skillfully at workplace.*'

2. COMPETENCY

The aim of this course is to help the students to attain the following industry identified competency through various teaching learning experiences

- **Communicate effectively and skillfully at workplace.**

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. Communicate effectively by avoiding barriers in various formal and informal situations.
b. Communicate skillfully using non-verbal methods of communication.
c. Give presentations by using audio- visual aids.
d. Write reports using correct guidelines.
e. Compose e-mail and formal business letters.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
--	--	2	2	--	--	--	--	--	--	--	35@^	14	15~	06	50	20

(~[1]): For only practical courses, the PA (15 marks) has two components under practical marks i.e. the assessment of practical has a weightage of 60% (i.e.09 marks) and micro-project assessment has a weightage of 40% (i.e.06 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

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.

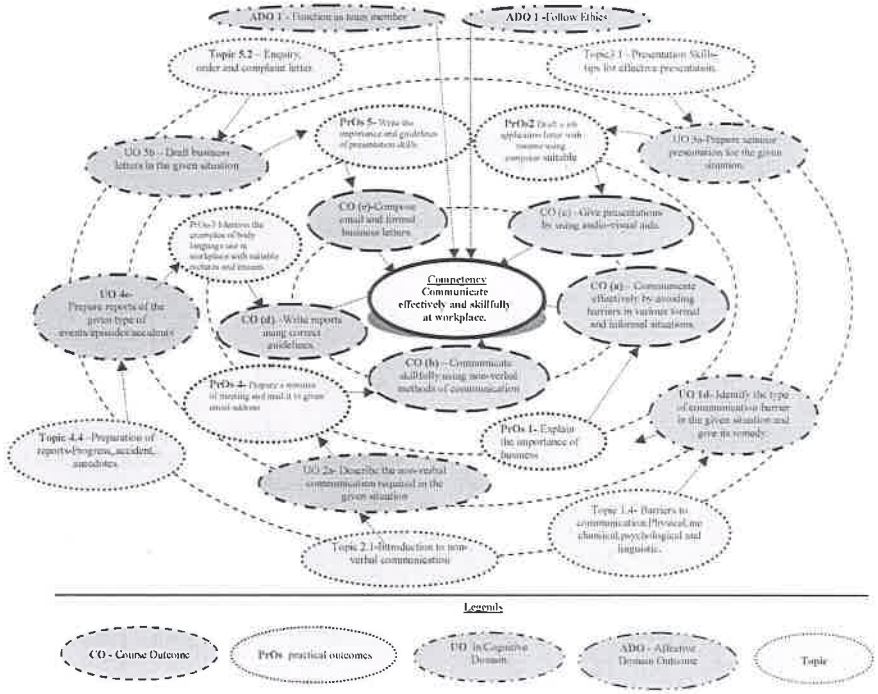

Figure 1 - Course Map

6. SUGGESTED PRACTICALS ACTIVITIES / EXERCISES (Integrate the theory in the laboratory when conducting practical)

The practical 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	Explain the importance of business communication for an organization using case study	I	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
2	Draft a job application letter with resume using computer.	V	2*
3	Mention the examples of body language use at workplace with suitable pictures and images.	II	2*
4	Prepare a minutes of meeting and mail it to given email address	VI	2
5	Write the importance and guidelines of presentation skills.	III	2*
6	Draft a detailed Progress Report.	IV	2*
7	Organize a debate on types of communication.	I & III	2
8	Summarize an industry report using techniques of summarizing.	IV	2
9	Draft a complaint letter on given topic.	V	2
10	Design PowerPoint presentation on any technical topic.	III	2*
11	Explain the eight principles of effective communication.	I	2*
12	Explain various non-verbal codes with examples.	II	2
13	Explain the importance of personal appearance stating tips of grooming for a professional.	II	2*
14	Draft a memo on given topic.	V	2
15	Present any Two barriers to communication using case study.	I	2*
16	Present a technical paper using IEEE format.	III	2*
			32

Note

i. *A suggestive list of practical LOs is given in the above table, more such practical LOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical LOs/tutorials 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. The size of batch for the practical should not exceed more than 21 students strictly for the maximum attainment of COs and PrOs.*

ii. *Hence, the 'Process' and 'Product' related skills associated with each LO of the laboratory/workshop/field work are to be assessed according to a suggested sample given below:*

7. MAJOR EQUIPMENTS / 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	Exp. S.No.
1	LCD Projector	All
2	Smart Board with networking	All
3	Language lab with internet	All
4	Printer	Wherever Applicable

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs in cognitive domain for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)		Topics and Sub-topics
	Writing Skills	Speaking Skills	
Unit – I Introduction to Business Communication	1a. Describe the importance of the business communication in the given situation. 1b. Identify the missing element in the given communication process. 1c. Identify the type of communication in the given situation. 1d. Identify the type of communication barrier in the given situation and its remedy.	1e. Use different types of verbal and non–verbal communication for the given situation.	1.1 Introduction to Communication- Elements, Importance, Functions. 1.2 Types (meaning and importance) –Verbal (Oral-Written), Formal, Informal, Vertical, Horizontal and Diagonal communication. 1.3 Principles of effective communication. 1.4 Barriers to communication - Physical, mechanical, psychological and linguistic. 1.5 Business communication: Meaning, characteristics and importance.
Unit– II Non-Verbal Communication	2a. Describe the non-verbal communication required in the given situation. 2b. Describe personal appearance required in the given communication situation. 2c. Describe the given facial expressions.	2d. Use relevant facial expressions in the given situation. 2e. Answer questions after listening to presentations.	2.1 Introduction to Non-Verbal communication (Meaning and importance) 2.2 Body Language: Aspects of body language: gestures, eye contact, posture, facial expressions, personal appearance (dressing and grooming) vocalics. 2.3 Body language - positive and negative body language.
Unit– III Presentation skills	3a. Prepare seminar presentation for the given situation. 3b. Prepare debate points 'for' and 'against' the given topic. 3c. Prepare the points for computer presentation	3d. Make seminar presentation 3e. Participate in debate speaking 'for' or 'against' the given topic. 3f. Make effective	3.1 Presentation skills- tips for effective presentation. 3.2 Guidelines for developing power point presentation. 3.3 Presenting Technical papers.

Unit	Unit Outcomes (UOs) (in cognitive domain)		Topics and Sub-topics
	Writing Skills	Speaking Skills	
	for the given topic.	computer presentations	
Unit– IV Office Drafting	4a. Draft the given notice using the relevant format. 4b. Draft the given memorandum using the relevant format. 4c. Prepare agenda for the given type of meetings. 4d. Prepare minutes of the given type of meetings. 4e. Prepare reports of the given type of events/episodes/ accidents	4f. Read the agenda of the given meeting. 4g. Read the report of the given event. 4h. Initiate telephone calls for given situation. 4i. Answer official phone calls for given situation.	4.1. Office drafting: Formats and Guidelines. 4.2. Formulating notices and memoranda. 4.3. Preparation of agenda and writing minutes of meetings. 4.4. Preparation of reports- progress reports, Accident reports, case study. 4.5. Summarizing techniques.
Unit-V Business Correspondence	5a. Respond to given job advertisements by writing your CV/ Resume. 5b. Draft business letters in the given situations. 5c. Draft complaint letters for the given situations. 5d. Compose E- mails with relevant for the given situation.		5.1 Business correspondence. 5.2 Enquiry, order and complaint letters. 5.3 E-mails- netiquettes. 5.4 Difference –Curriculum Vitae, Bio-data and Resume. 5.5 Job application and resume writing

Note: To attain the COs and competency, above listed Learning Outcomes (UOs) need to be undertaken to achieve the 'Application Level' of Blooms's 'Cognitive Domain Taxonomy' Theory related topic should be covered during practical hours using multimedia.

9. SUGGESTED SPECIFICATION TABLE FOR INTERNAL END SEMISTER EXAMINATION

Unit No.	Unit Title	Distribution of practical Marks			
		R Level	U Level	A Level	Total Marks
I	Introduction to Business Communication	02	02	01	05
II	Non-verbal Communication	02	01	02	05
III	Presentation Skills	02	01	02	05
IV	Office Drafting	02	04	04	10
V	Business Correspondence	02	04	04	10
	Total	**10**	**12**	**13**	**35**

***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 PrOs and 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 GUIDELINES FOR ASSESSMENT TOOL TO CONDUCT INTERNAL END SEMETER EXAM (ESE) .

Weightage (20 Marks) A	Weightage (15 Marks) B	Total
Assessment based on PrOs, practicals conducted during semester **Based on computer and written skill.** **(Minimum four questions each five marks)** **Sample questions:** **Eg. I Draft an email to The manager regarding the shortage of raw material at production department.** **Note-submit the printout of mail. (Computer based)** **Eg. II Write job application with resume. (written)**	**Oral examination based on UOs Topics mentioned in syllabus.** **(Minimum five questions each two marks to be asked)** **Eg. I Explain the importance of communication in professional life.** **II. State any four guidelines of presentation skills.**	**(35 Marks)** **A+B** **Duration: 2 hours**

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:

a. Collect good articles from newspapers and magazines and read them with correct intonation.
b. Listen to Business news on TV and radio.
c. Watch videos of effective presentations on television and open learning sources for presentation skills and body language.
d. Undertake micro-projects.

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 traditional 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***.
a. Arrange various communication activities using functional grammar.
b. Show video/animation films to develop listening skills and enhance vocabulary.
c. Use real life situations for explanation.
d. Prepare and give oral presentations.
e. Guide micro-projects in groups as well as individually.

12. SUGGESTED TITLES OF 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. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of CrAs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. Study the personal appearance and grooming of employees visiting sales store, shopping mall in the vicinity.
b. Comparative study of Bio-data, Resume and Curriculum vitae.
c. A detailed study of guidelines required for presentation skills.
d. Summarize technical content using English newspaper, magazines or online resources.
e. Prepare a booklet on aspects of body language in pictorial form.
f. A detailed study of the importance, of technical paper of technical paper presentation.
g. Case study on the importance of Business communication in an organization.
h. Report on various formal/business activities.
i. Study of oral presentation of famous business leader.
j. Detailed study of business etiquettes observed in organization.
k. Summarize the business article with the help of English newspapers/magazines and other sources.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Effective Communication Skills	M Ashraf Rizvi	Tata McGraw-Hill

S. No.	Title of Book	Author	Publication
2	Communication Skills	Sanjay Kumar and Pushp Lata	Oxford University Press
3	Personality Development and Soft Skills	Barun K. Mitra	Oxford University Press

14. SOFTWARE/LEARNING WEBSITES

a. https://www.britishcouncil.in/english/learn-online
b. http://learnenglish.britishcouncil.org/en/content
c. http://www.talkenglish.com/
d. languagelabsystem.com
e. www.wordsworthelt.com
f. www.notesdesk.com
g. http://www.tutorialspoint.com
h. www.studylecturenotes.com
i. totalcommunicator.com
j. www.speaking-tips.com

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Second**

Course Title : **Medical Electronics Workshop**

Course Code : 22019

1. RATIONALE

Medical electronics diploma pass outs are expected to handle various electronic and biomedical equipment in the industry. It is also expected that they should be able to identify various sensors for biomedical related application. This basic course will lead the student to develop such practical skills. By undertaking this course, the student will be able to build simple circuits that are used for medical applications as well as troubleshoot and maintain the biomedical system efficiently.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Build /Test electronic circuits and PCBs.**

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. Identify various electronic components.
b. Identify various biomedical sensors.
c. Identify biomedical equipment used in measurement of various physiological parameters.
d. Test the function of sensors and other electronic components in medical equipment.
e. Use electronic equipment for measuring circuit output.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
--	--	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40

*(~): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e.30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e.20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***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.

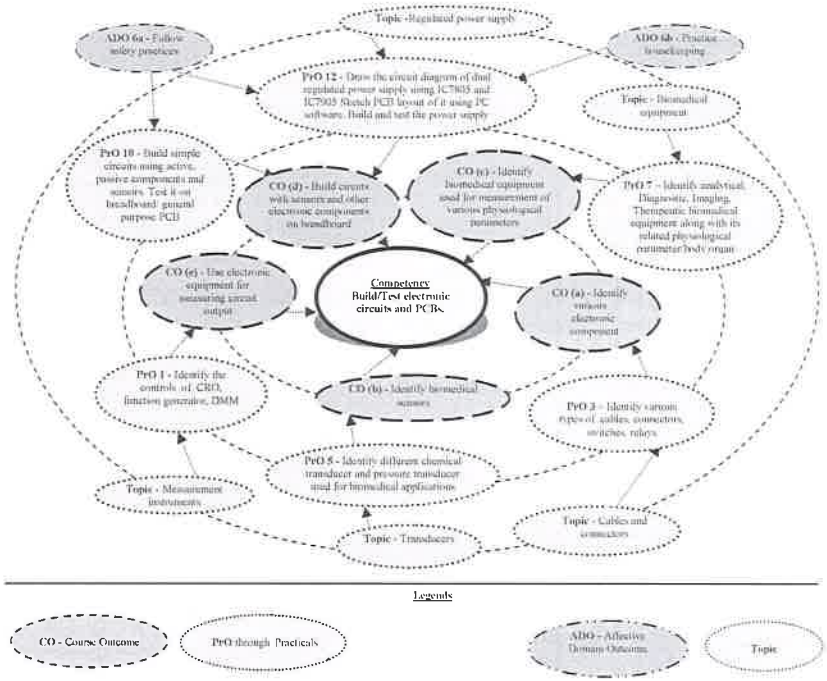

Figure 1 - Course Map

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)	Approx. Hrs. Required
1	a) Identify the controls of CRO. b) Test R, L, C using multimeter and CRO.	2
2	Test diode and transistor using multimeter and CRO.	2*
3	a) Identify the controls of function generator. b) Identify the output waveforms of function generator on CRO.	2
4	Identify various types of cables, connector, switches and relays. Part I	2
5	Identify various types of cables, connector, switches and relays. Part II	2
6	Identify opto-coupler, opto-isolator and other opto-electronic devices. Part I	2*

S. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
7	Identify opto-coupler, opto-isolator and other opto-electronic devices. Part II	2
8	Identify different chemical transducer and pressure transducer used for biomedical applications. Part I	2*
9	Identify different chemical transducer and pressure transducer used for biomedical applications. Part II	2
10	Identify various temperature sensors and their parts.	2
11	Identify analytical, diagnostic, imaging, therapeutic biomedical equipment along with its related physiological parameter / body organ.	2*
12	Undertake market survey of electronic components through visit to nearby industries / internet. Write name of the manufacturers, cost, and specifications of minimum five components from each category (passive and active components, sensors). Part I	2*
13	Undertake market survey of electronic components through visit to nearby industries / internet. Write name of the manufacturers, cost, and specifications of minimum five components from each category (passive and active components, sensors). Part II	2
14	Undertake market survey of biomedical equipment through visit to nearby hospitals / industries / internet. Write name of the manufacturers, cost, and specifications of minimum five equipment. Part I	2
15	Undertake market survey of biomedical equipment through visit to nearby hospitals / industries / internet. Write name of the manufacturers, cost, and specifications of minimum five equipment. Part II	2
16	Build/Test simple circuits using active, passive components and sensors on breadboard and general purpose PCB. Part I	2*
17	Build/Test simple circuits using active, passive components and sensors on breadboard and general purpose PCB. Part II	2
18	Build/Test simple circuits using active, passive components and sensors on breadboard and general purpose PCB. Part III	2
19	Build/Test simple circuits using active, passive components and sensors on breadboard and general purpose PCB. Part IV	2
20	Build/Test simple circuits using active, passive components and sensors on breadboard and general purpose PCB. Part V	2
21	Build and test circuit of single regulated power supply using IC7805 / IC7905 on breadboard and general purpose PCB. Part I	2
22	Build and test circuit of single regulated power supply using IC7805 / IC7905 on breadboard and general purpose PCB. Part II	2
23	Build and test circuit of single regulated power supply using IC7805 / IC7905 on breadboard and general purpose PCB. Part III	2
24	Build and test circuit of single regulated power supply using IC7805 / IC7905 on breadboard and general purpose PCB. Part IV	2
25	Build and test circuit of single regulated power supply using IC7805 / IC7905 on breadboard and general purpose PCB. Part V	2
26	Use PC software to sketch layout of different electronic circuits. Part I	2*
27	Use PC software to sketch layout of different electronic circuits. Part II	2
28	Draw circuit diagram of dual regulated power supply using IC7812 and	2*

S. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
	IC7912. Mount components on breadboard and test the circuit. Part I	
29	Draw circuit diagram of dual regulated power supply using IC7812 and IC7912. Mount components on breadboard and test the circuit. Part II	2
30	Draw circuit diagram of dual regulated power supply using IC7812 and IC7912. Mount components on breadboard and test the circuit. Part III	2
31	Using software draw layout of dual regulated power supply, make PCB. Place components on PCB to test the circuit. Part I	2*
32	Using software draw layout of dual regulated power supply, make PCB. Place components on PCB to test the circuit. Part II	2
	Total	**64**

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 24 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 %
a.	Setting of experimental set up	20
b.	Operate equipment skillfully	30
c.	Follow safety measures	10
d.	Work in team	10
e.	Record observations	10
f.	Interpret results to conclude	10
g.	Answer to sample questions	05
h.	Submit report in time	05
	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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. 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	Exp. No.
1	CRO: 50MHz, dual trace, dual beam, inbuilt +-5 V supply, component tester, function generator	1, 2
2	Function Generator: 1 MHz - 3MHz	2
3	LCR-Q meter	10, 11, 13
4	Soldering gun: 40watts, holding stand, temperature control, power chord	10, 11, 13
5	De-soldering gun: 80 watts, output voltage 24 V	10, 11, 13
6	Digital multi meter 3 and ½ digit with component tester	1, 3
7	Wire cutter	3, 10, 11, 13
8	Wire stripper	3, 10, 11, 12
9	Consumable components: Resisters, capacitors, diodes, transistors, ICs, IC sockets, general purpose PCBs, LEDs, relays, switches, connectors, sensors, connecting wires, soldering metal, soldering flux, de-soldering mesh	10, 11, 12
10	Universal IC tester	10, 11, 12
11	Digital storage oscilloscope: Bandwidth 50/100MHz	10, 11, 12
12	Display chart for symbols of various components	4, 5, 6, 7
13	Personal computer with internet facility	8, 9, 12, 13

8. UNDERPINNING THEORY COMPONENTS

-Not applicable-

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

-Not applicable-

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:

a. Prepare chart of various cables, connectors, switches and relays.
b. Prepare chart of opto-coupler and opto-isolator, opto-electronic devices.
c. Prepare chart of different chemical transducer and pressure transducer used for biomedical applications.
d. Prepare chart of various temperature sensors.
e. Prepare chart of different voltage regulator ICs.
f. Download the catalogue of switches, connectors, cables and relays from websites of reputed manufacturers to learn the latest developments.

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

b. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
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. Arrange visit to nearby electronics/biomedical manufacturer/testing industry.
e. Show video/animation films to explain functioning of all electronics components / biomedical sensors and their application.
f. Assign interesting micro projects to students to develop simple electronic circuits.

12. SUGGESTED MICRO-PROJECTS

13. ***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. S/he ought to submit it by the end of the semester to in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application develop the industry oriented COs. Each micro-project should encompass two or more COs which are based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. Test switches, connectors, cables, sensors, relays and submit report on it.
b. Test optoelectronic devices and submit report on it.
c. Build and test lie detector circuit and submit report on it.
d. Build and test photo sensor circuit and submit report on it.
e. Build and test mosquito repellent circuit and submit report on it.
f. Make report on market survey of sensors used in the electronics industry.

14. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Components Handbook	Jones, Thomas H.	Reston Publishing, Reston, Virginia, United states latest edition, ISBN: 978-0879092221
2	Biomedical sensors and measurements	Ping Wang; Qingjun Liu	Zhejiang University Press/ Springer, 2011, ISBN: 978-7308082693
3	Medical Instrumentation Application and Design	Webster, John G.	Wiley India, 4th edition, 2015, ISBN: 978-8126553792
4	Biomedical Engineering Handbook, Volume 1	Bronzino, Joseph D.	CRC Press,1999, ISBN: 978-0849304613

15. SOFTWARE/LEARNING WEBSITES

a. http://textofvideo.nptel.iitm.ac.in/

b. http://www.eleccircuit.com
c. http://www.electroschematics.com
d. http://electronicsclub.info/circuitsymbols.htm
e. http://robotshop.com/media/files/pdf/eck-10-manual.pdf

Program Name : **Diploma in Industrial Electronics / Diploma in Medical Electronics**

Program Code : **IE / MU**

Semester : **Second**

Course Title : **Programming in 'C' (IE, MU & 3rd Sem IS)**

Course Code : **22020**

1. RATIONALE

The electrical and electronics related specialised branches deal with microcontrollers and embedded systems, in many applications. To interface with such devices, knowledge of programming language is required. The 'C' language is very helpful to develop and enhance skills of programming. 'C' is used to develop device drivers, operating systems, system software and applications. This course will enable students to learn developing programming logic as well as debug, compile and execute 'C' program on different operating systems.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Develop 'C' programs to solve engineering problems.**

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. Write simple 'C' programs using arithmetic expressions.
b. Use control structures in 'C' program.
c. Develop 'C' programs using array.
d. Develop 'C' programs using functions for modular programming approach.
e. Develop 'C' programs using structure and union.
f. Create graphics employing 'C' functions.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
2	--	2	4	--	--	--	--	--	--	--	25@	10	25~	10	50	20

*(~): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 20 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

***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.

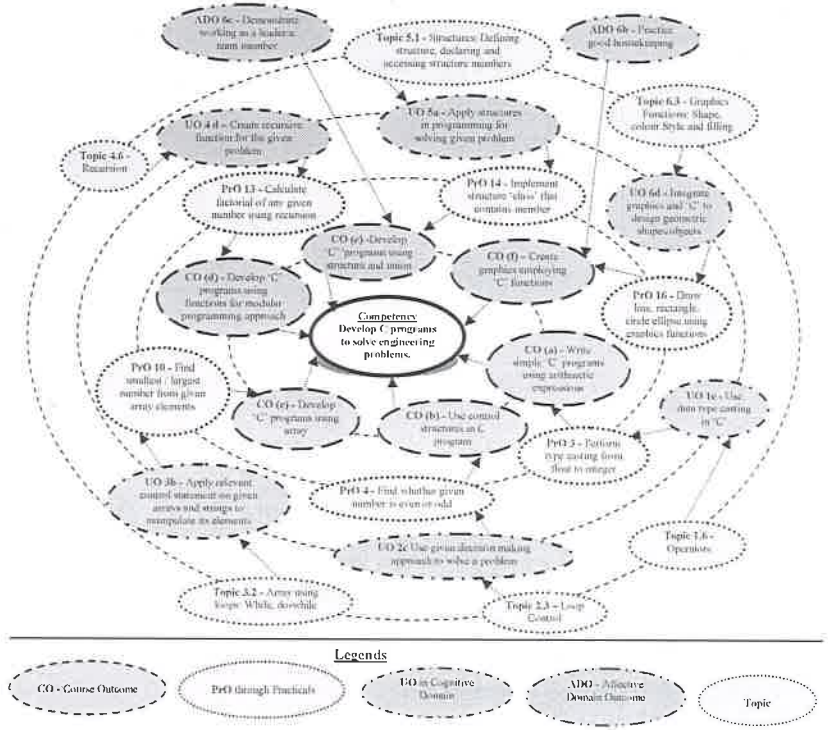

Figure 1 - Course Map

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
	Construct flowchart, algorithm and develop a 'C' program to do the following:		
1	a. Display "Hello World" on computer screen. b. Display your name, address and college name on screen.	I	02*
2	a. Display square, cube of given number on computer screen. b. Calculate area of, triangle, square and circle	I	02
3	a. Perform type casting from float to integer. b. Demonstrate use of format specifiers.	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	a. Find whether given number is even or odd. b. Find greatest and smallest of 3 numbers.	II	02*
5	a. Convert a given decimal number to binary and hexadecimal number. b. Convert a binary number to decimal number.	II	02
6	Display pass class, second class, first class, distinction according to the marks entered using switch case.	II	02
7	Display menu to perform- • Addition • Subtraction • Multiplication • Division and Based on user's choice execute it using switch case.	II	02
8	a. Display Fibonacci series of length 5. b. Display following pattern 1 2 2 3 3 3 4 4 4 4	II	02
9	a. Print ASCII tables of alphabets (use continue statements). b. Print prime numbers from 1 to 100 (use break statement).	II	02
10	a. Find smallest / largest number from given array elements. b. Find sum of first 10 elements of array.	III	02*
11	a. Enter elements for 3X3 matrix and display them. b. Calculate addition and subtraction of 2 dimensional matrix.	III	02
12	a. Calculate length of String "Digital India". b. Replace word 'Digital' from above string with 'Incredible'. c. Concatenate "Incredible India" and "Campaign" as a one string. d. Check if given string is palindrome or not.	III	02
13	a. Calculate area of circle, triangle and rectangle using function. b. Calculate factorial of any given number using recursion.	IV	02*
14	Implement a structure named 'class' that contains following member variables: Roll No, Name, Marks of three subjects Read the information from keyboard calculate percentage of total marks and print Roll No, Name, Marks of three subjects and percentage marks on screen.	V	02*
15	Implement union 'Book' that contains following member variables: Book title, Author's name, Book price Read the information from keyboard and print same on screen	V	02
16	Draw line, rectangle, circle and ellipse using graphics functions.	VI	02*
17	Draw a smiley using graphics functions.	VI	02
	Total		**34**

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	Ability to prepare flowchart	20
2	Ability to develop algorithm	20
3	Compile, debug and run 'C' programs	40
5	Answer to oral questions	10
6	Submission of program print-out 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 safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. 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.
- 'Organizing Level' in 2nd year.
- 'Characterizing 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 administrators.

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
1	Desktop computer with optimum configuration	All
2	'C' compiler	

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of 'C'	1a. Interpret working of the given system software in the execution of 'C' program. 1b. Explain the feature of the given data types in 'C'. 1c. Explain use of the given operators in 'C' with example. 1d. Describe the given formatting procedure in 'C'. 1e. Describe the use of the given data type casting in 'C' with example.	1.1 Applications and functions of system software: Assembler, compiler, interpreter, debugger, linker 1.2 Basic concepts of 'C': Evolution, building components of C, Features, advantages, structure of 'C' program 1.3 Constants, variables and data types, character set, keywords, constants, variables, declaration initializations and assigning values of variables, data type and their size, formatting characters 1.4 Operators (arithmetic, Logical, assignment, relational, increment and decrement, conditional, bit wise, special operators),operator precedence, expressions, formatted input and output, type conversion
Unit– II Loops in C- Decision Making	2a. Describe the procedure to construct flowcharts for given problem. 2b. Describe the procedure to develop algorithm for the given problem. 2c. Use given decision making approach to solve a problem. 2d. Explain the procedure of using the given loop statement with examples.	2.1 Fundamentals of algorithm and flowcharts 2.2 Decision making and branching: If statement (if, if-else, if-else-if ladder, nested if-else),switch statement 2.3 Loop Control: Loop concepts, use of loops, pre test and post test loops, while, do-while and for loops, nested loops, break and continue statement
Unit– III Arrays and Strings	3a. Write statements to read, write the given array. 3b. Apply relevant control statement on the given arrays and strings to manipulate its elements. 3c. Explain use of numerical arrays in the given mathematical application with examples. 3d. Describe the procedure for string operations in 'C' for the given data.	3.1 Arrays: declaration, initialization of one dimensional, two dimensional arrays, size of array, memory allocation of array 3.2 Array operations using control structures: while, do-while and for 3.3 Multi dimensional array 3.4 Declaration and initialization of string variables.
Unit-IV	4a. Use the given built-in C function.	4.1 Concept of Functions, benefits of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Functions	4b. Develop relevant user defined functions for the given problem. 4c. Write program to pass the given function parameters using "call by value" and "call by reference" approach. 4d. Create recursive function for the given problem.	using functions, Built in functions from C library: Math, character/string, miscellaneous functions 4.2 User defined Function, Function declaration, definition and call 4.3 Return values and their types, function with return values 4.4 Internal and external variables, scope and lifetime of variables 4.5 Function call, passing arguments to functions (call by value, call by reference) 4.6 Recursion
Unit –V Structure and Union	5a. Apply structures in programming for solving the given problem. 5b. Differentiate the given structure and union with examples. 5c. Apply union to solve the given problem. 5d. Explain the memory utilization by member variables in the given structures/Union.	5.1 Structures: Defining structure, declaring and accessing structure members, initialization of structure 5.2 Arrays of structure 5.3 Union: Definition of union, declaring and accessing union members, difference between structure and union
Unit-VI Graphics in C	6a. Explain the given graphics component in 'C' with examples. 6b. Describe the use of the given graphics driver in C programming. 6c. Describe the use of the given in-built graphics functions in 'C'. 6d. Integrate graphics and 'C' to design the given geometric shapes/ objects.	6.1 Computer graphics overview 6.2 Graphics drivers and graphics mode definition, declaration 6.3 Graphics functions: Shape, colour, style and filling

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

-Not applicable -

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:

a. List any five major scientific and medical applications based on 'C' programming.
b. List any five major commercial applications based on 'C' programming.
c. Illustrate various languages based on the concepts of 'C'.

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 traditional 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. Guide student(s) in undertaking micro-projects.
f. Arrange group discussion of students on live day-to- ay problems leading to useful 'C' programming.
g. Arrange spoken tutorial on 'C' programming.
h. Evaluate programming skills through multiple choice questions on 'C' programming.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Modern Periodic Table using 'C'** - Prepare a periodic table using functions:
Void add() and Void show()
b. **Simple Calculator** - Prepare a menu driven program to perform any five mathematical operations.
c. **Employee Record System** - Prepare a menu driven program to perform following operations :
   i. Add record
   ii. List record.
d. **Digital clock using 'C'**
e. **String Manipulation project** - Prepare a menu driven program to perform following operations (any five) :
   i. Substrings
   ii. Palindromes
   iii. Comparison
   iv. Reverse string
   v. String to integer
   vi. Sort a string.

f. **Matrix Operations** - Prepare a menu driven program to perform following operations:
   i. Matrix addition
   ii. Matrix multiplication
   iii. Matrix transpose
   iv. Sum of diagonal of a matrix.

g. **Basic mathematic functions** - Prepare a menu driven program to perform following operations:
   i. Pascal triangle
   ii. Armstrong No.
   iii. Floyd's triangle
   iv. HCF and LCM.

h. **Patterns** - Prepare a menu driven program to obtain following patterns :

```
1          1          *          1
121        12         **         2 2
12321      123        ***        3 3 3
1234321    1234       **         4 4 4 4
                      *
```

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Programming in 'C'	Balguruswamy, E.	Tata Mc-Graw Hill, New Delhi, 2008, ISBN: 978-0070648227
2	Let Us 'C'	Kanetkar, Yashwant P.	BPB Publications 13th Edition, 2016, ISBN: 978-8183331630
3	Programming in 'C': A Practical Approach	Mittal, Ajay	Pearson Education India, New Delhi, 2010, ISBN: 978-8131729342
4	Programming with 'C' (Schaum's Outlines Series)	Gottfried, Byron; Chhabra Jitender	McGraw Hill Education, 2010, ISBN: 978-0070145900
5	'C' Programming Absolute Beginner's Guide	Perry Greg	Pearson Education, 1st edition. 2014, ISBN: 978-9332539570
6	'C': The Complete Reference	Schildt, Herbert	Tata Mc-Graw Hill, New York 2000, ISBN: 978-00072121247

14. SOFTWARE/LEARNING WEBSITES

a. Turbo C Editor
b. Dosbox
c. www.tutorialspoint.com/cprogramming
d. www.cprogramming.com
e. www.programiz.com/c-programming
f. www.w3schools.in/c-tutorial
g. www.fresh2refresh.com/c-programming
h. www.programming-techniques.com
i. www.learn-c.org
j. www.spoken-tutorial.org
k. www.cplus.about.com
l. www.computer.howstuffworks.com/c.htm
m. www.indiastudycenter.com/studyguides/cs/default.asp

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Fourth**

Course Title : **Microcontroller and Embedded System**

Course Code : **22434**

1. RATIONALE

In industry, microcontroller is heart of most of the domestic, industrial, consumable and other high end electronic products. Automation in every field is being used and microcontroller is inbuilt element of these embedded systems, requiring knowledge of microcontrollers is very vital. This course is intended to develop the skills to diagnose and rectify embedded system related problems in the industry.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain biomedical instruments based on microcontroller and embedded 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. Select the microcontroller for various biomedical applications.
b. Use IDE to write embedded C programs for AT89C51 microcontroller.
c. Interface I/O devices with microcontroller.
d. Maintain various communication protocolsin medical systems.
e. Maintain embedded systems in biomedical applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	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.

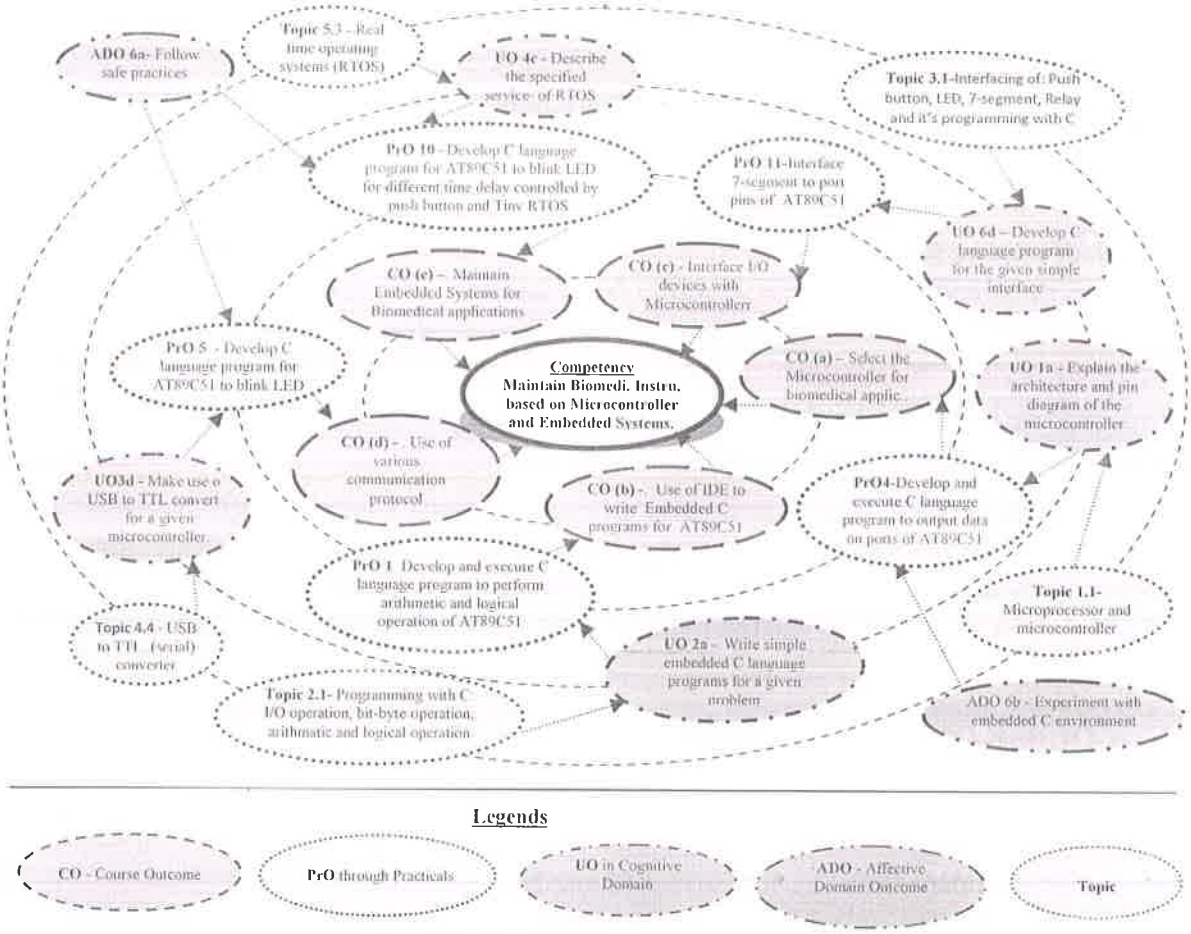

Figure 1 - Course Map

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.	Develop and execute assembly and C language program to output data on ports of AT89C51.	II	02*
2.	Develop and execute assembly and C language program to perform arithmetic and logical operations of AT89C51.	II	02
3.	Develop and execute time delay program for AT89C51 using assembly and C language.	II	02
4.	Develop and execute C language program to generate square wave on port pin of AT89C51.	II	02*
5.	Develop and execute C language program to send data serially on TXD line of AT89C51.	II	02
6.	Interface single digit 7-segment to port of AT89C51 and write C language program to display numbers.	III	02*
7.	Interface Relay to port pin of AT89C51 and write C language	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	program to turn ON the bulb through the relay.		
8.	Interface 4x4 matrix keyboard to AT89C51 and write C language program to scan the code of pressed key and display it on port.	III	02
9.	Interface 16x2 LCD with AT89C51and write C language program to display message.	III	02
10.	Interface ADC0808 with AT89C51 and write C language program to convert analog data to digital and display it on port.	III	02
11.	Interface DAC0808 with AT89C51and write C language program to generate various waveform.	III	02
12.	Interface stepper motor with AT89C51 and write C language program to rotate it by different angles.	III	02
13.	Interface Push button and LED to port pins of Arduino board and write C language program to turn ON LED when Push button is pressed.	III	02
14.	Interface DC motor with Arduino board and write C language program to rotate it CW and CCW.	III	02
15.	Develop C language program for AT89C51 to blink LED and load it to microcontroller using CP2102.	IV	02*
16.	Develop C language program for AT89C51 to blink LED for different time delay controlled by push button and Tiny RTOS.	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	Write algorithm and draw flowchart	10
2	Use IDE tools for programming	40
3	Debug, test and execute the program	20
4	Observations and Interpretation	10
5	Answer to sample questions	10
6	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. Handle command prompt environment
b. Experiment with embedded C environment
c. Plan, construct, compile, debug and test embedded C program
d. Practice good housekeeping

e. Practice energy conservation
f. Demonstrate working as a leader/a team member
g. Maintain tools and equipment
h. 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	Hardware: Personal Computer Pentium 4, 2GHz onwards, I3-I5 preferable, RAM minimum 2 GB onwards	1 to 17
2	Operating system: Windows XP/ Windows 7/Linux onwards	1 to 17
3	Trainer kit for AT89C51 with onboard 16x2 LCD, 4x4 matrix keyboard, 7-segment display, ADC and DAC interface	1 to 13. 16, 17
4	Trainer kit for stepper motor	13
5	Trainer kit for DC motor	15
6	Keil/SPJ IDE	1 to 13, 16, 17
7	Proteus software	1 to 17
8	Hyperterminal	5.16
9	Device programmer for AT89C51	1 to 13, 16, 17
10	USB to TTL (serial) converter CP2102	16
11	Digital Multmeter	1 to 17
12	Digital storage oscilloscope 50MHz	4.8.12
13	Arduino board	14,15

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 Microcontroller MCS-51	1a. Explain with sketches the function of the given pin of AT89C51. 1b. Explain with sketches the function of the given interrupt of AT89C51. 1c. Describe with sketches Timer/Counter	1.1 Microprocessor and microcontroller 1.2 Features of MCS-51 microcontroller, it's architecture and pin diagram

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	mode for specific application of the given microcontroller. 1d. Describe the use of the given serial communication mode for data transfer in the given situation. 1e. Select microcontroller for specified application wih justification. 1f. Compare the features of the given two types of microcontrollers from the MCS-51 family. 1g. Describe with sketches the procedure to troubleshoot the given type of microcontroller.	1.3 Interrupt structure, timer/counters and it's modes, modes of serial communication and related SFRs 1.4 Selection factors of microcontroller 1.5 Derivatives of MCS-51: 8031,8032,8051,8052,8751, 8752 and AT89C51
Unit-II Programming AT89C51 microcontroller with Embedded C	2a. Describe with sketches the functions of the given IDE tool. 2b. Explain with sketches the embedded software development cycle of the given IDE tool. 2c. Compare features of the assembly and C language on the basis of specified parameters. 2d. Write simple Embedded C language programs for the given problem. 2e. Use assembly instructions in C program for specific time delay for the given microcontroller.	2.1 Integrated Development Environment (IDE) for developing program, IDE tools: Editor, assembler, compiler, debugger and linker 2.2 Assembly language versus embedded C 2.3 Programming with C: I/O operation, bit-byte operation, arithmatic and logical operation, timer/counter operation, time delay routine, serial communication 2.4 Assembly instructions for time delay in C
Unit– III I/O Interfacing application with AT89C51 and Aurdino board	3a. Develop C language program for the given simple interface. 3b. Develop the logic to locate a specified key which is pressed on the 4x4 matrix keyboard interfaced to the given type of microcontroller. 3c. Write commands to initialize 16x2 LCD interfaced to the given microcontroller in the given situation. 3d. Develop the logic to convert 8-bit data using ADC0808/9 interfaced to the given microcontroller in the given situation. 3e. Develop the C language program to generate the given waveform by interfacing DAC0808 with the given microcontroller in the given situation. 3f. Develop the logic to rotate the given	3.1 Interfacing of: Push button, LED, 7-segment, Relay and it's programming with C 3.2 Interfacing of 4x4 matrix keyboard (no program) 3.3 Interfacing of 16x2 LCD (only initialization commands and logic, no program) 3.4 Interfacing of ADC0808/9 (only interfacing diagram, no program) 3.5 Interfacing DAC0808 and write C program to generate square, triangular and sawtooth waveform 3.6 Interfacing of stepper motor with AT89C51

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	motor for the specified criteria interfaced to the microcontroller. 3g. Explain with sketches the procedure of interfacing the given device with aurdino board.	3.7 Arduino board: pinout diagram, function of pins, interfacing with LED and DC motor
Unit– IV Communication Protocols	4a. Compare the given parameters of the specified communication modes. 4b. Explain with sketches the working of the given serial protocol. 4c. Explain with sketches the working of the given wireless communication protocol. 4d. Explain with sketches of how to use the USB to serial converter for the given microcontroller. 4e. Describe the procedure to troubleshoot the given type of communication protocol	4.1 Serial and parallel communication, synchronous and asynchronous communication 4.2 Serial communication protocol: I2C, USB, serial peripheral interface (SPI) 4.3 Wireless communication protocol:IrDA, Bluetooth 4.4 USB to TTL (serial) converter CP2102
Unit –V Embedded System Design	5a. Classify embedded system on the basis of given parameters. 5b. Describe the characteristics of the embedded system for the given application. 5c. Compare features of the OS and RTOS on the basis of the given parameters. 5d. Describe with sketches the specified service of RTOS. 5e. Troubleshoot the specified problems in intertask communication with justification.	5.1 Embedded System: Introduction, classification, application, advantages and disadvantages 5.2 Characteristics of embedded systems 5.3 Real time operating systems (RTOS): Comparison of normal OS and RTOS, need of RTOS in embedded system, multitasking, inter task communication

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	Microcontroller MCS-51	12	04	06	06	16
II	Programming AT89C51 microcontroller with embedded C	14	02	06	08	16
III	I/O Interfacing application with AT89C51 and Aurdino board	10	02	06	08	16
IV	Communication protocols	06	02	04	04	10
V	Embedded system design	06	04	04	04	12

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Total		48	14	26	30	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. Use various microcontrollers and IDEs to develop small scale embedded system.
b. Conduct Library / Internet survey of Microcontrollers and I/O devices.
c. Prepare power point presentation on microcontroller based system.
d. Develop a small report on "Applications of Microcontrollers for health, safety, environment and society'

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 traditional 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 PPT to explain the communication protocols.
f. Guide student(s) for using data sheets.
g. Guide student(s) in undertaking interesting micro-projects. For some groups of bright students, microprojects using other microcontrollers like PIC16F877 and AVR can also be given.

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. **DC motor control using DTMF decoder and microcontroller:** Develop DC motor control system using CM8870 DTMF decoder IC and AT89C51. Write report on the same.
b. **LED control using DTMF decoder and microcontroller:** Develop LED ON/OFF control system using CM8870 DTMF decoder IC and **microcontroller**. Write report on the same.
c. **LED ON/OFF using Bluetooth and AT89C51:** Develop LED ON/OFF operation board using HC05 bluetooth device and AT89C51. Write report on the same.
d. **LED pattern generation using Arduino/Rasberry pi:** Generate LED pattern using Arduino board. Write report on the same.
e. **Heart beat Monitoring using Arduino/Rasberry pi:** Design heart beat monitoring system using Arduino board. Write report on the same.
f. **Distance measurement using Ultrasonic module and Arduino:** Design distance measurement unit using ultrasonic module and Arduino board. Write report on the same

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	The 8051 Microcontroller & Embedded Systems Using Assembly and C with CD	Ayla, Kenneth J.	Cengage Learning India Pvt. Ltd., New Delhi, 2010 ISBN: 978-8131511053
2	The 8051 microcontroller and embedded system using Assembly and C	Mazidi, Mohmad-ali; Mazidi, Janice-Gelispe;Mckinlay, Roline D.	Pearson India, New Delhi, 2008 ISBN: 9788131710265
3	Microcontroller theory and application	Deshmukh, Ajay	McGraw- Hill, New Delhi, 2011, ISBN: 9780070585959
4	Microcontrollers: Architecture, Programming, Interfacing and System Design	Kamal, Raj	Pearson Education India, New Delhi, 2011, ISBN: 9788131759905
5	Embedded System Design: A Unified Hardware/Software Introduction	Vahid, Frank; Givargis, Tony D.	Wiley, New Delhi, 2006 ISBN: 9780471386780
6	Embedded / Real-Time Systems: Concepts, Design and Programming -Black Book	Prasad, K.V.K.K.	Dreamtech Press, New Delhi, 2003, ISBN: 978-8177224610

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. freevideolectures.com/Course/3018/Microprocessors-and-Microcontrollers
b. nptel.ac.in/courses/Webcourse-contents/IIT.../microcontrollers
c. www.elprocus.com/basics-and-structure-of-embedded-c-program-with-examples-for-beginners/
d. www.scriptoriumdesigns.com/embedded/programming_basics.php
e. www.edgefx.in/steps-to-build-embedded-c-programming-tutorial/
f. www.eeherald.com/section/design-guide/esmod7.html
g. maxembedded.com/2013/09/serial-communication-introduction/
h. www.byteparadigm.com/applications/introduction-to-i2c-and-spi-protocols/
i. learn.sparkfun.com/tutorials/serial-peripheral-interface-spi
j. www.tutorialspoint.com/embedded_systems/es_overview.htm
k. nptel.ac.in/courses/108102045/1
l. www.sunrom.com/p/cp2102-usb-ttl-uart-module
m. www.youtube.com/watch?v=nlAweTBYISM
n. www.youtube.com/watch?v=RaOuzwQDHKg
o. www.circuitstoday.com/getting-started-with-keil-uvision
p. www.youtube.com/watch?v=Oy_cA1d6TqE
q. www.8051projects.net/wiki/Keil_Embedded_C_Tutorial#Introduction_to_Keil_C
r. www.arduino.cc/en/Tutorial/BuiltInExamples
s. www.arduino.cc/en/Guide/Introduction

Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Fourth**

Course Title : **Analytical Equipment**

Course Code : **22435**

1. RATIONALE

A medical electronics engineer must be familiar with modern analytical equipment for the purpose of diagnosis of various physiological abnormalities. This course is useful in understanding the design concept, working principle, application oriented operating procedure, installation and maintenance of almost all analytical equipment used in hospital and pathology laboratory. Through this course the students will develop skills to handle modern analytical equipment in the pathology lab, different food industries, fabric industries, and agriculture area as well as research laboratories.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Operate various analytical equipment.**

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 basic analytical equipment.
b. Operate different types of centrifuges and sterilizing equipment.
c. Measure different types of components of blood using analytical instruments.
d. Quantify pH and conductivity of body fluid.
e. Measure the different pollutants present in the environment.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	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.

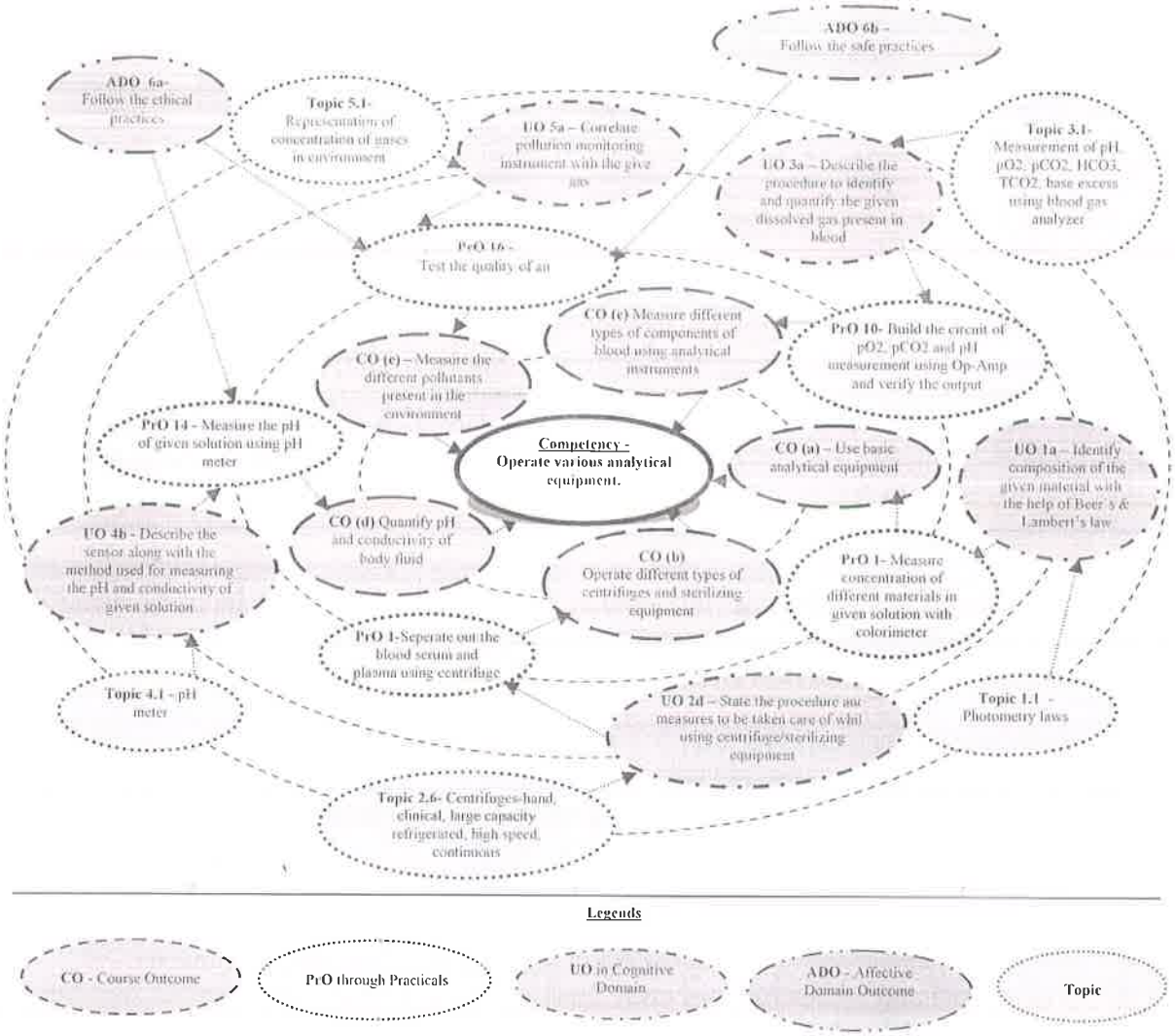

Figure 1 - Course Map

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.	Measure concentration of different materials in given solution with the help of colorimeter.	I	02*
2.	Measure concentration of different materials in given solution with the help of spectrophotometer.	I	02
3.	Use flame photo meter to calculate the concentration of sodium potassium, iodine calcium.	I	02
4.	Use centrifuge to separate out the blood serum and plasma.	II	02*
5.	Use ultrasonic cleaner to sterilize micro components.	II	02
6.	Use hot air oven to sterilize hospital utensils.	II	02
7.	Use autoclave to sterilize biomedical waste.	II	02
8.	Use incinerator machine dispose biomedical wastes.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9.	Use electrophoresis apparatus to separate out the bio particles.	III	02*
10.	Use Op-Amp to build the circuit for pO2, pCO2 and pH measurement.	III	02
11.	Use auto-analyzer to find out the concentration of different components of blood.	IV	02*
12.	Use Blood cell counter to measure WBC, RBC, platelets in the blood.	IV	02
13.	Interpret the contents of the given sample using SEM and TEM.	IV	02
14.	Use pH meter m to measure the pH of given solution.	IV	02
15.	Use conductivity meter to xamine the conductivity of the given solution.	IV	02
16.	Use air quality detector to test the quality of air.	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	10
3	Safety measures	10
4	Observations and recording	20
5	Interpretation of result and conclusion	20
6	Repairing and maintenance	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	Colorimeter : Automatic cooling,6-7 tests per hour, fixed bomb cylinder with removable head for fast sample loading, operator time per test is 1 minute,0.1% precision class instrument.0.0001 °c temperature resolution.5000 – 8000 calorie sample range,0.05% linearity across operating range.	I
2	Spectrophotometer: wavelength 190 to1100 nm,baseline stability less than 0.0003 Abs/H at 700 nm (one hour after light source turned ON), Baseline flatness: within ±0.0006 Abs (190 to 1100nm,one hour after light source turned ON), Noise level: Within 0.00005 Abs RMS value (at 700 nm)	II
3	Flame photometer: Filters: Na and K (Ca and Li optional), Range: Na: 0-100 ppm, Ca: 20-100 ppm, K : 0-100 ppm, Li: 10-100 ppm, Sensitivity: Na: 5 ppm, Ca: 10 ppm, K : 5 ppm, Li: 10 ppm	III
4	Ultrasonic Cleaner: Capacity:1.3 to 14 Liter Tank, Ultrasonic Cleaning Power:60W to 750W, Ultrasonic frequencies: 20KHz / 40KHz, Digital timer adjustment: 1-99 minutes, Digital temperature adjustment: 0-70 ^{0}C, Stainless Steel Basket and cover lid, Tank and housing made from Stainless Steel.	V
5	Centrifuge : max capacity: 3.0 L, Refrigerated and constant controlled models, 10,200 RPM, 11,400 x *g* ,ARIES Smart Balance Rotor System	IV
6	Hot air oven: Temperature Range: 5°C above ambient to 250°C maximum, Temperature Accuracy: + / - 2°C, Temperature Uniformity: + / - 1°C, Controls: PID Controller, Sensor: PT-100 Kanthal A1, Heating Element: Nichrome wire	VI
7	Autoclave : Electrical Power:18 KW or Sufficient wattage of industrial immersion type water heater to generate steam within a reasonable period of time on 3 phase 440V 50 HZ AC supply, Working pressure and Temperature : 1.2 to 2.2 Kg/sq.cm at 121 Deg C, Material of Construction Inner chamber , Jacket, Door : SS 316.(5mm-10mm), Outer Chamber : SS 304 (Insulated properly), Steam Generator : Non corrosive SS / Chromium plated Brass, Heater Plate : Brass / Stainless Steel	VII
8	Auto analyzer: Auto sampler, peristaltic pump, nitrate manifold designed for auto analyzer used, single channel colorimeter equipped with 15 mm flow cell and 550 nm filter /rp18 5 µm, 250 mm x 4 mm chromatographic hplc column, sampler- random access sampler with throughput of more than 150 samples in cups or tubes, manifold- should include applications for hydrogen cyanide measurements, flow cell- should be having bubble through the flow cell operation, colorimeter should be suitable for hydrogen cyanide analysis.	XI
9	Blood cell counter: 18 parameters with 3-part differential,1000 samples storage with histogram, touch screen operation, built-in self-monitoring system, low cost per test.	XII
10	Blood gas analyzer: Essential Measured parameters: pH, pCO2, pO2, Hb, Barometric Pressure Na+, K+, Ca++, Cl$^-$. All these parameters should be measured simultaneously , Calculated parameters should include BE, BE ecf, HCO_3, Lactate, Anion Gap, SaO_2 etc, Sample volume: less than 100ul, Fast analysis time: less than 60 sec	X

S. No.	Equipment Name with Broad Specifications	PrO. No.
11	Air quality detector: Power: Rechargeable NiMH battery pack: 18 - 24 hours of continuous operation time *(dependent upon the sensor array installed)* c/w plug-in battery charger / wall adapter (12 VDC or 100 - 240 VAC), Sample : Internal, automatic sample pump for "active" sampling of target environment, Operating Ranges: Temperature: 5°C to 50°C (41°F to 122°F); Relative Humidity: 0 - 99% RH non-condensing, Sensors: Carbon Monoxide (CO), Carbon Dioxide (CO_2), Sulphur Dioxide (SO_2), Ozone (O_3), Oxygen (O_2)	XVI

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 Laboratory Equipment	1a. Identify composition of the given material with the help of Beer's and Lambert's law with justification. 1b. Describe with sketches the function of the specified element of a generalized analytical instrument with a sketch. 1c. Describe the steps for calibration of the given analytical equipment. 1d. Describe with sketches the functions of the given parts of the specified analytical equipment. 1e. Identify the analytical equipment for the given application with justification. 1f. Explain with sketches the operating principle of the given analytical instrument along with its technical specifications.	1.1 Photometry laws (Beer's and Lambert's Law), deviation from Beer's law, quantitative analysis and choice of wavelength 1.2 Elements of analytical instruments 1.3 Colorimeter 1.4 Spectrophotometer – Single and dual beam 1.5 Flame photometer 1.6 Auto analyzer
Unit-II Centrifuges and Sterilizing Equipment	2a. Describe with sketches the construction of the given instrument. 2b. Explain with sketches the operating principle of the given analytical instrument along with its technical specifications. 2c. Identify the application of the specified centrifuge/ sterilizing equipment along with its importance and justification. 2d. Describe the procedure and measures to be taken care of when using the specified equipment.	2.1 Incinerator (Medical) 2.2 Ultracentrifuges-Preparative, Analytical 2.3 Hot air oven 2.4 Autoclave (Horizontal and vertical) 2.5 Sterilizer (Clinical) 2.6 Centrifuges-Hand, clinical, Large Capacity Refrigerated, High Speed, Continuous. 2.7 Ultrasonic cleaner 2.8 Freezer -40°/-80°C
Unit– III Blood Gas Analyzer, Blood Cell	3a. Describe the procedure to identify and quantify the given dissolved gas present in blood. 3b. Describe the procedure to measure the	3.1 Measurement of pH, pO_2, pCO_2, HCO_3, TCO_2, base excess using blood gas analyzer 3.2 Electro- Conductive blood cell

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Counter and Electron Microscope	amount of specified blood cell. 3c. Describe with sketches the construction of the given equipment used to measure dissolved gases and cells present in blood. 3d. Describe with sketches the procedure of separation technique used for the specified application. 3e. Describe with sketches the construction of the given chromatography/ electrophoresis equipment. 3f. Identify in the given figure the parts of electron microscope with its function.	counter, Dark field blood cell counter 3.3 Definition, principle of Chromatography and electrophoresis 3.4 Classification of Chromatography: Gas and Liquid Chromatography 3.5 Capillary electrophoresis 3.6 Polyacrylamide gel electrophoresis (PAGE) 3.7 TEM (Transmission Electron Microscope) 3.8 SEM (Scanning Electron Microscope)
Unit– IV pH and Conductivity meter	4a. Describe with sketches the construction of equipment used to measure pH of the given solution. 4b. Describe with sketches of the specified sensor along with the method used for measuring the pH and conductivity of given solution. 4c. Interpret high frequency circuit of the given conductivity cell. 4d. Recommend the relevant method to improve the accuracy of the given type of conductivity meter with justification.	4.1 pH meter, Null method and direct method for conductivity measurement 4.2 2-electrode conductivity sensor, 4-electrode conductivity sensor, Inductive conductivity sensor 4.3 Beat frequency method 4.4 Equivalent circuit diagram of conductivity cell 4.5 Temperature compensation of conductivity measurement
Unit– V Environmental Pollution Monitoring Equipment	5a. Correlate pollution monitoring instrument with the given gas. 5b. Provide specifications of pollution monitoring station with respect to the given parameter. 5c. Explain with sketches the principle of operation of given type of air analyzer for analysis of the specified contents.	5.1 Representation of concentration of gases in environment 5.2 Instrument techniques and measurement range 5.3 Carbon monoxide 5.4 Hydrocarbons 5.5 Sulpher dioxide 5.6 Nitrogen dioxide 5.7 Ozone 5.8 Pollution monitoring station 5.9 Automated wet-chemical air analysis

***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	Unit Title	Teaching	Distribution of Theory Marks

No.		Hours	R Level	U Level	A Level	Total Marks
I	Laboratory Equipment	10	04	04	06	14
II	Centrifuges and Sterilizing Equipment	10	02	06	06	14
III	Blood Gas Analyzer, Blood Cell Counter and Electron Microscope	10	04	04	06	14
IV	pH and Conductivity meter	12	04	06	08	18
V	Environmental Pollution Monitoring Equipment	06	02	04	04	10
Total		**48**	**16**	**24**	**30**	**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. Survey and present a report on details of various analytical equipment from Library / Internet.
b. Prepare power point presentation or animation for understanding operation and demonstration of analytical equipment.

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 traditional 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 theorems in circuit analysis
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. Find out specifications of analytical instruments from various manufacturers. Prepare comparative statement of different analytical instrument with their specifications. Make a report.
b. Prepare model of colorimeter/spectrophotometer/flame meter using electronic components.
c. Build circuit for measurement of pCO2/ pO2 /pH using op amp circuits. Make a report.
d. Observe the performance of different analytical instruments and prepare calibration and testing report of the same.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Handbook of Analytical Instruments	Khandpur, R. S.	McGraw-Hill Education, New Delhi, 2014, ISBN: 9339221362
2	Bioinstrumentation	Veerakumari, L.	MIR Publishers, Moscow, 2015 ISBN:9788180940187
3	Analytical Instrumentation: A Guide to Laboratory, Portable and Miniaturized Instruments	McMahon, Gillian	John Wiley & Sons, New Delhi, 2014, ISBN : 9780470027950
4	Principles of Instrumental Analysis	Skoog, Douglas A.; Holler, James F.; Stanley, R. Crouch	Cengage Learning, New Delhi, , 2017, ISBN: 9781337468039
5	Medical Instrumentation: Application and Design	Webster, John G.	John Wiley and Sons, New Delhi, 2009, ISBN: 9788126511068
6	Ewing's Analytical Instrumentation Handbook	Cazes, Jack	CRC Press, 2005 ISBN : 9780824753481

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://www.parrinst.com/products/oxygen-bomb-calorimeters/6400-automatic-isoperibol-calorimeter/specifications
b. http://www.shimadzu.com/an/molecular_spectro/uv/uv1800/uv3.html
c. www.labtronicsspectrophotometers.com/digital-flame-photometers.html
d. http://smedunia.co.in/highcleanultrasonic
e. http://centrifugebybeckman.com/?page_id=1777/?pi_ad_id=92693587516andgclid=CPr7i8nlltICFUgXaAodFhkMQg
f. http://www.bionicsscientific.com/laboratory-oven/hot-air-oven.html
g. http://www.k2bw.com/gasanalyzers.htm
h. http://www.kmscl.kerala.gov.in/ratecontractspec/Autoclave%20horizontal.pdf

i. http://www.mohfw.nic.in/WriteReadData/l892s/file9-94625409.pdf
j. http://www.agdbio.com/product/pce-210-fully-automatic-blood-cell-counter
k. http://bmsicl.gov.in/uploads/Drugs/Blood%20Gas%20Analyser%20With%20Electrolyte.pdf
l. http://www.nptel.ac.in/courses/104104066/
m. http://www.eeprocess.com/CET/yesair-junior.html