Program Name : **Diploma in Civil Engineering/ Computer Engineering / Information Technology /Automobile Engineering/ Fashion & Clothing Technology / Electrical Engineering Group / Electronics Engineering Group**

Program Code : **CE/CR/CS/CO/CM/CW/IF/AE/DC/EE/EP/EU/DE/EJ/ET/EN/ EX/EQ/IE/IS/IC**

Semester : **Fifth**

Course Title : **Environmental Studies**

Course Code : **22447**

1. RATIONALE

The world today is facing the biggest challenge of survival. Degradation of ecosystem, depletion of natural resources, increasing levels of pollution pose major threat to the survival of mankind. The need of the hour, therefore, is to concentrate on the area of environmental aspects, which shall provide an insight into various environment related issues. Environmental studies are an interdisciplinary academic field that integrates physical, chemical and biological sciences, with the study of the environment. It provides an integrated, quantitative, and interdisciplinary approach to the study of environmental system & gives an insight into solutions of environmental problems.

2. COMPETENCY

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

- **Diagnose and manage environment related issues**

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. Develop Public awareness about environment
b. Select alternative energy resources for Engineering Practice
c. Conserve Ecosystem and Biodiversity
d. Apply techniques to reduce Environmental Pollution
e. Manage social issues and Environmental Ethics as lifelong learning

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	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	

(#) Online Theory Examination.

(*): 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.

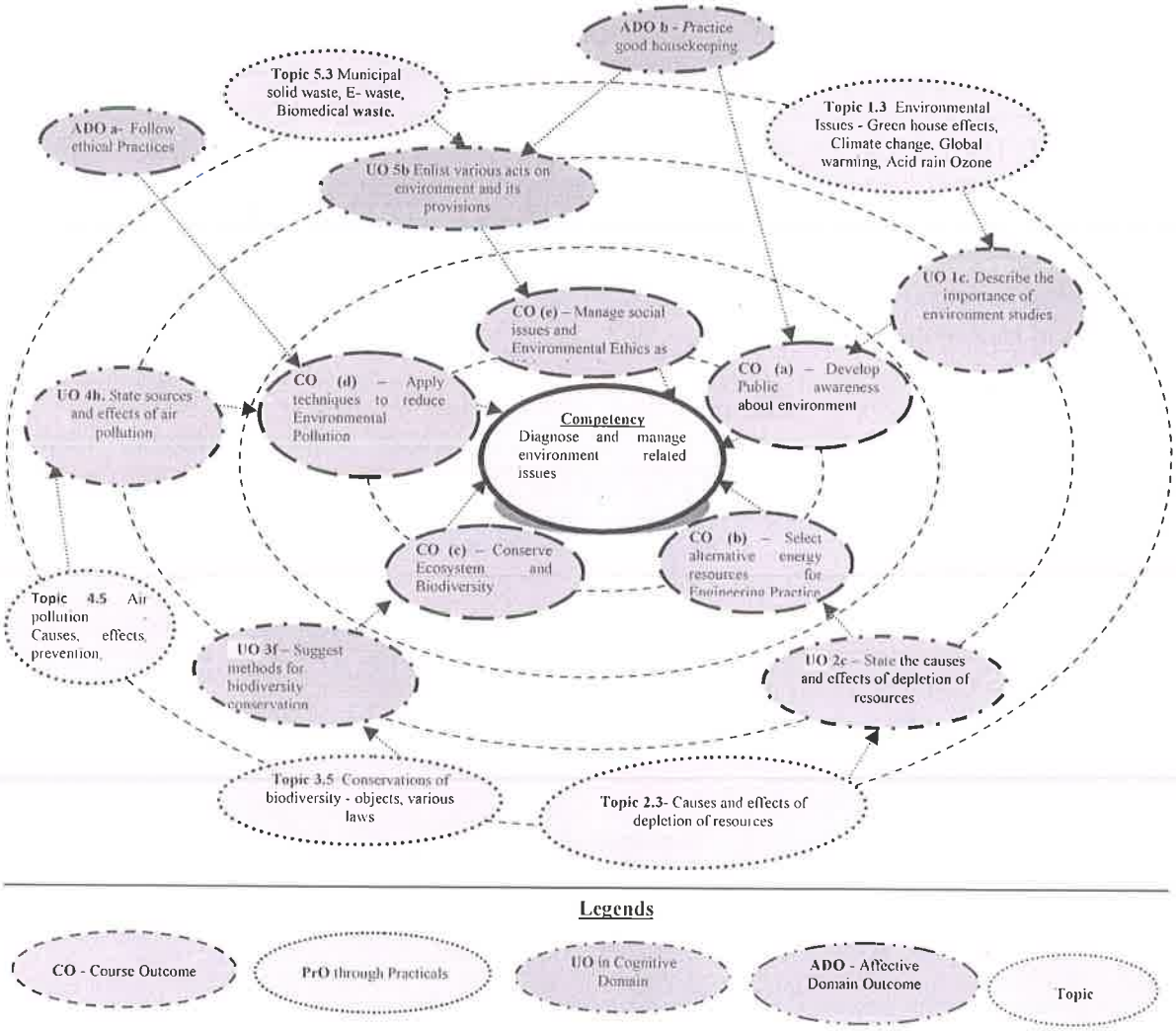

Figure 1 - Course Map

6. SUGGESTED 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	NIL		
	Total		

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	NIL	
Total		

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. 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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	NIL	-

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 Environment	1a. Discuss the scope of Environment. 1b. Describe various types of environment 1c. Describe the importance of environment studies. 1d. Discuss about the need of public awareness about environment. 1e. Describe various environmental issues.	1.1 Definitions, need of environmental studies. 1.2 Segments of environment- Atmosphere, Hydrosphere Lithosphere, Biosphere. 1.3 Environmental Issues - Green house effects, Climate change, Global warming, Acid rain Ozone layer depletion, Nuclear accidents. 1.4 Concept of 4R (Reduce, Reuse, Recycle and Recover), 1.5 Public awareness about environment.
Unit– II Energy Resources	2a. List various natural resources. 2b. Describe Renewable, Nonrenewable and Cyclic resources. 2c. State the causes and effects of depletion of resources. 2d. State advantages and disadvantages of forms of energy. 2e. Select appropriate solutions of efficient use of energy. 2f. State the impacts of overuse of natural resources.	2.1 Natural Resources - Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources. 2.2 Renewable, Non-renewable and Cyclic Resources. 2.3 Causes and effects of depletion of resources. 2.4 Energy forms (Conventional and non-conventional). 2.5 Present global energy use and future demands. 2.6 Energy conservation. 2.7 Over use of natural resources and its impacts on environment.
Unit- III Ecosystem and Biodiversity	3a. State the aspects and division of ecosystem. 3b. State the general characteristics and function of ecosystem. 3c. List levels of biodiversity. 3d. Enlist the endangered species. 3e. Describe value of biodiversity. 3f. Suggest methods for biodiversity conservation.	3.1 Ecosystem - Definition , Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem. 3.2 Biodiversity - Definitions, Levels, Value and loss of biodiversity. 3.3 Biodiversity assessment initiatives in India. 3.4 Threats and Hotspots of biodiversity. 3.5 Conservations of biodiversity - objects, various laws.
Unit– IV Environmental Pollution	4a. Define pollution. 4b. State the sources of pollution. 4c. State the effects of land pollution on environment and lives. 4d. State various units and their functions of water treatment plant. 4e. State the needs of water conservation.	4.1 Definition of pollution, types- Natural & Artificial (Man- made). 4.2 Soil / Land Pollution – Causes and effects on environment and lives , preventive measures. 4.3 Water Pollution - Sources of water (surface and sub surface), sources of water pollution, effects on environment and lives, preventive measures, BIS water quality

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4f. State the impacts of sewage. 4g. State various units and their functions of sewage treatment plant. 4h. State sources and effects of air pollution. 4i. Describe various methods to prevent air pollution. 4j. State sources and effects of noise pollution. 4k. Describe preventive measures for noise pollution. 4l. State characteristics of solid waste. 4m. State the impacts of solid waste. 4n. Describe incineration, RDF and sanitary landfilling. 4o. State the standards limiting/controlling values of various types of pollution.	standards, flow diagram of water treatment plant, Water conservation. 4.4 Wastewater - Generation(domestic and industrial), Impacts, flow diagram of sewage treatment plant, CPCB norms of sewage discharge. 4.5 Air pollution - Causes, effects, prevention, Ambient air quality standards. 4.6 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city. 4.7 Municipal Solid Waste, Bio-medical waste and E-waste - Sources, generation, characteristics, effects, and methods to manage.
Unit-V Social Issues and Environmental Education	5a. Elaborate article (48-A) and (51-A (g)) 5b. Enlist various acts on environment and its provisions. 5c. State the roles and responsibilities of CPCB. 5d. Define sustainable development, and EIA. 5e. Describe rain water harvesting and groundwater recharge. 5f. Differentiate between formal and non formal education.	5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts, CPCB and MPCB norms and responsibilities, The role of NGOs. 5.2 Concept of sustainable development, EIA and environmental morality. 5.3 Management Measures - Rain Water harvesting, Ground water recharge, Green Belt Development, Use of Renewable energy, water shed management, interlinking of rivers. 5.4 Role of information technology in environment and human health.

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	Environment	06	4	6	-	10
II	Energy Resources	10	4	8	-	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
III	Ecosystem and Biodiversity	08	4	4	4	12
IV	Environmental Pollution	16	8	8	4	20
V	Social Issues and Environmental Education	08	4	4	4	12
	Total	**48**	**24**	**30**	**16**	**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. Plant and adopt a tree in your nearby locality/Polytechnic campus and prepare report about its growth and survival after six months with photos.
b. Organize seminar on air pollutants of relevant MIDC area/vehicle
c. Organize poster exhibition about global warming and ozone depletion.
d. Visit a nearest water purification/effluent treatment plant.

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 proper equivalent analogy to explain different concepts.
g. Use Flash/Animations to explain various topics.

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 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. Prepare a report on visit to PUC Center.
b. Visit a near by RO plant and prepare detail technical report.
c. Prepare report on Household water filtration unit
d. Prepare a list of polluted natural resources which are responsible for pollution and collect information on how to manage them .
e. **Collection of Data from Hospital: Collect** everyday information on percentage of solid hazardous and toxic waste for two month
f. **Visit of Municipal Effluent Treatment Plant:** Visit effluent treatment plant and prepare report on waste management.
g. **Visit of Water Treatment Plant:** Visit water treatment plant and prepare report on various units of water treatment and its management.
h. **Preparation of report**: Prepare the chart of solid waste management showing effects on environment.
i. **And any other relevant topic related to course**

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Basic Environmental Sciences	Michael Allaby	Routledge Publication, 2nd Edition, 2000, ISBN: 0-415-21176-X
2	Environmental Science	Y. K. Singh	New Age International Publishers, 2006, ISBN: 81-224-2330-2
3	Environmental Studies	Erach Bharucha	University Grants Commission, New Delhi
4	Environmental Studies	Rajagopalan	Third Edition, Oxford University Press, USA, ISBN: 9780199459759, 0199459754
5	A text book of Environmental Science	Arvind Kumar	APH Publishing New Delhi
6	A text book of Environmental Studies	Shashi Chawla	Tata Mc Graw-Hill New Delhi

14. SOFTWARE/LEARNING WEBSITES

a. www.eco-prayer.org
b. www.teriin.org
c. www.cpcb.nic.in

d. www.indiaenvironmentportal.org.in
e. www.whatis.techtarget.com
f. www.sustainabledevelopment.un.org
g. www.conserve-energy-future.com

Program Name : **Electronics Engineering Programme Group**

Program Code : **DE/EJ/ET/EN/EX/EQ**

Semester : **Fifth**

Course Title : **Control Systems and PLC**

Course Code : **22531**

1. RATIONALE

A control system is a discipline that applies automatic control theory to design systems in such a way as to achieve a desired control of operation of the system. Control engineering has an essential role in a wide range of control systems. It seeks to understand physical systems, using mathematical modeling, in terms of inputs, outputs and various components with different behaviors. This course will facilitate students to use the different control systems used in various range of applications from simple home heating controller using a thermostat to a large Industrial control systems which are used for controlling processes or machines. The course introduces Control system and PLC which is adapted for the control of manufacturing processes.

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 automated systems in process and manufacturing industries.**

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 different types of control systems.
b. Determine the stability of the control system.
c. Test the performance of various types of controllers.
d. Maintain various components of PLC based process control system.
e. Maintain PLC based process control systems.

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	-	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 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.

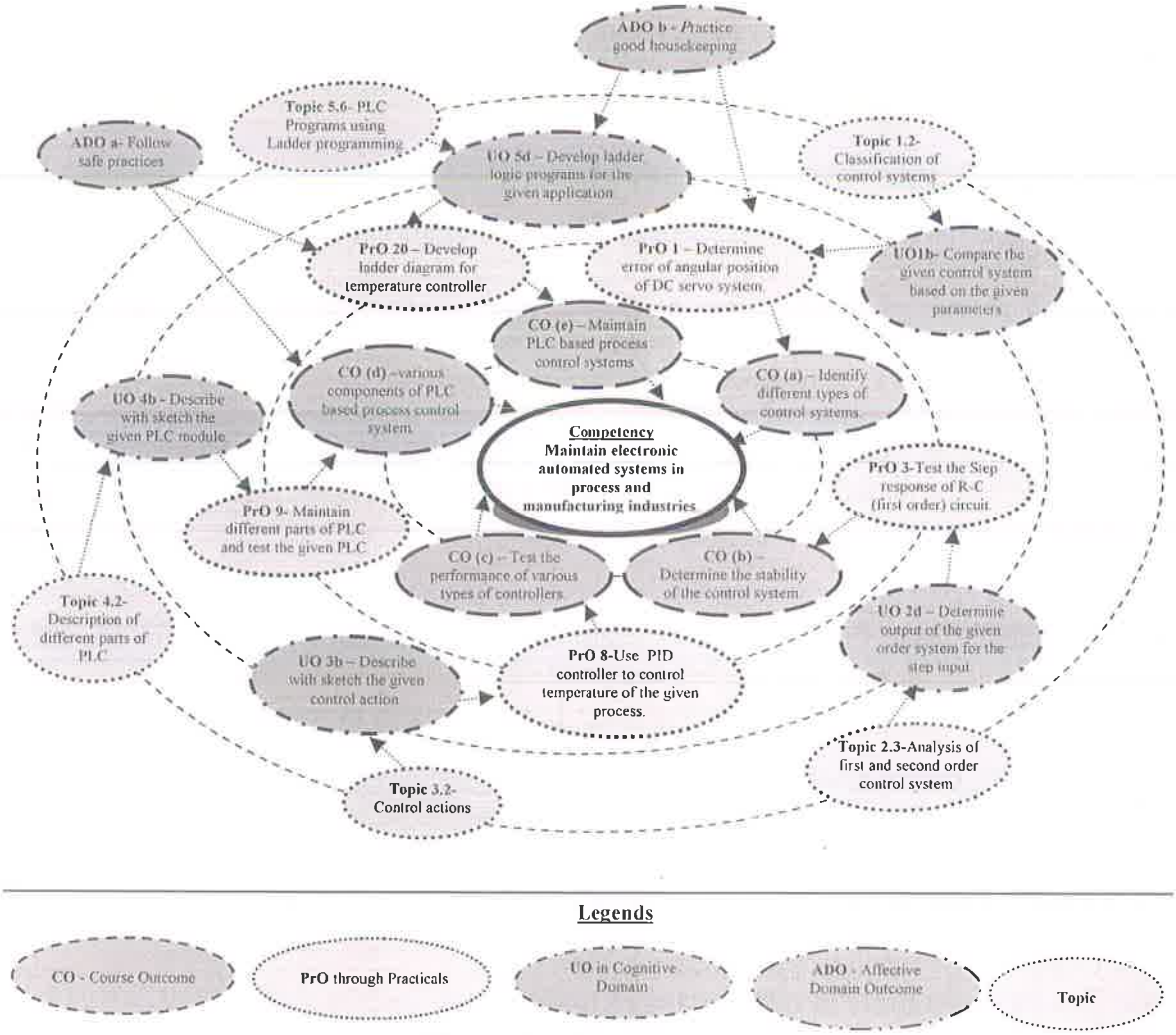

Figure 1 - Course Map

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	Use potentiometer as error detector.	I	02*
2	Determine error of angular position of DC servo system.	I	02
3	Test the Step response of R-C (first order) circuit.	II	02*
4	Test the Step response of R-L-C (second order) circuit.	II	02
5	Test the functionality of temperature control with on-off controller.	III	02*
6	Use PI controller to control temperature of the given process.	III	02
7	Use PD controller to control temperature of the given process.	III	02
8	Use PID controller to control temperature of the given process.	III	02*
9	Identify and test different parts of PLC .	IV	02*
10	Develop ladder diagram to test the functionality of the logic gates.	V	02
11	Develop ladder diagram to test Demorgan's theorem.	V	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
12	Develop the ladder diagram for Adder and Subtractor by using PLC.	V	02
13	Develop ladder diagram for ON and OFF control of lamp using timer and counter.	V	02
14	Develop ladder diagram for traffic light Control system.	V	02
15	Develop ladder diagram for stepper motor control.	V	02*
16	Develop ladder diagram for temperature controller.	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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Practice energy conservation.
d. Work as a leader/a team member.
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	PrO. No.
1	Cathode ray oscilloscope: Dual trace 50Mhz	03,04
2	Multimeter 3 1/2: AC/DC,0-200V	01 ,02,06 to 08
3	DC position trainer kit	02
4	Potentiometer trainer kit	01
5	RC kit	03
6	RLC kit	04
7	ON-OFF controller kit	05
8	PID controller trainer kit	06 to 08
9	PLC trainer kit (20 digital I/O points and 2 analog I/O channels)	09 to 16
10	Desktop PC	10 to 16
11	Simulation Software: Picosoft,Scilab, Matlab, Prosim, PSpice, LabVIEW, Electronics Workbench, Win pro ladder	01 to 16

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 Basics of control system	1a. Explain with sketches the working of the given type of control systems. 1b. Compare the given control systems based on the given parameters. 1c. Derive transfer function of the given electrical circuits. 1d. Use block diagram reduction rules to determine optimize transfer function of the given system.	1.1 **Control system:** Basics of control system block diagram and practical examples 1.2 **Classification of control systems:** Open loop and closed loop systems- block diagram, practical example and comparison, Linear and non -linear systems, Time varying and Time In-varying systems- practical example and comparison servo system - 1.3 **Transfer function:** Close loop and open loop system RC, LC and RLC circuits-Differential equations and transfer functions and analysis using Laplace transform 1.4 **Block diagram reduction technique:** Need, reduction rules,
Unit– II Time domain stability analysis	2a. Compare the parameter of given standard test inputs. 2b. Identify poles, zeros, type and order for the given transfer function. 2c. Sketch pole zero plot for the given transfer function. 2d. Determine output of the given order system for the step input.	2.1 **Time Response:** Transient and steady state response. 2.2 **Standard test inputs:** Step, ramp, parabolic, impulse and their corresponding Laplace transform 2.3 **Analysis of first and second order control system:** i. **Poles and zeros** - S-plane representation Order of system (0, 1, 2)- standard equations, examples and numerical problems ii. **First order system**-Analysis for unit step input, concept of time constant

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	2e. Calculate time response specifications of the given transfer function. 2f. Calculate error constants of the given type of control system. 2g. Determine stability of the given control system using Routh's stability criteria.	iii. **Second order system-** Analysis for unit step input (no derivation), concept, definition and effect of damping iv. **Time response specifications** (no derivations) - Tp, Ts, Tr, Td, Mp, Ess, numerical problems 2.4 **Steady state analysis**: Type 0, 1, 2 systems- steady state error and error constants, numerical problems 2.5 **Stability:** Concept of stability, root locations in S-plane and analysis- stable system, unstable system, critically stable systems, conditionally stable system, relative stability 2.6 **Routh's stability criterion:** Steps and procedures to find stability by Routh's stability criteria,
Unit –III Process controllers	3a. Explain with sketch the given process control system. 3b. Describe with sketch the given control action. 3c. Compare different electronic controllers on the basis of the given parameters. 3d. Sketch the response of the given controller with respect to error.	3.1 **Process Control System**: Block diagram, functions of each block 3.2 **Control actions:** i **Discontinuous mode-** ON-OFF controllers- equation, neutral zone ii **Continuous modes:** Proportional Controller - offset, proportional band. Proportional, Integral and Derivative controllers -o/p equation, response, characteristics, 3.3 **Composite controllers**: PI, PD, PID controllers- o/p equation,response
Unit-IV Fundamentals of PLC	4a. Explain with sketch PLC based automation system. 4b. Describe with sketch the given PLC module. 4c. Identify different devices interfaced with PLC. 4d. Explain the steps for PLC installation.	4.1 **PLC**-Block diagram, classification, (fixed and modular PLCs), need and benefits of PLC in automation 4.2 **Description of different parts of PLC**: CPU –function, scanning cycle, speed of execution, Power supply- block diagram and function of each block Memory – function and organization of ROM and RAM Input and output modules- function, different input and output devices of PLC (only name and their uses). 4.3 **PLC Installation**
Unit-V PLC hardware and programming	5a. Identify and describe the given module of PLC. 5b. Describe the given addressing of PLC. 5c. Use instruction set to perform the given operation. 5d. Develop ladder logic programs for the given	5.1 **Discrete input modules:** Block diagram, specifications of AC input modules and DC input module. Sinking and sourcing concept in DC input modules 5.2 **Discrete output modules:** Block diagram description, specifications of AC output module and DC output modules 5.3 **Analog input and output modules:** Block diagram, specifications

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	application.	5.4 **I/O addressing of PLC**: Addressing data files, format of logical address, different addressing types 5.5 **PLC Instruction set**: Relay instructions, timer and counter instructions, data movement instructions, logical and comparison instructions 5.6 **PLC Programs** using Ladder programming language.

***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	Basics of Control System	10	02	04	06	12
II	Time domain stability analysis	16	04	04	08	16
III	Process Controllers	08	02	04	04	10
IV	Fundamentals of PLC	12	04	04	06	14
V	PLC Hardware and Programming	18	04	06	08	18
Total		64	**16**	**22**	**32**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare manuals based on practical performed in laboratory.
b. Follow the safety precautions.
c. Give seminar on relevant topic.
d. Library / Internet survey regarding different data books and manuals.
e. Prepare power point presentation on PLC.
f. Undertake a market survey of different manufacturer of PLC.

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 Flash/Animations to explain working of control system.
g. Use open source simulation software modules to perform different applications using PLC.

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. Simulate and test the performance of 1st order RC and 2nd order RLC Circuit using simulation software.
b. Prepare a chart to show the error constants of type 0, 1 and 2 systems for different standard test inputs.
c. Simulate and test the performance of PI, PD, and PID-control action using simulation software.
d. Prepare a chart to show characteristics of control actions with respect to error.
e. Prepare a report on the basis of PLC data sheets of various manufacturers.
f. Develop/Test a ladder diagram for controlling washing machine operations.(Wash cycle-inlet valve should open for 10 sec. Motor starts running after 10sec. Running time for motor is 20sec. After that motors stops. Then outlet valve opens and water is drained out. Same operations are repeated for rinse cycle. Spin cycle- Motor runs at high speed for 20 sec and outlet valve remains open for the whole period of spin cycle.)
g. Develop/Test a ladder diagram for automatic cold drink bottle filling system.(When sensor senses a bottle, after 3 sec outlet valve of the container containing cold drink will open . It will be open for 10 sec and then the valve will be closed. The bottle will be moved forward automatically. The process should stop after filling of 25 bottles.)
h. Develop/Test a ladder diagram for Interlock Control circuit. (The entry/exit of the parking lot is a single lane passage. By controlling the indicators only one car should pass through the entry/exit so as to prevent car accidents between entering and leaving cars.)

i. Develop/Test a ladder diagram for product mass packaging. (When the photoelectric sensor detects specified number of products, robotic arm will begin to pack up. When the action is completed, robotic arm and counter will be reset.)
j. Develop/Test a ladder diagram for 24 hour clock operated by 3 counters.
k. Develop/Test a ladder diagram for sequential delay output i.e starting 3 motors sequentially. (Example- Start the oil pump motor when the start button is pressed. Main motor will be started after 10 sec delay and then the auxiliary motor after 5 sec delay. Also stop all the motors immediately when stop button is pressed.)
l. Develop/Test a ladder diagram for performing Pulse-Width modulation by changing the set value in the timer.
m. Develop/Test a ladder diagram for Artificial Fish pond water level monitoring system. (Feeding /Draining water immediately when the water level of the artificial fish pond is not at the normal level. Also enabling the alarm and alarm lamp when the water is above or below the normal level.)
n. Develop/Test a ladder diagram for Automatic Door Control system. (When someone enters the door should open automatically and if no one enters for about 10sec, door should close automatically. Also if someone enters the sensing field during door closing process, closing action should stop immediately.)
o. Develop/Test a ladder diagram for Automatic Coffee Making system. (When a coin is inserted paper cup should come out from the outlet. At the same time coffee pours in the mixing container. After 2 sec hot water pours in. After 60 sec readymade coffee will come out from coffee outlet.)
p. Develop/Test a ladder diagram for automatic control of a machine which is required to direct 6 objects along one path for packaging in a box and then 12 objects along another path for packaging in another box. A deflector plate might be controlled by a photocell sensor gives an output every time an object passes it.

13. SUGGESTED LEARNING RESOURCES

S. No.	Author	Title of Book	Publication
1	Process control instrumentation Technology	Johnson, C. D.	Prentice Hall, 8th edition, United States of America,2014 ISBN: 978-0131194571
2	Intro. To Programmable logic control	Dunning, Gary	Cenage Learning, United States of America,2005 ISBN: 9781401884260
3	Control System Engineering	Nagrath, J.J. ; Gopal, M.	Anshan Publishers (2008) ISBN: 9781848290037
4	Modern control Engineering	Ogata, K.	PHI , 5th Edition, NEW DELHI,2010 ISBN: 978812034010
5	Programmable logic controllers and industrial automation an introduction	Mitra, Madhuchhanda ; Gupta, Samarjit Sen	Penram,1st Edition, Mumbai, 2007 ISBN: 9788187972174
6	Programmable logic controllers	Petruzella, F.D.	Tata- McGraw Hill, 3rd Edition, 2010 ISBN: 9780071067386

14. SOFTWARE/LEARNING WEBSITES

a. www.scilab.org

b. www.openplc.fossee.in
c. www.github.com/FOSSEE/OpenPLC
d. www.youtube.com /plc
e. www.dreamtechpress.com /ebooks
f. www.nptelvideos.com/control_systems/
g. www.in.mathworks.com/solutions/control-systems.html?s_tid=srchtitle
h. www.edx.org/course?subject=Engineering&course=all&language=English
i. www.plcs.net
j. www.ab.rockwellautomation.com › Allen-Bradley
k. www.plc-training-rslogix-simulator.soft32.com/free-download/


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Program Name : **Diploma in Industrial Electronics**

Program Code : **IE**

Semester : **Sixth**

Course Title : **Embedded System**

Course Code : **22532**

1. RATIONALE

In the rapidly growing digital world, role of embedded systems is increasingly vital in various domains such as industrial and home automation, entertainment systems, medical equipments and many more. The core of all such system is powered by electronic hardware and associated software. It is therefore evident to impart the knowledge of the related technology and hands on skills to develop and maintain electronics hardware based embedded 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:

- **Maintain 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 relevant microcontrollers for various industrial applications.
b. Use 'Embedded C' programming language to maintain embedded systems.
c. Interpret the communication standards of embedded systems.
d. Develop simple applications of embedded system.
e. Interpret features of Real Time Operating System.

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.

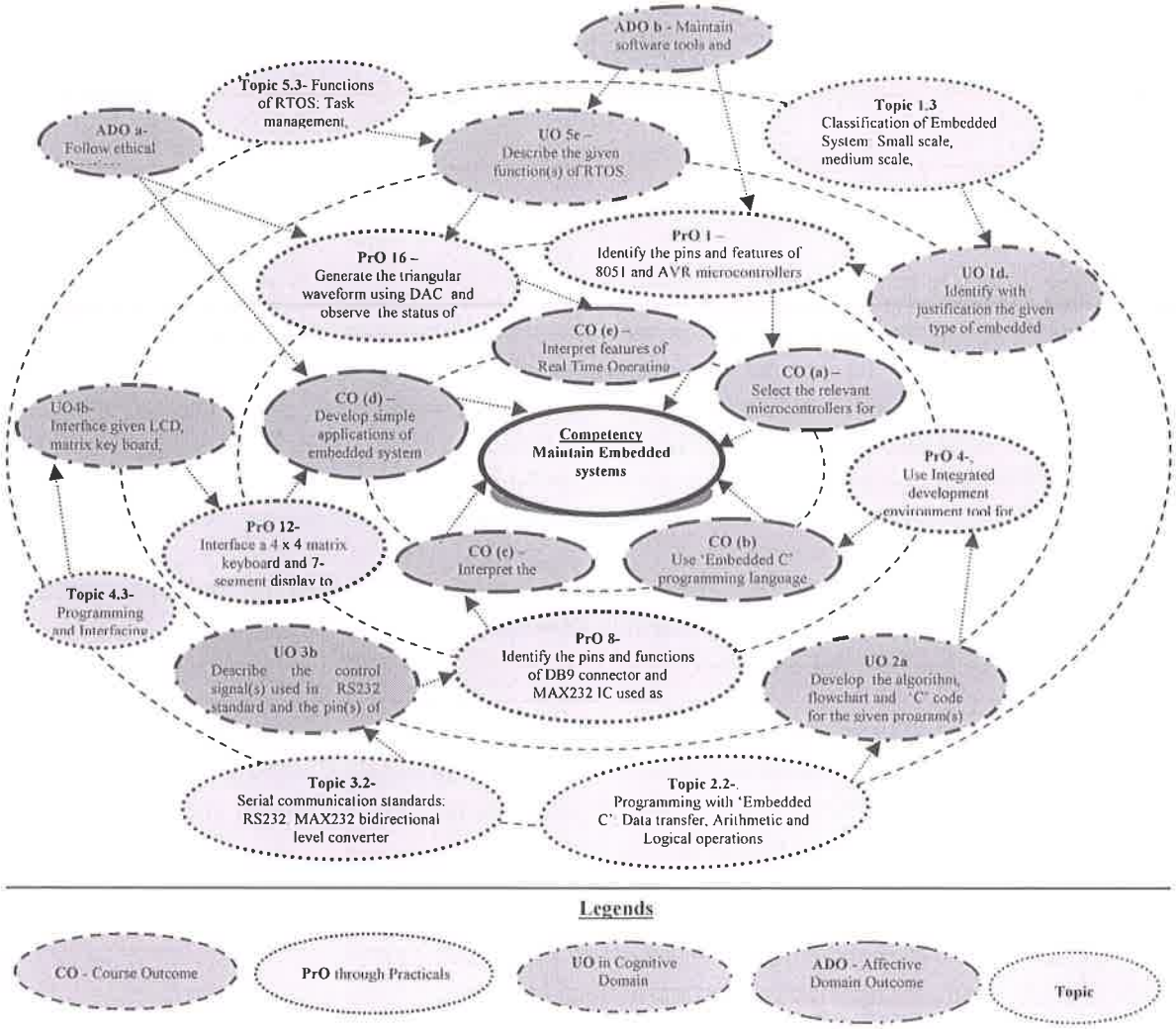

Figure 1 - Course Map

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	Identify the pins and features of 8051 and AVR microcontrollers.	I	2*
2	Identify the pins and features of PIC and ARM microcontrollers.	I	2
3	Identify the family of the given microcontroller.	I	2
4	Use Integrated development environment tool for developing embedded system (Using MicroProC, Keil)	II	2*
5	Execute the C program to perform following arithmetic operations on 8-bit data:-addition, subtraction, multiplication and division for microcontroller	II	2*
6	Execute the C program to perform following arithmetic operations on 16-bit data:-addition, subtraction.	II	2
7	Execute the C program to perform transfer of data from source to destination internal data memory location	II	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Identify the pins and functions of DB9 connector and MAX232 IC used as bidirectional level converter used in RS232 interface.	III	2
9	Execute the C program to turn on LED with respect to Switches connected to port pins of 8051.	IV	2*
10	Execute the C program to display numbers 0 to 9 on 7-segment display with some delay.	IV	2
11	Interface 16 x 2 LCD to 8051. Execute embedded C language program to display string on it.	IV	2
12	Interface a 4 x 4 matrix keyboard and 7-segment display to 8051. Execute C language program to read and display key code on 7-segment display.	IV	2*
13	Interface 8 bit ADC to 8051. Execute C language program to read data of ADC and store the converted digital data in memory.	IV	2*
14	Interface 8 bit DAC to 8051. Execute C language program to generate square, sawtooth and triangular waveforms.	IV	2
15	Interface stepper motor to 8051. Execute C language program to rotate stepper motor with different speed in clockwise and counter clockwise direction.	IV	2*
16	Generate the triangular waveform using DAC and observe the status of control signals using IDE tool(MicroProC, Keil)	V	2*
	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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Practice energy conservation.

d. Demonstrate working as a leader/a team member.
e. Maintain software 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	Microcontroller kit (8051,AVR/PIC/ARM):-single board systems with minimum 8K RAM,ROM memory with battery back up,16X4, LCD display,7-segment Display, PC keyboard interfacing facility, 4X4 matrix keyboard, cross c-compiler, USB, interfacing facility with built in power supply.	All
2	Desktop PC with Integrated Development Environment (MicroPro C, Keil)	All
3	Stepper Motor, 50/100 RPM	15
4	CRO- Bandwidth AC 10Hz ~ 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe	13,14,
5	Keyboard 4X4 trainer board	12
6	7-segment LED Display:- 0.56 in 1-digit, common anode/common cathode	10,12
7	ADC (0808)trainer board	13
8	DAC (0808)trainer board	14
9	LCD trainer board	11
10	Add on cards for 8 Switches and 8 LED interface	9
11	Digital Multimeter	13,14, 15,16

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should 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 Introduction to Embedded systems.	1a. Describe the given component(s) of the given embedded system. 1b. Describe with sketches the architecture of given processor(s). 1c. Describe the given characteristics of the given embedded systems. 1d. Identify with justification the given type of embedded systems used for the given application. 1e. Select with justification the relevant microcontroller from the existing microcontroller families for the given application.	1.1 Block diagram of embedded system with hardware components. 1.2 Harvard and Von-Neumann architecture. RISC and CISC processors. 1.3 Characteristics of embedded system: Processor, power, memory, operating system, reliability, performance, power consumption, NRE cost, unit cost, size, flexibility, time-to-prototype, time-to-market, maintainability, correctness and safety. 1.4 Classification of Embedded System: Small scale, medium scale, sophisticated, stand-alone, reactive/real time (soft and hard real time) 1.5 Features of PIC,AVR and ARM microcontrollers with their applications.
Unit– II Programming using Embedded C	2a. Develop the algorithm, flowchart and 'C' code for the given program(s) used in data transfer, arithmetic /logical, Decision control and looping operations with the given microcontroller. 2b. Develop the algorithm, flowchart and 'C' code for the given program(s) used in timer/counter operations with microcontroller. 2c. Develop the algorithm, flowchart and 'C' code for the given program(s) used in serial communication with microcontroller. 2d. Develop the algorithm, flowchart and 'C' code for the given program(s) used in interrupt handling with microcontroller.	2.1 Programming with 'Embedded C': Data transfer, Arithmetic and Logical operations. Decision Control & Looping. 2.2 Timer/Counter programming with 'embedded C' for microcontroller. 2.3 Serial communication programming with 'embedded C 'for microcontroller 2.4 Interrupt control programming with 'embedded C' for microcontroller.
Unit-III Communication standards and protocols.	3a. Describe the mode(s) of communication 3b. Describe the control signal(s) used in RS232 standard and the pin(s) of MAX232 voltage level converter 3c. Describe the given communication	3.1 Modes of data communication: Simplex, Duplex, Half Duplex, Serial, Parallel, Synchronous and Asynchronous Communication 3.2 Serial communication standards:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	protocol(s) with relevant block schematic. 3d. Describe the given advanced serial communication interface(s)	RS232. MAX232 bidirectional level converter. 3.3 Communication protocols i. Serial Communication Protocol: I^2C, CAN, USB, Serial Peripheral Interface (SPI), Synchronous Serial Protocol (SSP). ii. Parallel Communication Protocol: PCI, PCI-X 3.4 Overview of advanced serial protocol: IrDA, Bluetooth, Zigbee.
Unit –IV Interfacing Input and Output devices	4a. Interface the given basic input/output device(s) with the given microcontroller and develop a simple embedded C program. 4b. Interface given LCD, matrix key board, multiplexed 7-Segment display with the given microcontroller and develop a simple embedded C program. 4c. Interface the given DC motor and stepper motor with the given microcontroller and develop a simple embedded C program. 4d. Interface the given ADC/DAC with the given microcontroller and develop a simple embedded C program.	4.1 Programming and Interfacing of switches, keys, pushbutton, sensors 4.2 Programming and Interfacing of LED, 7-Segment, Relays 4.3 Programming and Interfacing of Matrix keyboard, multiplex 7-Segment display, LCD. 4.4 Programming and Interfacing of stepper motor, DC motor 4.5 Programming and Interfacing of 8 bit ADC/DAC (0808/09)
Unit-V Real Time Operating Systems	5a. Describe general operating system and RTOS 5b. Describe the given characteristic(s) of RTOS. 5c. Describe the given function(s) of RTOS. 5d. Describe the given feature(s) of RTOS	5.1 Operating System: General and Real time operating system. 5.2 Characteristics of Real Time Operating System: Consistency, Reliability, scalability, Performance, Predictability. 5.3 Functions of RTOS: Task management, Scheduling, Resource allocation and interrupt handling 5.4 Features of RTOS: Watchdog timer, Semaphore, Deadlock

***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	Introduction to Embedded systems	08	03	04	05	12
II	Programming using Embedded C	12	04	05	07	16
III	Communication standards and protocols	08	03	04	05	12
IV	Interfacing Input and Output devices	12	04	06	08	18
V	Real Time Operating Systems	08	03	04	05	12
	Total	**48**	**17**	**23**	**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. Download the data sheets of all the components used in the practical.
b. Prepare a documentation of all the components and device along with their specifications
c. Deliver seminar on relevant topic.
d. Library / Web survey regarding different data books and manuals.
e. Prepare power point presentation on applications of microcontroller.
f. Undertake a market survey of different microcontrollers.
g. Follow the safety precautions.

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.

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. Prepare a chart of various features using data sheets of 8051,PIC,AVR,ARM microcontroller and its derivatives.
b. Prepare a chart of stepper motor to display its features and steps for its operations using data sheets.
c. Prepare a chart of various features and operations of temperature sensors using data sheets.
d. Prepare a chart of various types of ADC and DAC to display its features and pin functions using data sheets.
e. Prepare a chart of various types of LCDs to display its features, pin functions and steps of operations using data sheets.
f. Prepare a chart of various types of seven segment displays, keyboard to display its features and steps for its operations using data sheets.
g. Build a flashing display.
h. Build a rolling display
i. Build a buzzer system for rapid fire quiz competition.
j. Build a two digit counter.
k. Build a class period bell.
l. Build a temperature monitoring system.
m. Build a pollution monitoring system.
n. Build a humidity monitoring system.
o. Build automated door control system.
p. Build traffic light controller for specified delay.
q. Build a water level controller for given parameters.
r. Build a automated concert lighting.

Note: Use appropriate software for programming. Build the circuit on PCB.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller Architecture Programming	Ayala, Kenneth	EEE/Prentice Hall of India, 2nd edition, New Delhi, 1 July 2004,

S. No.	Title of Book	Author	Publication
	and Application		ISBN-13: 978-1401861582
2	The 8051 Microcontroller and Embedded system	Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; Mckinlay Roline D.	Pearson /Prentice Hall, , 2nd edition, Delhi,2008, ISBN 978-8177589030
3	Microcontroller Principle and Application	Pal, Ajit	Prentice Hall of India,New Delhi,2014, ISBN: 978-81-203-4392-4
4	Microcontroller Theory and Application	Ajay, Deshmukh	McGraw Hill Education, New Delhi, 2011, ISBN- 9780070585959
5	Microcontroller Architecture Programming, Interfacing and System Design	Raj ,Kamal	Pearson Education India, Delhi,2012, ISBN 13:9788131759905
6	The Embedded Software Primer	David E. Simon	Addison-Wesley ISBN 13: 9780201615692

14. SOFTWARE/LEARNING WEBSITES

a. www.keil.com
b. www.faqs.org/microcontroller
c. www.nptel.ac.in/courses/Webcourse-contents/IITKANPUR/microcontrollers/micro/ui/Course_home2_5.html
d. http://www.nptelvideos.in/2012/11/real-time-systems.html
e. https://www.youtube.com/watch?v=rpdygqOI9mM
f. www.intorobotics.com/8051-microcontroller-programming-tutorials- simulators-compilers-and-programmers/
g. www.electrofriends.com/articles/electronics/microcontroller-electronics-articles/8051-8951/80518951-microcontroller-instruction-set/
h. www.ikalogic.com/part-1-introduction-to-8051-microcontrollers
i. www.binaryupdates.com/switch-with-8051-microcontroller/
j. www.mikroe.com/chapters/view/64/chapter-1-introduction-to-microcontrollers/ www.8051projects.net/download-c4-8051-projects.html
k. https://www.elprocus.com/difference-between-avr-arm-8051-and-pic-microcontroller/

Program Name : **Electronics Engineering Programme Group**

Program Code : **DE/EJ/ET/EN/EX/EQ**

Semester : **Fifth**

Course Title : **Mobile and Wireless Communication**

Course Code : **22533**

1. RATIONALE

In this world of connectivity and collaborative work environment, it is necessary to connect to the network from anywhere, with anybody, at anytime. Wireless communication provides connectivity with mobility, flexibility and convenience. Wireless devices are used across the various industries like Healthcare, Education, Automation, Renewable energy sector, Automobile etc. Effective use of Social networking has become possible due to high end wireless devices. This course will help the students to develop skills to handle wireless and mobile communication 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:

- **Maintain mobile communication systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above-mentioned competency:

a. Troubleshoot mobile handsets.
b. Assess cellular systems capacity.
c. Assess performance of standards of different cellular mobile systems.
d. Select relevant wireless technology suitable for various applications.
e. Test the performance of various wireless protocols.

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	8	3	70	28	30*	00	100	40	50#	20	50	20	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 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.

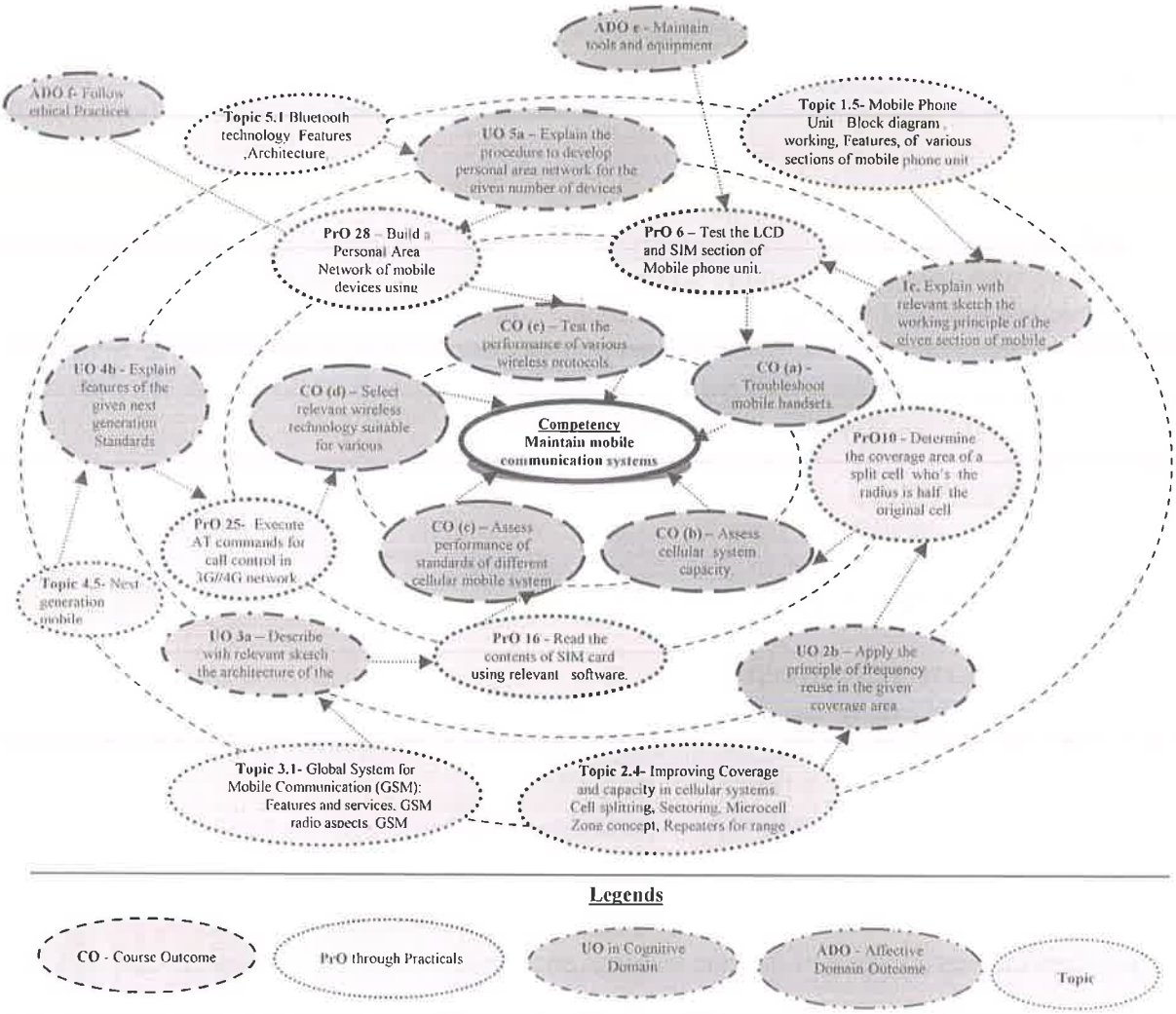

Figure 1 - Course Map

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	Identify different sections and components of mobile phone such as ringer section, dialer section, receiver section and transmitter section, camera, microphone, speaker, flash light.	I	02*
2	Identify the inbuilt sensors of mobile handset and test their performance.	I	02
3	Perform cold test of different sections of mobile phone unit.	I	02*
4	Test the supply of the Transmitter /Receiver section of mobile phone unit.	I	02*
5	Test the Battery charger section and power management unit of	I	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	mobile phone unit.		
6	Test the LCD and SIM section of mobile phone unit.	I	02
7	Test the user Interface section (Keyboard Buzzer, Vibrator, LED, Mic, and Speaker) of Mobile phone unit.	I	02*
8	Troubleshoot the Battery charger section, LCD section and SIM card section of the mobile handset.	I	02*
9	Troubleshoot the speaker problem, Ringer problem, Microphone problem, vibrator problem (User Interface section).	I	02
10	Determine the coverage area of a split cell which has radius half the radius of original cell.	II	02*
11	Determine the channel capacity of a cellular system service area comprised of 4/7/12 microcells with 8/12/16 channels per microcell.	II	02*
12	Determine the channel capacity if each microcell in the above lab exercise split into 4 minicells and each minicell is further split into 4 microcells.	II	02
13	For the 7- cell cluster and 168-voice channels cellular system, determine the assignment of voice channel to each cell if Omni-directional antenna is used at the cell site.	II	02*
14	For the 7- cell cluster, 168-voice channels cellular system, determine the assignment of voice channel to each sector if 3-sector 120^0 and 6 -sector 60^0 directional antenna are used at the cell site.	II	02*
15	Perform installation, registration, activation and authentication of mobile applications on mobile handset.	III,IV	02
16	Read/Retrieve the contents of SIM card using relevant software.	III,IV	02*
17	Execute call control commands using relevant software.	III,IV	02*
18	Execute Network service commands using relevant software.	III,IV	02
19	Execute Security commands using relevant software.	III,IV	02
20	Execute Phone book commands using relevant software.	III,IV	02*
21	Execute Short message commands using relevant software.	III,IV	02*
22	Execute Data commands using relevant software.	III,IV	02
23	Execute Specific AT commands using relevant software.	III,IV	02
24	Execute AT commands for call control in 3G/4G network.	IV	02*
25	Execute AT commands for Video call and Phone camera related commands in 3G/4G network.	IV	02
26	Execute AT commands for Microphone and Loudspeaker volume control related commands in 3G/4G network.	IV	02
27	Build a Personal Area Network of mobile devices using Bluetooth.	V	02*
28	Test the hard reset function, hotspot and other networking functions of the given smart phone.	V	02
	Total		**56**

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.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Practice energy conservation.
d. Work as a leader/a team member.
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	PrO. No.
1	Mobile Phone Trainer kit: Cellular System : EGSM/GSM 900/ 1800 MHz (3GDualband),Rx frequency band (Downlink): EGSM 900 : 925-960 MHz GSM 900 : 935- 960 MHz GSM 1800 : 1805-1880MHz Tx frequency band (Uplink) : EGSM 900 : 880- 890MHz GSM 900 : 890- 915 MHz GSM 1800 : 1710-1785MHz Output power : +5 ,+33 dBm / 3.2 mW , Channel spacing : 200 KHz Display : TFT, 256 K colours,128X 160 Pixels, 2.0", SIM support : Smart Dual SIM, Dual stand by (both GSM),Battery type : Li-Ion 1000m AH CPU : 208 MHz,Sound : Speaker and Earphone Jack (3.5 mm) On board sections : Keypad, Dual SIM, Charging.Circuit, Clock, User interface such as Buzzer,Vibrator, LEDs. Test points: 50 nos. (Gold plated)	1,2 to 8,

S. No.	Equipment Name with Broad Specifications	PrO. No.
	Features that can be set :Screen savers, Ring tones, Logos, SMS	
2	3G GSM Mobile Phone trainer: GSM capability: GSM 900 /1800, E-GSM GSM data services: Asynchronous, Transparent & Non Transparent modes. 14.4 K bits/s, SIM Interface : 3 V RF , Transmitter : Maximum output power : 33 dBm +/- 236dB,(EGSM) Maximum output power : 30 dBm +/- 2 dB (DCS) Minimum output power : 5 dBm +/- 5 dB (EGSM) Minimum output power : 0 dBm +/- 5 dB (DCS1800)	2,4,5,6
3	Spectrum Analyzer: 9Khz to 1.5 GHz frequency range, Typical 135dBm Displayed average noise level(DANL) 80dBc/Hz @ 10KHz offset, phase noise Total amplitude Uncertainty <`1.5dB, 100Hz Minimum Resolution Bandwidth (RBW), Frequency Resolution 1Hz, Frequency span range 0 Hz, 100 Hz to maximum Frequency of instrument, Video bandwidth (-3db) 1Hz to 3 MHz in 1-3-10 sequence	2 to 08
4	Digital Multimeter (¾ Digital Multimeter): 4000 counts large LCD display with auto/manual range, No Power OFF under natural operation ,Data Hold, Max/Min value Hold Capacitance, Frequency/Duty Cycle	2 to 8
5	CRO: Bandwidth : DC-30 MHz (-3 dB)] Rise time : 12 ns approx Accuracy : ± 3 % Input Impedance : 1 MΩ 30 pF approx Sensitivity : Internal 5 mm, Ext 0.8 V approx Deflection coefficients : Micro-controller based 12 calibrated steps 5mV/Div – 20V/Div 1-2-5 sequence X-Y mode : Component Testing	2to 8
6	Digital Storage Oscilloscope : 100 MHz with 64K color TFT, 16kbps memory, FFT function, alternate triggering, Roll Mode, Math Function, digital filter, waveform recorder,20 automatic measurements, Standard USB host, USB device with waveform analysis software	2to 12
7	SIM Card Reader: Trainer for SIM card reader, USB SIM card reader, store, read and save the SIM card data	2 to 09
8	Fast Battery charger: 5 to 20 V,100W,1Amp or 2 Amp.	8 to 09
9	Mobile handset Tools:- **Tools** to repair any smart phone or **mobile phone** include - soldering iron, soldering station, solder wire, solder paste, liquid flux, paste flux, jumper wire, tweezers, screwdriver, multimeter, dc power supply, ESD-Safe antistatic wrist strap, mat, apron, hand gloves, LCD tester, Battery tester, PCB holder, PCB Cleaner	2 to 09
10	Computer system with 3G/4G modem	14 to 27

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 Wireless Communication System	1a. Explain the features of the given mobile radio standards. 1b. Describe with relevant sketch the working of the specified application of the mobile/ fixed wireless communication system. 1c. Explain with relevant sketch the working principle of the given section of mobile handset unit. 1d. Describe with relevant sketch the working of the given fixed wireless network system. 1e. Describe step-by-step trouble shooting procedure for the given section of mobile phone.	1.1 Wireless network generations 1.2 Mobile Radio standards- AMPS, N-AMPS, IS -95, GSM, UMTS, CDMA 2000 1.3 Mobile wireless systems : Cordless Telephone system and Cellular telephone system 1.4 Fixed wireless networks : Wireless Local Loop (WLL) & Local Multipoint Distribution System (LMDS) 1.5 Mobile Phone Unit : Block diagram , working, features, of transmitter, and receiver section, Frequency Synthesizer, Control unit and Logic Unit of Mobile phone, sensors: speakers, camera, touch screen, motion sensors and other common sensors
Unit– II Fundamentals of Cellular System	2a. Explain the given terms, with respect to Cellular systems. 2b. Apply the principle of frequency reuse for the given coverage area. 2c. Choose the handoff mechanism for the given situation with justification. 2d. Explain the effect of the given interference on cellular system performance. 2e. Select the relevant method to improve coverage and system capacity of the given cellular system with justification. 2f. Calculate number of traffic channels and control channels for the given frequency spectrum and the given frequency reuse ratio.	2.1 Cellular concept fundamentals: Cell, cell structure, Cluster, Reuse factor, minimum reuse distance, basic cellular system : mobile station, base station, Traffic channel (Forward and Reverse) , Control channel (Forward and Reverse), Frequency reuse, channel assignment strategies 2.2 Handoff strategies: Concept of handoff, Types of Handoffs: Hard, Soft, Queued, delayed, MAHO (Mobile Assisted Handoff) , Proper and Improper Handoff, Umbrella cell approach 2.3 Interference and system capacity: Co-Channel interference, Adjacent Channel Interference, Channel Planning for wireless systems 2.4 Improving Coverage and capacity in cellular systems: Cell splitting, Sectoring, Microcell Zone concept, Repeaters for range extension
Unit-III Digital Cellular Mobile Standards	3a. Describe with relevant sketch the architecture of the given 3G cellular standard. 3b. Explain features, of the given mobile communication standard. 3c. Describe with relevant sketch call	3.1 Global System for Mobile Communication (GSM): Features and services, GSM radio aspects, GSM architecture, GSM channel types, Security aspects 3.2 GSM call routing : Mobile terminated call and mobile

Unit	Unit Outcomes (Uos) (in cognitive domain)	Topics and Sub-topics
	processing stages in the given cellular standard. 3d. Describe with relevant sketch the layered architecture of the given SS7 protocol. 3e. Explain the features of the services and performance of the given type of signaling system.	originated call sequence , stages of call processing in GSM 3.3 IS-95/CDMA One: features, Radio aspects, comparison with GSM standards 3.4 Signaling System No.7 (SS7): Network services part(NSP) , Message transfer Part (MTP), Signaling Correction Control part (SCCP), Services and performance of SS7
Unit –IV Advance Wireless Standards	4a. Explain compatibility requirements of the given wireless standard. 4b. Explain features of the given next generation wireless standard. 4c. Describe with relevant sketch the functions of the given section of UMTS network architecture. 4d. Compare features of two given next generation mobile communication standards. 4e. Select the relevant wireless technology for the given application.	4.1 Need for 3G and 4G technology 4.2 IMT-2000 global standards: Vision, Compatibility, service and spectrum requirements 4.3 UMTS /W-CDMA standard: Features, architecture, UMTS Air-interface specification, security procedure 4.4 CDMA 2000, features and advanced versions, advantages of CDMA 2000 over 3G- GSM standards 4.5 Next generation mobile standards: Features of 4G & 4G LTE, VoLTE, 4.5G, 5G
Unit-V Wireless Network Technologies	5a. Explain the procedure to develop personal area network for the given number of devices using Bluetooth. 5b. Describe with relevant sketch given IEEE protocol standard for wireless communication networks 5c. Classify RFID tags on the basis of the given type of parameters. 5d. Compare the performance of given wireless network technologies based on given parameters. 5e. Describe with relevant sketch the given type of wireless networking technologies applications.	5.1 Bluetooth technology: Features, architecture, frequency band , IEEE 802.15.1 and other wireless protocol, applications , personal area network(PAN) 5.2 RFID: Concept, frequency band, classification of RFID tags, applications 5.3 WLAN technology: IEEE 802.11, WLAN system architecture, radio spectrum 5.4 WMAN /Wi-max/ :IEEE 802.16 WMAN and IEEE 802.16a Wimax 5.5 Mobile Ad-hoc networks (MANET's): MANET topologies, applications.

***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	Wireless Communication System	10	04	04	04	12
II	Fundamental of Cellular System	12	04	04	04	12
III	Digital Cellular Mobile Standards	12	04	06	06	16
IV	Advance Wireless Standards	18	04	04	10	18
V	Wireless Network Technologies	12	02	04	06	12
Total		64	**18**	**22**	**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. Visit nearby MTNL/BSNL exchange and prepare detail report of entire setup of their cellular system.
b. Visit nearby CDMA based cellular switching center and prepare details of the entire setup of their cellular system
c. Demonstrate the general steps to repair Mobile handset.
d. Prepare a detail list of equipment and software required to troubleshoot the mobile handset.
e. Interpret the IS code 15040:2010 CISPR 25:2008. (Radio Disturbance Characteristics for Protection of receivers Used on Board Vehicles, Boats and Internal Combustion Engines – Limits and Methods of Measurement)

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. Correlate subtopics with Electronics communication and Digital communication(like: modulation ,wave propagation, Frequency modulation, multiplexing) .

g. Use proper equivalent analogy to explain different concepts.
h. Use Flash /Animations to explain functions of mobile handset.

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 is given here. The concerned faculty could add similar micro-projects:

a. Compare the specifications/ features / technology of different types of mobile phones available in the market (Min 12 specifications).
b. Collect the information regarding the special services provided by various mobile service providers (Min 4) in your area.
c. Prepare a report on TRAI regulations related to mobile communication.(spectrum allocation)
d. Prepare a report on FCC regulations for spectrum allocation/interference/ Qos for mobile communication.
e. Prepare a brief report on how radiations from BTS and handsets affect Human beings.
f. Market survey on various wireless devices available in the market.(wireless hands free, wireless speaker, wireless charger)
g. Prepare a short report on Li-Fi (light fidelity) technology.
h. Collect detailed information on various wireless technologies based on IEEE standard, frequency band, speed, range, advantages and disadvantages and submit the brief report of it.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Mobile Cellular Telecommunications System	Lee, C. Y. William	Mcgraw Hill Education, New Delhi, 2017 ISBN-13: 978-0070635999
2	Wireless communication-Principles and practice	Rappaport, S.Theodore	Pearson publication New Delhi, 2005 ISBN: 978-81-317-3186-4
3	Wireless Communication	Singal, T. L.	McGraw Hill Education Private Limited, New Delhi, 2010, ISBN: 978-0-07-068178-1
4	Wireless and mobile network Architectures	Lin Yi-Bang Clamtac Imrich	John Wiley& sons, New Delhi,2001 ISBN : 978-81-265-1560-8

14. SOFTWARE/LEARNING WEBSITES

a. eBook:- www.philadelphia.edu.jo/newlibrary/.../file101fc6e5c77f4675b2958dc10a8c99c9.pdf
b. Mobile network standards:- https://gallucci.net/blog/gsm-cdma-and-lte-a-guide-to-mobile-network.../3/4
c. Mobile phone repairing tools and equipments : - www.mobilecellphonerepairing.com › Mobile Phone Repairing Tools
d. Bluetooth technology:- www.radio- electronics.com/info/wireless/Bluetooth /bluetooth_overview.php
e. VoLTE:- /www.gsma.com/futurenetworks/wp-content/uploads/2014/.../FCM.01-v1.1.pdf
f. The Evolution of mobile technologies: - https://www.qualcomm.com/.../the-evolution-of-mobile-technologies-1g-to-2g-to-3g-.
g. Wireless tutorials:- https://www.octoscope.com/English/.../octoScope_WirelessTutorial_20090209.pdf
h. 5G Wireless Technology:- https://www.qualcomm.com/invention/5g/technologies
i. Wireless Networks : NPTEL Video lectures :- https://www.youtube.com/watch?v=Eu_mTZxPofI
j. TRAI official website: www.trai.gov.in/

Program Name : **Electronics Engineering Programme Group**

Program Code : **DE/EJ/ET/EN/EX/EQ/IS/IC**

Semester : **Fifth**

Course Title : **Industrial Automation (Elective for DE/EJ/ET/EN/EX/EQ)**

Course Code : **22534**

1. RATIONALE

In the present global scenario of manufacturing, industries are moving towards complete automation. Small and medium scale industries are in the phase of switching to PLC and SCADA technology for the data acquisition and control. Therefore, it is necessary for Electronics/Instrumentation engineers to have knowledge of both PLC and SCADA technology. This course attempts to provide basic knowledge of these technologies to develop operational competency. Hence this course is foundation for the engineers who want to further specialize in the Industrial automation field.

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 Industrial Automation 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. Identify different components of an automation system.
b. Interface the given I/O device with appropriate PLC module.
c. Prepare a PLC ladder program for the given application.
d. Select the suitable motor drives for the specified application.
e. Prepare a simple SCADA application.

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.

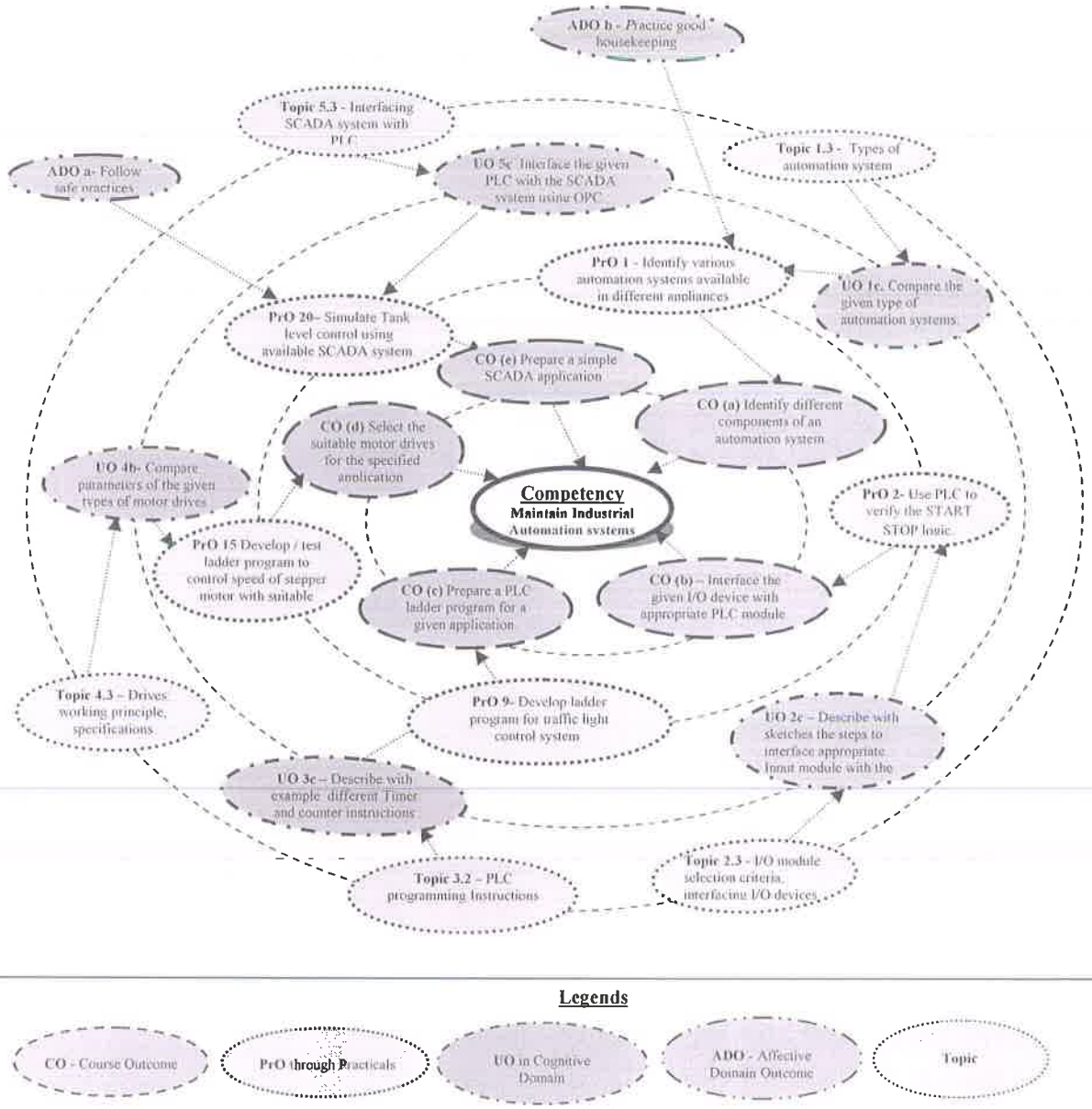

Figure 1 - Course Map

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	Identify various automation systems available in different appliances/devices/machines in day-to-day use.	I	02
2	Identify various parts and front panel status indicators of the given PLC.	II	02
3	Use PLC to test the START STOP logic for two inputs and one	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	output system.		
4	Develop/Execute a ladder program for the given application using following:- timer, counter, comparison, logical, arithmetic instructions.	II,III	02
5	Use PLC to control the following devices : lamp, motor, push button switches, proximity sensor	II,III	02
6	Measure temperature of the given liquid using RTD or Thermocouple and PLC.	II,III	02
7	Develop/test ladder program to blink LED/lamp.	III	02
8	Develop and test the Ladder program for sequential control application of lamps/ DC motors.	III	02
9	Develop and test ladder program for traffic light control system.	III	02
10	Develop and test ladder program for pulse counting using limit switch /Proximity sensor.	III	02
11	Develop /test ladder program for automated car parking system.	III	02
12	Develop / test ladder program for automated elevator control.	III	02
13	Develop / test ladder program for rotating stepper motor in forward and reverse direction at constant speed.	III	02
14	Develop /test ladder program for tank water level control.	III	02
15	Develop / test ladder program to control speed of stepper motor with suitable drivers.	IV	02
16	a. Identify various front panel controls of Variable Frequency Drive (VFD) (smart drive). b. Control speed of AC/DC motor using VFD.	IV	02
17	Use various functions of SCADA simulation editors to develop simple project.	V	02
18	Develop a SCADA mimic diagram for Tank level control.	V	02
19	Develop SCADA mimic diagram for Flow control of the given system.	V	02
20	Simulate Tank level control using available SCADA system.	V	02
	Total		**40**

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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10

S.No.	Performance Indicators	Weightage in %
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Practice energy conservation.
d. Work as a leader/a team member.
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	PrO. No.
1	IEC 1131-3 compatible PLC with programming Software and interfacing hardware, user manual, (complete PLC Trainer system)	1
2	Input and Output devices for PLC: like Lamp, DC Motor, Proximity sensors, Thermocouple/RTD, Red, green, yellow LEDs, Stepper Motor, limit switches, push button	2,3,6
3	Nano PLC, Mini PLC, Micro PLC with analog and Digital I/O, memory, peripheral interfaces	1-16
4	Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Simple EDA tools(open source)	1-13
5	Servomotor, DC motor, AC motor, steeper motor	14,15,16
6	Motor drives, drivers for special motors (VFD)	14,15,16
7	SCADA software: like Ellipse/FTVSE/Wonderware	14-16
8	Digital Multimeter (¾ Digital Multimeter): 4000 counts large LCD display with auto/manual range, No Power OFF under natural operation ,Data Hold, Max/Min value Hold Capacitance, Frequency/Duty Cycle	3 to 6

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 Introduction to Industrial Automation	1a. Describe the benefits of the given Industrial automation system. 1b. Describe functions of the given components of automation system. 1c. Compare the characteristics of the given type of automation systems. 1d. Describe applications of the given automation system.	1.1 Need and benefits of Industrial Automation 1.2 Automation Hierarchy, Basic components of automation system, description of each component 1.3 Types of automation system:- Fixed, programmable, flexible 1.4 Different systems for Industrial automation: PLC, HMI, SCADA, DCS, Drives
Unit– II PLC Fundamentals	2a. Explain with sketches the redundancy concept for the given PLC. 2b. Identify the specified parts of the given PLC along with its function. 2c. Describe with sketches the steps to interface appropriate Input module of the given PLC with the given input device. 2d. Explain the criteria to select appropriate module for the given I/O devices. 2e. Describe with sketches the steps to interface appropriate output device with the given output module of the given PLC.	2.1 Building blocks of PLC: CPU, Memory organization, Input-output modules (discrete and analog), Special I/O Modules, Power supply 2.2 Fixed and Modular PLC and their types, Redundancy in PLC module 2.3 I/O module selection criteria Interfacing different I/O devices with appropriate I/O modules
Unit-III PLC Programming and Applications	3a. Specify the proper I/O addressing format of the given PLC. 3b. Explain the use of different relay type instructions for the given operation. 3c. Use timer and counter instructions to write a program to perform the given operation. 3d. Use Logical and Comparison instruction to write a program to perform the given operation. 3e. Describe with example the given type of data handling instructions. 3f. Describe the given elements of different programming languages used to program PLC. 3g. Develop PLC ladder program for the given simple application. 3h. Describe a PLC ladder program	3.1 PLC I/O addressing 3.2 PLC programming Instructions : Relay type instructions, timer instructions: On delay, off delay, retentive, Counter instructions, Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic instructions 3.3 PLC programming language– Functional Block Diagram (FBD), Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming 3.4 Simple Programming examples using ladder logic: Language based on relay, timer counter,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	for the given industrial application.	logical, comparison, arithmetic and data handling instructions 3.5 PLC based applications: Motor sequence control, Traffic light control, elevator control, Tank level control, conveyor system, Stepper motor control, reactor control
Unit – IV Electric Drives and Special Machines	4a. Describe with sketches the working of the given type of drive(s). 4b. State the functions of the given type of V/F converter. 4c. Compare given parameters of the specified type of motor drives. 4d. Describe the application of the given type of drive(s).	4.1 Electric drives: Types, functions, characteristics, four quadrant operation 4.2 DC and AC drive controls: V/F control, Parameters, direct torque control 4.3 Drives: working principle, specifications, parameters, types and applications 4.4 Applications- Speed control of AC motor /DC Motor
Unit-V Supervisory Control and Data Acquisition System	5a. Describe the function of the given element of SCADA. 5b. Describe the steps to develop a simple SCADA screen for the given application. 5c. Interface the given PLC with the SCADA system using OPC. 5d. Describe the steps to develop SCADA system for the given industrial application.	5.1 Introduction to SCADA, typical SCADA architecture/block diagram, benefits of SCADA 5.2 Various editors of SCADA 5.3 Interfacing SCADA system with PLC: Typical connection diagram, Object linking and embedding for Process Control(OPC) architecture, Steps in Creating SCADA Screen for simple object, Steps for Linking SCADA object (defining Tags and items) with PLC ladder program using OPC 5.4 Applications of SCADA: Traffic light control, water distribution, pipeline control

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	Introduction to Industrial Automation	04	02	04	-	06
II	PLC Fundamentals	12	04	06	08	18

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
III	PLC Programming and Applications	16	04	06	12	22
IV	Electric Drives and Special Machines	08	02	04	06	12
V	Supervisory Control and Data Acquisition System	08	02	04	06	12
Total		**48**	**14**	**24**	**32**	**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. Do the internet survey and make a list of leading manufactures of the PLC, SCADA, DCS, HMI and other industrial automation tools with their brand name.
b. Refer operating manual of the PLCs of reputed Manufactures and prepare a step by step procedure to use PLC for the specified application.
c. Prepare a Power point presentation on the troubleshooting techniques of PLC.
d. Prepare the safety precautions list to be followed for installation of PLC system.
e. Download animated videos from the internet for any theory topic and make presentation on it.
f. Prepare a list of available analog input /output devices, digital input /output devices available in the market.
g. Guide the students for steps to be followed to configure available SCADA software.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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. Students can participate in the online industrial automation forums.

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 is 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 is given here. Similar micro-projects could be added by the concerned faculty:

a. **Automatic street light controller:** Prepare a PLC based system to control the street light as per the intensity of natural light.
b. **Automatic agriculture irrigation system:** Prepare a PLC based system to control drip irrigation.
c. **Railway gate automation:** Prepare a PLC and SCADA based system to open or close the proto type railway gate automatically.
d. **Home automation:** Implement the versatile automation system for home that can automate any three home appliances.
e. **Bottle filling station:** Prepare a PLC and SCADA based system for proto type bottle filling station.
f. **Troubleshoot the Faulty Equipment/Kit available in automation Laboratory.**

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN : 9788174092281
2	Programmable logic controllers	Petruzella, F.D.	Tata – McGraw Hill India, New Delhi, Fourth edition,2010, ISBN: 9780071067386
3	Programmable logic controllers and Industrial automation An introduction	Mitra, Madhuchandra; Sengupta, Samarjit	Penram International Publication, New Delhi, 2015, Fifth reprint, ISBN: 9788187972174
4	Introduction to Programmable logic controllers	Dunning, G.	Thomson /Delmar learning, New Delhi, 2005, ISBN 13 : 9781401884260
5	Supervisory control and Data acquisition	Boyar, S. A.	ISA Publication New Dxelhi (4th edition) ISBN: 978-1936007097
6	Programmable logic controllers	Hackworth, John; Hackworth, Federic	PHI Learning, New Delhi, 2003 ISBN : 9780130607188

S. No.	Title of Book	Author	Publication
7	Industrial automation and Process control	Stenerson, Jon	PHI Learning, New Delhi, ISBN : 9780130618900
8	Practical SCADA for Industry	Bailey, David ; Wright, Edwin	Newnes (an imprint of Elsevier)international edition, 2003 ISBN: 0750658053

14. SOFTWARE/LEARNING WEBSITES

a. Software:- www.fossee.com
b. Software:- www.logixpro.com
c. Software:- www.plctutor.com
d. Software;-www.ellipse.com
e. PLC lecture:- https://www.youtube.com/watch?v=pPiXEfBO2qo
f. PLC tutorial:-http://users.isr.ist.utl.pt/~jag/aulas/api13/docs/API_I_C3_3_ST.pdf


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

Program Name : **Diploma in Digital Electronics /Electronics Engineering Programme Group**

Program Code : **DE/EJ/ET/EN/EX/EQ**

Semester : **Fifth**

Course Title : **Microwave and RADAR**

Course Code : **22535**

1. RATIONALE

Microwave communication is the back bone of terrestrial communication and also the sole of mobile communication. To provide communication at difficult geographical locations and for specific task microwave links and RADAR are the established telecommunication solution. This course has been designed to develop skills in the diploma engineers to maintain microwave and RADAR based telecommunication 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:

- **Maintain microwave and RADAR based communication systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Use specified waveguides in microwave communication system.
b. Maintain passive microwave components and devices.
c. Maintain active microwave components and devices.
d. Interpret RADAR based systems for range detection.
e. Maintain various types of RADAR system for the specified application.

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.

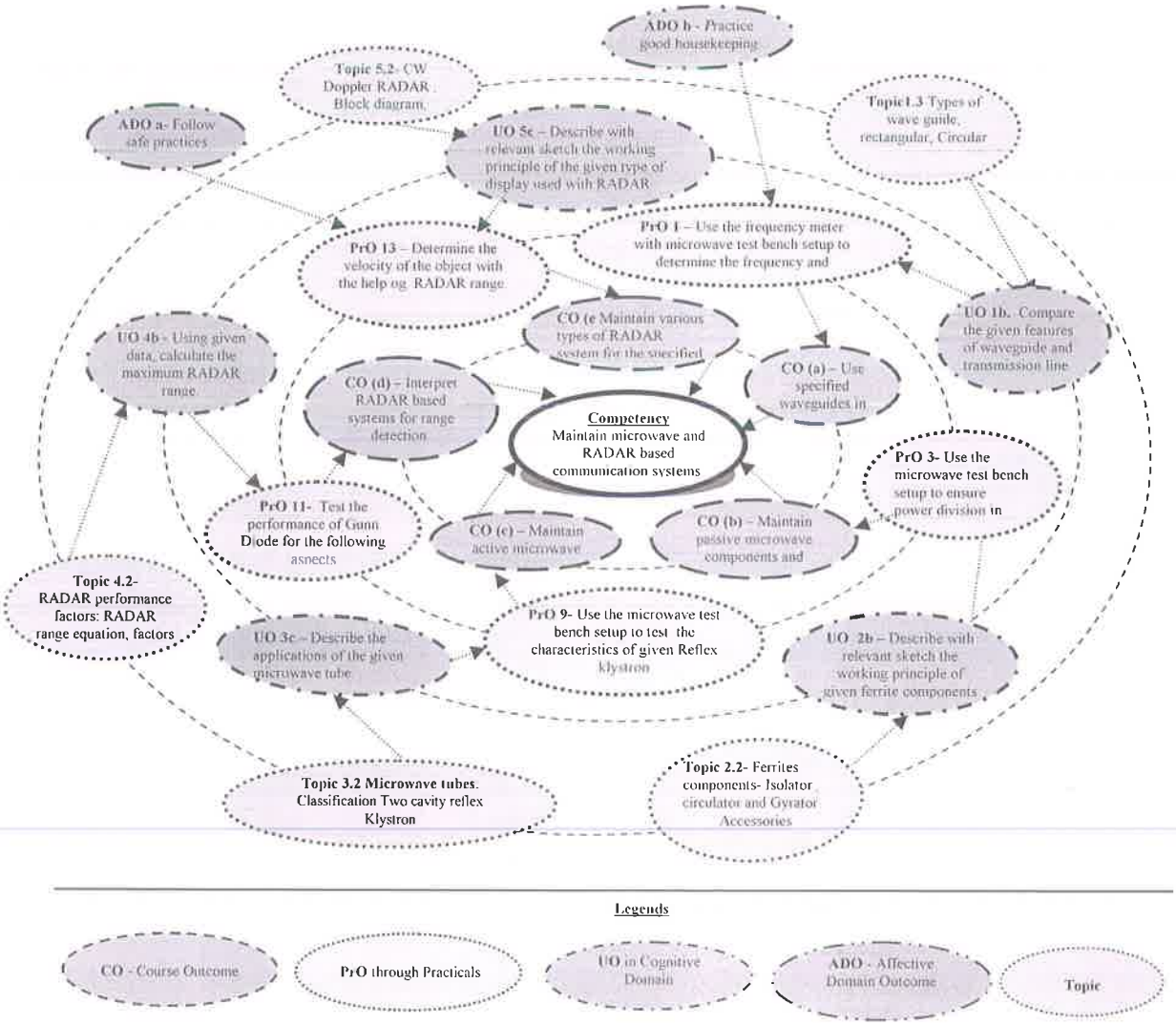

Figure 1 - Course Map

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	Use the frequency meter with microwave test bench setup to determine the frequency and wavelength of waveguide for TE10 mode.	I	02*
2	Use freeware/open source simulation tools to perform Practicals related to microwave waveguide .	I	02
3	Use the microwave test bench setup to ensure power division in microwave tees E-plane, H-plane and E-H plane.	II	02*
4	Determine coupling factor and insertion loss for the given circulator.	II	02
5	Measure VSWR for the given Microwave load.	II	02*
6	Measure attenuation of the given attenuator.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Determine the directivity, insertion loss and coupling factor for the given Multi- Hole Directional Coupler.	II	02
8	Use given microwave test bench setup to measure the gain of the horn antenna.	II	02
9	Use the microwave test bench setup to test the performance of the given Reflex Klystron tube.	III	02*
10	Test the performance parameter of the given type of microwave active components on freeware/open source simulation tools.	IV	02
11	Test the performance of Gunn Diode for the following aspects i. V-I characteristics ii. Output power and frequency as a function of voltage	IV	02*
12	Use Doppler RADAR to detect the maximum range .	V	02*
13	Determine the velocity of the moving object with the help of RADAR range.	V	02
14	Use RADAR system to measure the distance traveled by any object.	V	02
15	Use freeware/open source simulation tools to performance Practical related to RADAR communication.	V	02
	Total		**30**

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 %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	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. Practice energy conservation.
d. Work as a leader/a team member.
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	PrO. No.
1	**Microwave Test Bench –X Band (Klystron based) /** or any other equivalent, Klystron Power Supply, Klystron tube with Klystron mounts, Frequency meter, Variable attenuator, Detector mount, Wave guide stand, SWR meter and oscilloscope, E Plane Tee, H Plane Tee and Magic Tee Isolator and Circulator, Directional Coupler, Horn Antenna proto type	1 To 10
2	Microwave test bench –X Band (GUNN Diode based)/ or any other equivalent, Gunn oscillator, Gun power supply, PIN modulator, Isolator, Frequency meter, Variable attenuator, Detector mount, Wave guide stands, SWR Meter, Cables and accessories	11
3	RADAR Trainer (X Band)/or any other equivalent Technical Specifications: Transmitting Frequency : 10 GHz, Output Power : 10 to 15mW, Operating Voltage : 8.6V or adjustable, Antenna : Horn and parabolic dish with LNA and mounting IF Output : Audio range, Power Supply : 230V ± 10%, 50Hz	12,13, 14
4	**List of Software/Learning Websites** List of software RF Tool box: MATLAB and SIMULINK or any other open source software. EZNEC, HFSS-CST, VSim, Microwave office	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 Fundamentals of Microwave communication and Waveguides	1a. Summarize the range and applications of the given microwave frequency bands. 1b. Compare the given parameters of waveguide and transmission line. 1c. Explain the properties of the given parameters for the circular waveguide with example. 1d. Calculate the cut off wavelength, cut off frequency, group and phase velocity of the given rectangular waveguide. 1e. Describe with relevant sketch the field pattern of the given mode of rectangular waveguide. 1f. Compare the features of circular and rectangular waveguide for the given parameters.	1.1 Microwave frequency spectrum , band designations and applications of microwave in various fields 1.2 Comparison of wave guide with Transmission line 1.3 Types of Waveguides: Rectangular ,Circular , Propagation of waves in rectangular waveguides Reflection of waves from a conducting plane, dominant mode, The parallel plane waveguide, cut off wavelength, cut off frequency, group and phase velocity (Simple numerical) 1.4 Rectangular waveguide modes: TE ,TM TEM, field patterns of TE1,0,TE2,0,TE1,1 modes 1.5 Circular waveguide: Advantages, disadvantages and applications of circular waveguide
Unit– II Microwave Passive Components	2a. Describe with relevant sketch operation of the given microwave passive component. 2b. Describe with relevant sketch the working principle of given ferrite components. 2c. Describe the procedure to built/prepare the microwave test bench setup with the help of given microwave accessories and components 2d. Explain functions of the given parameters for a directional coupler.	2.1 Multiple Junctions : Working principle and applications of - E plane, H- plane , Magic Tee and Rat race ring 2.2 Ferrites components- Isolator , circulator and Gyrator Accessories: Flanges, Rotating coupling, Bends and corners, Taper and Twist 2.3 Directional couplers : Two hole directional coupler- Working principle and applications , directivity, coupling factor and isolation 2.4 Basic microwave antenna (Horn and Dish)
Unit-III Microwave Active Components	3a. Describe with relevant sketch the concept of velocity modulation and bunching effect for the given microwave tube. 3b. Prepare/Draw the apple gate diagram for the given parameters of the microwave tube. 3c. Describe the applications of the given microwave tube. 3d. Compare the performance of	3.1 Microwave tubes Classification Two cavity ,Reflex klystron i. Construction ii. Modulation iii. Bunching process iv. Principle of operation v. Magnetron: construction , operating principle and applications 3.2 Slow wave devices: Helix TWT construction and principle of operation and applications

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	Klystron, Magnetron and TWT on the given parameters. 3e. Describe with relevant sketch the transfer electron effect for the given energy level diagram of Gunn Diode. 3f. Describe with relevant sketch the operation of the given active microwave component.	3.3 Compare the performance of Klystron, Magnetron and TWT. 3.4 TED (Transferred Electron Devices): Gunn diode – construction, operation principle, modes and application of Gunn diode as an oscillator Avalanche transient time device: 3.5 IMPATT diode - construction, operation and applications 3.6 PIN diode-. construction, operation and applications Esaki diode: Tunnel diode –V-I Characteristics, equivalent circuit, application as an oscillator and as an amplifier
Unit-IV RADAR Fundamentals	4a. Describe with relevant sketch functions of the given component of the RADAR system. 4b. Calculate the maximum RADAR range for the given data.	4.1 Basic block diagram of RADAR system 4.2 RADAR performance factors: RADAR range equation, factors influencing range, effect of noise 4.3 Basic pulse RADAR system: Block diagram and description, applications
	4c. State the affect on the RADAR range for the given the parameters. 4d. Explain with relevant sketch the given type of scanning and tracking methods used for RADAR communication. 4e. Describe with relevant sketch the construction and working of the given microwave antenna.	4.4 Antenna Scanning (types and principle): Horizontal, vertical, helical and spiral. Antenna Tracking (types and principle): Sequential, conical and mono pulse 4.5 Antenna feed Mechanism: horn and cassegrain feed antenna
Unit –V RADAR Systems	5a. Explain with relevant sketch working principle of the given type of RADAR. 5b. Describe the applications of the given type of RADAR. 5c. Describe with relevant sketch the working principle of the given type of display used with RADAR system. 5d. Compare CW and Pulsed RADAR for the given parameters. 5e. Describe with relevant sketch	5.1 Doppler effect 5.2 CW Doppler RADAR : Block diagram, operation and application FM CW RADAR: Block diagram, operation and application 5.3 MTI: Block diagram, operation concept of blind speed, application, Automatic target detection RADAR 5.4 Display Methods: A-Scope, PPI, Beacons 5.5 SONAR system :working principle and applications

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	the applications of the given SONAR system.	

***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	Fundamentals of Microwave communication and Waveguides	08	04	04	06	14
II	Microwave Passive Components	08	04	04	04	12
III	Microwave Active components	16	06	08	06	20
IV	RADAR Fundamentals	08	04	04	04	12
V	RADAR Systems	08	04	04	04	12
Total		**48**	**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: 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 chart showing various microwave components.
b. Prepare /download an animation and share with the class to illustrate the working principle of the following
   i. Microwave Tubes
   ii. EM wave propagation.
c. Visit a place where waveguides are used for microwave communication (such as earth Station, Radio station, telephone exchange, airport, TV broadcast, navigation center) and prepare the report.
d. Conduct a Library / Internet based survey of microwave components.
e. Interpret the various BIS Code for microwave communication.
f. Compare specifications of at least two different types of RADAR system.

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 proper equivalent analogy to explain different concepts.
g. Use Flash/Animations to explain various microwave components, tubes and RADAR systems.
h. Use open source /MATLAB models to explain different concepts of microwave devices.

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 is given here. Similar micro-projects could be added by the concerned faculty:

a. Market survey of consumer microwave equipments with respect to working principle, manufacturer, technical specification and submit the detail report of it.
b. Prepare survey report on mobile van used for live telecast of any event.
c. Prepare a report on the applications of RADAR for Defense and Air navigation.
d. Prepare power point presentation to explain working of various microwave components and Microwave tubes.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	RADAR systems and radio aids to navigation	Sen, A. K. and Bhattacharya, A. B.	Mercury Learning & Information. PVT.LTD. New Delhi, 2017,ISBN: 978-1683921189
2	Microwave Engineering	Das, Annapurna and Das, S. K.	Mc Graw Hill, New Delhi(3rd edition 2017, ISBN: 978-9332902879
3	Microwave Engineering	Gupta, Sanjeev	Khanna Publication, Nai sadak Delhi (3rd edition,2015, ISBN: 9788174090878
4	Microwave and RADAR Engineering	Gautam, A. K.	S K Kataria Publications, New Delhi 2012, ISBN: 978-9350141519
5	Fundamentals of	Sharma, K.K.	S.Chand and Company PVT. LTD.

S. No.	Title of Book	Author	Publication
	Microwave and RADAR Engineering		New Delhi,2011, ISBN:9788121935371
6	Electronics Communication System	Kennedy, George; Davis, Brendan ; Prasanna, Srm	Mc Graw Hill, New Delhi,5th edition,2011,ISBN: 978-0071077828
7	Microwave devices and circuits	Liao Samuel Y	PHI Learning ,New Delhi,(Latest Edition), ISBN: 978-8131762288
8	Microwave and RADAR Engineering	Kulkarni, M.	Umesh Publications, New Delhi,2009,ISBN978-8188114009

14. SOFTWARE/LEARNING WEBSITES

a. Microwave components:-www.youtube.com /microwave components and devices
b. RADAR:-www.youtube.com /RADARs
c. Microwave fundamentals:-www.nptelvideos.in/microwave engineering
d. Microwave:-www.learnerstv.com/free-engineering
e. Rectangular Waveguides:- www.ece.uprm.edu/ppt/rectangularwave
f. Waveguide:- www.academia.edu/waveguide
g. Microwave engineering Book:- monitor.westernfriend.org/microwave-engineering-by-sanjeev-gupta.pdf


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