

National Institute of Electronics & Information Technology, Aurangabad

Teaching and Examination Scheme for Diploma in Electronics Production and Maintenance

Program Name: Diploma in Electronics Production and Maintenance

Program Code: DEPM

With Effect from Academic Year: 2021-2022

Duration of Program: 6 Semesters

Duration: 16 Weeks

Semester: Fifth

S r. N o	Course Title	Abbre viation	Sub. code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total	
				L	T	P		Theory						Practical							
								ESE		PA		Total		ESE		PA		Total			
								Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		Max
1	Product Design	PDE	21D51	3	-	2	5	3	70	28	30	12	100	40	25	10	25	10	50	20	150
2	Control system and PLC	CSP	21D52	4	-	2	6	3	70	28	30	12	100	40	25	10	25	10	50	20	150
3	Embedded Systems	ESY	21D53	3	-	2	5	3	70	28	30	12	100	40	25	10	25	10	50	20	150
4	Mobile and Wireless Communication	MWC	21D54	4	-	2	6	3	70	28	30	12	100	40	25	10	25	10	50	20	150
Elective																					
5	Industrial Automation	IAU	21D55	3	-	2	5	3	70	28	30	12	100	40	25	10	25	10	50	20	150
	Principle of Industrial IoT	IOT	21D56	3	-	2	5	3	70	28	30	12	100	40	25	10	25	10	50	20	150
6	Printed Circuit Board-I	PCB1	21D57	3	-	2	5	3	70	28	30	12	100	40	25	10	25	10	50	20	150
7	Industrial Training	INTR	21D58	-	-	6	6	-	-	-	-	-	-	-	25	10	25	10	50	20	50
8	Capstone Project planning	CPP	21D59	-	-	3	3	-	-	-	-	-	-	-	25	10	25	10	50	20	50
Total				23	0	18	41	-	420	-	180	-	600	-	225	-	225	-	450	-	-

Student Contact Hours Per Week: 41 Hrs. Medium of Instruction: English

Theory and practical periods of 60 minutes each.

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

• Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

For the courses having ONLY Practical Examination, the PA has two parts, marks for : (1) Practical Part - 60% of total marks (ii) Micro-Project Part - 40% of total marks.

- Candidate remaining absent in practical examination will be declare as Absent in Mark List and has to reappear for examination. The marks of the part for which candidate was present will not be processed or carried forward.
- In-Plant training during summer vacation for minimum six weeks at the end of fourth semester(2nd year).

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Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Product Design
Course Code : 21D51

1. RATIONALE: -

The set of strategic and tactical activities, from idea generation to commercialization, used to create a product design. In a systematic approach, product designers conceptualize and evaluate ideas, turning them into tangible inventions and products. The product designer's role is to combine art, science, and technology to create new products that people can use. Their evolving role has been facilitated by digital tools that now allow designers to do things that include communicate, visualize, analyze, 3D modeling and actually produce tangible ideas in a way that would have taken greater human resources in the past.

2. COMPETENCY: -

- Students will be able to independently carryout complete Industrial Design considering aesthetics, ergonomics, etc.,
- Students will be able to work in multicultural cross discipline teams effectively.
- Students will be able to communicate the design and other technical aspects effectively using various tools.

3. COURSE OUTCOMES: -

- Having an ability to apply knowledge of mathematics, science, and engineering.
- Having a clear understanding of the subject related concepts and of contemporary issue.
- Having ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment.
- An ability to design and conduct experiments, as well as to analyze and interpret data.
- Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice.

4. TEACHING AND EXAMINATION SCHEME: -

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Paper Hrs.	Theory						Practical					
					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*	15	100	40	25	10	25	10	50	20
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(*): 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. SUGGESTED PRACTICAL/ EXERCISES:-

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Sketching simple objects with perspective.	I	2*
2	Free hand drawing –the lines are sketched without using instruments other than pencils and erasers.	II	2*
3	Draw freehand object drawing using perspectives.	II	2*
4	Free hand sketching of electronic objects.	II	2*
5	Rendering: a) Seven basic strokes for rendering b) Light source and rendering on basic shapes	II	2*
6	Exploded view of torch/ rot ring pens/ flashlight	III	2*
7	Control panel study- washing machine, photocopy machine	III	2*
8	Mount board model making of remote control.	III	2*
9	Making a model of Mic with clay /shadoo-mati/ terracotta).	III	2
10	Making model of measuring machine and cloth iron using Soap or suitable medium.	III	2*
11	Design and layout of a brochure.	IV	2*
12	Free hand line drawing practice (straight horizontal lines, vertical lines, dark to light lines-circles draw without mechanical tools, drawing ellipses, basic structure and freehand sketching practice of an objects, sketching of basic shapes in perspective.	V	2*
Total			24

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 judicious mix of minimum 12 or more practical need to be performed, out of which, the practical 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

Sr. 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:

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Work as a leader/a team member.
- Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: - NIL

7. 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	1a. Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice. 1b. Having problem-solving ability to solve social issues through design. 1c. Having adaptive thinking and adaptability.	1.1 Product development process and the role of product designer there in.
Unit - II Industrial design	2a. Describe the meaning of ergonomics. 2b. Able to apply concept of Ergonomics and Aesthetics. 2c. Inculcating curiosity for lifelong learning about design. 2d. Will be able to design sketch and render, the control panels.	2.1 Design methodology 2.2 Ergonomics & Aesthetics of design 2.3 Design of control panels 2.4 Communication techniques 2.5 Sketching, Rendering and Drawing.
Unit- III	3a. Having design thinking capability	3.1 Design of Assembly and individual

Physical Design	3b. Having Analytical thinking with computational skills. 3c. Having critical thinking and innovative skills 3d. will be able to provide solution on heat dissipation and EMI/RFI issues.	parts from Maintenance 3.2Manufacturing 3.3Assembly 3.4 Safety 3.5Strength 3.6Heat dissipation 3.7EMI/RFI Shielding considerations 3.8Assembly Detailing
Unit - IV Documentation	4a. Having a good documentation methodology. 4b. Apply fundamental concepts and theories of industrial design to develop solutions to practical industrial problems	4.1 Role of Product Documentation in product development process 4.2Preparation of following documents
Unit-V Product Concept	5a. Conduct research and development of new products for improving human life	5.1Sketching 5.2Product Perspective 5.3 Product Assembly 5.4 Individual Part Drawing Sheet Layout 5.5 Control panel layout 5.6 Wiring Harness Drawing 5.7Any other necessary document

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'

8. 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	04	02	04	04	10
II	Industrial design	12	04	06	08	18
III	Physical Design	16	04	06	04	14
IV	Documentation	08	02	04	08	14
V	Product Concept	08	02	04	08	14
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.

9. 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. Write assignments based on the theory taught in classrooms. Assignments consist of ten questions having long answers including charts, symbols, drawing, observations etc.
- b. Prepare/Download information about various industrial acts.
- c. Visit to any Manufacturing industry and prepare a report consisting of:
 - ii. Organization structure of the organization/ Dept.
 - iii. Safety measures taken in organization.
 - iv. Mechanism to handle the disputes.
 - v. Any specific observation you have noticed.
- d. Give seminar on relevant topic.
- e. Undertake micro-projects.

10. 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. 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).
- c. With respect to item No. 9, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- d. Guide student(s) in undertaking micro-projects.
- e. Demonstrate students thoroughly before they start doing the practice.
- f. Encourage students to refer different websites to have deeper understanding of the subject.
- g. Observe continuously and monitor the performance of students in Lab.

11. 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:

- System research documentation & presentation.
- Analysis & formulation of design brief.
- Ideation & exploration -- sketches & study models.
- Final design solution -- product detailing, rendering & finished models/prototype.

12. SUGGESTED LEARNING RESOURCES: -

S. No.	Title of Book	Author	Publication
1	Human factors in Engineering and design	M.S.Sanders and Ernest J McCormick	McGraw Hill International Editions, 2013.
2	Introduction to Human Factors and Ergonomics for Engineers	Lehto M., Landry S.J	2nd Edition, CRC Press, Taylor & Francis Group 2013.
3	Product Design and Manufacturing	A C Chitale and R C Gupta	Prentice Hall New Delhi 2011.

13. SOFTWARE/LEARNING WEBSITES:-

a) www.ocw.mit.edu

b) www.edx.org/learn/product-design

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Control Systems and PLC
Course Code : 21D52

1. RATIONALE

Different logical process automation is used for optimum controlling of the process parameters and hence Diploma Engineers should be able to maintain them. This requires that they should know very well about logical control action fundamentals. Hence this curriculum has been designed so that the students will be able to explain the construction, working and applications of various logical control strategies for automation.

2. COMPETENCY

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

- Operate and Maintain programmable logical controllers and distributed control system

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:

- Identify logical process control in automation (PLC and DCS based automation).
- Connect the PLC peripherals with the PLC for logical functioning.
- Develop basic PLC programmes.
- Maintain PLC

4. TEACHING AND EXAMINATION SCHEME

- Maintain PLC based process control systems.

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
L	T	P		Theory								Practical					
				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*	15	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^ ESE - End Semester Examination; PA - Progressive Assessment

5. SUGGESTED PRACTICALS/ EXERCISES

The practical's 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:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
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			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
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

- A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practical's marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's Psychomotor Domain Taxonomy' as generally required by the industry.
- The '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 ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organizing Level' in 2nd year.
- 'Characterizing Level' in 3rd year.

6. 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

7. 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-1 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	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

	given transfer function. 2d. Determine output of the given order system for the step input. 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 2 criteria	control system: i. Poles and zeros - S-plane representative, 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 iii. Second order system- Analysis for unit step input (no derivation), concept, definition and effect of damping iv. Time response specifications (no derivations) - T_p, T_s, T_r, T_d, M_p, E_{ss}, 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, Automotive Electronics	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 application.	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 module diagram, specifications 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'.

8. 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, Automotive Electronics	12	04	04	06	14
V	PLC Hardware and Programming	18	04	06	08	18
Total		64	16	22	32	70

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'

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.

9. 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.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

- a. Massive open online courses (*MOOCs*) may be used to teach various topic, 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. 9, 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.

11. 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. 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 10 sec. 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 10 sec, 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.

12. SUGGESTED LEARNING RESOURCES

Sr.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	Magrath, 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	Petrzella, F.D.	Tata- McGraw Hill, 3rd Edition, 2010 ISBN: 9780071067386

13. SOFTWARE/LEARNING WEBSITES

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

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Embedded Systems
Course Code : 21D53

1. RATIONALE

To add luxury to any product requires fully automation and for that we need embedded system, where we don't need user intervention. By learning this course students can develop their own embedded system which is application specific to solve given real time problem by using open source platform. Thus this course is an important course for students who want to work in the automation sector of electronic industry.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- Develop embedded systems for given application.

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Maintain microcontroller based system.
- Select appropriate family of microcontroller for different application.
- Interface relevant hardware for given application.
- Develop program for given application.
- Integrate hardware and software for embedded system for given application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P))	Examination Scheme												
L	T	P		Theory						Practical						
				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*	15	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. SUGGESTED PRACTICAL/ EXERCISES

The practical's 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:

Sr.	Practical Outcomes (PrOs)	Unit	Approx.
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No.		No.	Hrs. Required
1	Identify the pins of 8051 and AVR microcontrollers.	I	2*
2	Identify the pins and features of PIC microcontrollers.	I	2
3	Identify the features of ARM microcontroller on the basis of IC number.	I	2
4	Use Integrated development environment tool for developing embedded 'C programs (Using MicroPro. C/ Keil).	II	2*
5	Execute the 'C program to perform following arithmetic operations on 8-bit data: addition, subtraction, multiplication and division. Study of microprocessor kit, programming exercises covering data processing, Data transfer, Program control instructions	II	2*
6	Develop and Test the 'C program to perform following arithmetic operations on 16-bit data: addition, subtraction. Programming 8085 exercises on software & hardware interrupts, serial data transfer	II	2
7	Develop and Test the 'C program to perform data transfer from source to destination (Use internal data memory locations). Programming exercise on internal resources of microprocessor kit like use of display, keyboard, i/o parts etc.	II	2*
8	Interface RS232 connector to PC using MAX232 IC.	III	2
9	Develop and test the 'C program to turn on LED (S) with key (S) press.	IV	2*
10	Interface 89C51/AVR microcontroller and write the 'C program to display numbers from 0 to 9 on 7-segment display with specified delay.	IV	2
11	Interface 89C51/AVR microcontroller and write C program to display string on given 16x2 LCD.	IV	2*
12	Interface 89C51/AVR microcontroller and write 'C language program to read key code from 4x4 matrix keyboard and LCD display.	IV	2*
13	Interface 89C51/AVR microcontroller and write C program to convert analog signal into digital form using given 8-bit ADC and store the converted digital data in memory. Exercises on interfacing of LEDs, keys, seven segment display, matrix keyboard, ADC, DAC, relays etc.	IV	2*
14	Interface 89C51 and write C program to generate square and sawtooth waveforms using given 8-bit DAC.	IV	2*
15	Interface 89C51 /AVR microcontroller and write C program to rotate stepper motor with different speeds in clockwise and counter clockwise direction.	IV	2*
16	Interface 89C51 and write C program to observe the real time status of the triangular waveform generated using DAC (Use 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 practical's 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

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:

- f. Follow safety practices.
- g. Practice good housekeeping.
- h. Practice energy conservation.
- i. Work as a leader/a team member.
- j. Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

Sr. 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
u	Submission of report in time	10
Total		100

6. 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.

Sr. 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 backup, 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	Arduino Board with AVR microcontroller	All
3	Desktop PC with Integrated Development Environment (MicroProC I Keil / Proteus).	All
4	Stepper Motor- 50/100 RPM (or any relevant).	15
5	CRO- Bandwidth AC 10Hz - 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe.	13,14,

6	ADC (0808) trainer board.	13
7	DAC (0808) trainer board.	14
8	Add on cards.	9
9	Digital Multimeter: 3 1/2-digit display, 9999 counts digital multimeter measures: V_{ac} , V_{dc} (1000V max), A_{dc} , A_{ac} (10-amp max), Resistance (0-100 MQ), Capacitance and Temperature measurement	13,14, 15,16

7. 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-1 Introduction to Embedded systems	1a. Describe the given component of the given embedded system, 1b. Describe with the help of block diagram, the architecture of the given processor, 1c. Describe the given characteristic of the specified embedded systems. 1d. Identify with justification the 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. Study of Microprocessor.	1.1 Block diagram of embedded system with hardware components 1.2 Harvard and Von-Neumann architecture, RISC and CISC processors 1.3 Features of 89C51, PIC, AVR and ARM microcontrollers with their applications. 1.4 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 1.5 Classification of embedded system: small scale, medium scale, sophisticated, stand-alone, reactive/real time (soft and hard real time).
Unit- II Programming using Embedded C	2a. Develop the algorithm, flowchart and 'C program (s) for the given microcontroller to perform the given operation, (data transfer, arithmetic /logical, decision control and looping operations). 2b. Develop the algorithm, flowchart and 'C code for the given delay using timer/counter with microcontroller. 2c. Develop the algorithm, flowchart and 'C code for the	2.1 Programming with 'Embedded C: arithmetic and logical operations, data transfer with memory and port, decision control & looping 2.2 Timer/Counter program using 'embedded C for given microcontroller 2.3 Serial communication program using 'embedded C for given microcontroller 2.4 Interrupt control program with 'embedded C for given

	given data transfer through serial communication port. 2d. Develop the algorithm, flowchart and 'C code to control the given interrupt.	microcontroller
Unit-III Communication standards and protocols	3a. Describe the given mode (s) of communication. 3b. Describe the functions of the given, pin(s) of RS232 and MAX232 with suitable sketch. 3c. Describe the given communication protocol (s) with relevant sketch. 3d. Describe the given advanced serial communication interface.	3.1 Modes of data communication: serial parallel, synchronous and asynchronous communication 3.2 Serial communication standards: RS232 3.3 MAX232 as a bidirectional level converter 3.4 Communication protocols i. Serial communication 1 ² C, CAN, USB, script peripheral 3.5 Interface (SPI), synchronous serial protocol (SSP) i. Parallel communication protocols: PCI, PCI-X 3.6 Features of advanced serial protocol: <u>IrDA</u> , <u>Bluetooth</u> , <u>ZigBee</u>
Unit -IV Interfacing Input and Output Devices	4a. Explain the steps for interfacing of the given basic input/output device (s) to the given microcontroller with embedded 'C' program. 4b. Explain the steps for interfacing of the given LCD, matrix key board, multiplexed 7 segment display, sensor to the given microcontroller with embedded 'C' program. 4c. Explain interfacing of DC motor to the given microcontroller to rotate in the given direction using embedded 'C' program. 4d. Explain the steps for interfacing of given stepper motor with the microcontroller to rotate in given direction, angle of rotation, with half step/full step with embedded 'C' program. 4e. Explain interfacing steps of the given ADC/DAC to convert data with the given microcontroller with embedded C program.	4.1 Interface the various input, output and special devices to the microcontroller 89C51/AVR 4.2 Output Devices: LED, LCD, relays, 7-segment displays, multiplex 7-Segment display 4.3 Input Devices: key, matrix keyboard 4.4 Motor: stepper motor, DC motor 4.5 ADC/DAC: 8-bit ADC/DAC(0808/09) 4.6 Sensor: Temperature sensor(LM35)
Unit-V Real	5a. Describe the given functions	5.1 Operating system: general and

Time Operating Systems	of the specified operating system with suitable sketch. 5b. Compare the given characteristics of RTOS and General OS. 5c. Explain deadlock condition in RTOS with suitable sketch. 5d. Explain the given features of RTOS with suitable sketch.	real time operating system 5.2 Characteristics of real time operating system: consistency, reliability, scalability, performance, predictability 5.3 Functions of RTOS: 5.4 Task management: inter task communication and multitasking 5.5 Scheduling: scheduling algorithms. 5.6 Features of RTOS: watchdog timer, semaphore 5.7 Deadlock: i. Reason of occurrence ii. Handling of deadlock: detection, prevention, ignoring iii. Resource allocation and interrupt handling 5.8 Simple interfacing examples
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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'.

Unit No.	Unit Title	Teaching Hours	Distribution of Theory IV			arks
			RLevel	U Level	A Level	Total Marks
I	Introduction to Embedded systems	08	04	04	04	12
II	Communication standards and protocols	12	02	06	08	16
III	Communication standards and protocols	08	02	04	06	12
IV	Interfacing Input and Output Devices	12	04	06	08	18
V	Real Time Operating Systems	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.

8. 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 devices 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.

9. 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 as development of the COs through classroom presentations (see guideline for details).
- d) With respect to item No. 8, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- e) Guide student(s) in undertaking micro-projects.

10. 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. Prepare a chart of various features using data sheets of 8051, PIC, AVR, ARM microcontroller and its derivatives.
- b. Prepare a chart of various features and operations of temperature sensors, devices using data sheets.
- c. Prepare a chart of various types of LCDs to display its features, pin functions and steps of operations using data sheets.
- d. Interface potentiometer with development board (Arduino) and write a program to generate LED pattern on it.

- e. Programming of an Arduino (Arduino ISP) Interfacing Motor through L293D Driver with Arduino
 - f. Interfacing Accelerometer with Arduino Interfacing of Relay Driver ULN2803 with Arduino
 - g. Build a flashing display to flash advertisement of Mobile shop.
 - h. Build a system to display department name using rolling display.
 - i. Build a buzzer system for rapid fire quiz competition,
 - j. Build a two-digit counter.
 - k. Build a class period bell as per the given time table which includes 7 teaching periods and lunch hour.
 - l. Build a temperature monitoring system to maintain temperature in given range,
 - m. Build a pollution monitoring system to observe the level of CO₂.
 - n. Build automated door control system to open and close the door.
 - o. Build traffic light controller for traffic signals as per specified delay,
 - p. Build a water level controller for given water levels.
- Note: Use appropriate software for programming. Build the circuit on PCB or use development board such as Arduino.

11. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller Architecture, Programming and Application	Ayala, Kenneth	Cenage learning, 3 rd edition, New Delhi, 2007, ISBN: 978-8131502006
2	The 8051 Microcontroller and Embedded system	Mazidi, Mohmad Ali; Janice, Gelispe and Mckinlay, Roline D.	Pearson, 2 nd edition, Delhi, 2008, ISBN: 9788177589030
3	Microcontroller Principle and Application	Pal, Ajit	PHI, New Delhi, 2014, ISBN: 9788120343924
4	Microcontroller Theory and Application	Deshmukh, Ajay	McGraw Hill Education, New Delhi, 2011, ISBN: 9780070585959
5	Microcontroller Architecture Programming, Interfacing and System Design	Rajkamal	Pearson Education India, Delhi, 2012, ISBN: 9788131759905
6	The Embedded Software Primer	David E. Simon	Addison-Wesley, Delhi ISBN: 9780201615692

12. SOFTWARE/LEARNING WEBSITES

- a. Simulation Software :- WWW.keil.COM
- b. <https://www.arduino.cc>
- c. <https://scilab-arduino.fossee.in>
- d. www.nptel.ac.in/courses/Webcourse-contents/IITKANPUR/microcontrollers/micro/ui/Course_home2_5.html
- e. www.nptelvideos.in/2012/11/real-time-systems.html
- f. RTOS:- <https://www.youtube.com/watch?v=rpdygqOI9mM>
- g. www.intorobotics.com/8051-microcontroller-programming-tutorials-simulators-compilers-and-programmers
- h. www.electrofriends.com/articles/electronics/microcontroller-electronics-articles/8051-8951/8051-8951-microcontroller-instruction-set

- i. www.ikallogic.com/part-l-introduction-to-8051-microcontrollers
- j. www.binaryupdates.com/switch-with-8051-microcontroller
- k. www.mikroe.com/chapters/view/64/chapter-l-introduction-to-microcontrollers
- l. www.8051projects.net/download-c4-8051-projects.html
- m. <https://www.elproctis.com/difference-between-avr-arm-8051-and-pic-microcontroller>

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Mobile and Wireless Communication
Course Code : 21D54

1. RATIONALE

This Course is to expose the students to the most recent technological developments in Mobile communication systems.. The Course considers the basic concepts of cellular system. Following this, various propagation effects and propagation models used in mobile communication are included in the course. This course deals with various methodologies to improve the received signal quality in mobile communication. The Course provides various multiple access techniques and Standards in Cellular mobile Communication. Wireless communication provides mobility, flexibility, convenience. Wireless communication has opened up many areas for research also.

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 & wireless 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:

- Understand mobile and wireless network systems such as 2G/3G/4G Mobile telephony/data network.
- Understand GSM and GPRS.
- Understand the working of wireless LAN,Bluetooth.
- Select relevant wireless technology suitable for various applications.
- Test the performance of various wireless communication protocols.

(*): 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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
4	-	2	6	3	70	28	30*	15	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. SUGGESTED PRACTICALS/ EXERCISES

The practical's 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 mobile phone unit.	I	02
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° and 6 -sector 60° 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:

- A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practical's marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's Psychomotor Domain Taxonomy' as generally required by the industry.
- The Process' and Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

Sr.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:

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Work as a leader/a team member.
- Follow ethical Practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3 year

6. 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.	Equipment Name with Broad Specifications	PrO. No.
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No		
1.	Mobile Phone Trainer kit: Cellular System : EGSM/GSM 900/ 1800 MHz (3G Dualband), 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 colors, 128X 160 Pixels, 2.0", SIM support : Smart, Dual SIM, Dual stand by (both GSM), Battery type : Li-Ion 1000m AH C PI 208 MHz, Sound : Speaker and Earphone Jack (3.5 mm) On board sections : Keypad, Dual SIM, Charging. Circuit, Clock, User interface link such as Buzzer, Vibrator, LEDs. Test points: 50 nos. (Gold plated) Features that can be set : Screen savers, Ring tones, Logos, SMS	1,2 to 8,
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 (DCS 1800)	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 1 Hz, 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 (³ A 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 : $\pm 3\%$ Input Impedance : 1 M Ω 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	2 to 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	2 to 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

7. 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	3a. Describe with relevant sketch the architecture of the given 3G cellular standard. 3b. Explain features, of the given	3.1 Global System for Mobile Communication (GSM): Features and service, GSM radio

Standards	mobile communication standard. 3c. Describe with relevant sketch call 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.	aspects, GSM architecture GSM channel types, security aspects. 3.2 GSM call routing, mobile terminated, call and mobile 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'

8. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total
			Level	Level	Level	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:

- Visit nearby MTNL/BSNL exchange and prepare detail report of entire setup of their cellular system.
- Visit nearby CDMA based cellular switching center and prepare details of the entire setup of their cellular system
- Demonstrate the general steps to repair Mobile handset.
- Prepare a detail list of equipment and software required to troubleshoot the mobile handset.
- Interpret the IS code 15040:2010 C1SPR 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:

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- '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.
- 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).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- Guide student(s) in undertaking micro-projects.
- Correlate subtopics with Electronics communication and Digital communication (like: modulation, wave propagation, Frequency modulation, multiplexing).
- 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 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. The concerned faculty could add similar micro-projects:

- Compare the specifications/ features / technology of different types of mobile phones available in the market (Min 12 specifications).
- Collect the information regarding the special services provided by various mobile service providers (Min 4) in your area.
- Prepare a report on TRA1 regulations related to mobile communication.(spectrum allocation)
- Prepare a report on FCC regulations for spectrum allocation/interference/ Qos for mobile communication.
- Prepare a brief report on how radiations from BTS and handsets affect Human beings.
- Market survey on various wireless devices available in the market.(wireless hands free, wireless speaker, wireless charger)
- Prepare a short report on Li-Fi (light fidelity) technology.
- 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 hnrich	John Wiley& sons, New E^Sf.2001 ISBN : 978-81 -265-15 Mffi/...

14. SOFTWARE/LEARNING WEBSITES

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- a. eBook:- www.philadelphia.edu.jo/newlibrary/.../file101fc6e5c7
- 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/bluetoothoverview.php
- e. Vol ,TE> / 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-1 g-to-2g-to-3g-](https://www.qualcomm.com/..../the-evolution-of-mobile-technologies-1-g-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_mTZxPofl
- j. TRAI official website: www.trai.gov.in/

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Industrial Automation
Course Code : 21D55

1. RATIONALE

Automation is playing a key role in Industries. Industries rely heavily on automation for economic viability and mass production. It is important for the students to learn basic of automation, how system works and importance of PLC, SCADA and robots in automation. This course will provide opportunity to learn industrial automation techniques.

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:

- Understand various automation components and systems.
- Use programmable logic controllers for industrial automation.
- Integrate SCADA with PLC systems.
- Explain architecture of industrial automation system.
- Explain fundamentals of process control.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P))	Examination Scheme													
L	T	P		Theory								Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Min	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	15	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. SUGGESTED PRACTICALS/ EXERCISES

The practical's 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:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs.
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			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 output system.	II	02
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.		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

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

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Work as a leader/a team member.
- Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

6. 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, stepper 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 (% 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

7. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the 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
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DEPM V	SEMESTER	
Unit- I Introduction to Industrial Automation	1 a. 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	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 for the given industrial application.	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 example using ladder logic: Lan based on relay, timer counterlogical, 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'

8. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total
			Level	Level	Level	Marks
I	Introduction to Industrial Automation	04	02	04	-	06
II	PLC Fundamentals	12	04	06	08	18
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 (o f R, U and A) in the question paper may vary from above table.

9. 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:

- 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.
- Refer operating manual of the PLCs of reputed Manufactures and prepare a step-by-step procedure to use PLC for the specified application.
- Prepare a Power point presentation on the troubleshooting techniques of PLC.
- Prepare the safety precautions list to be followed for installation of PLC system.
- Download animated videos from the internet for any theory topic and make presentation on it.
- Prepare a list of available analog input /output devices, digital input /output devices available in the market.
- Guide the students for steps to be followed to configure available SCADA software.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- '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.
- 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).
- With respect to item No. 9, teachers need to ensure to create opportunities an_£ provisions for *co-curricular activities*.
- Guide student(s) in undertaking micro-projects.
- Students can participate in the online industrial automation forums.
-

11. 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.

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

12. 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	Petrusella, 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 Delhi (4 th edition) ISBN: 978-1936007097
6	Programmable logic controllers	Hackworth, John; Hackworth. Federic	PHI Learning, New Delhi 2003 : ISBN : 978013060
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

- Software:- www.fossee.com
- Software:- www.logixpro.com
- Software:- www.plctutor.com
- Software;- www.ellipse.com
- PLC lecture:- <https://www.youtube.com/watch?v=pPiXEFB02qo>
- PLC tutorial:- http://users.isr.ist.utl.pt/~jag/aulas/apil3/docs/API_I_C3_3_ST.pdf

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Principle of Industrial IoT
Course Code : 21D56

1. RATIONALE

The Industrial Internet of Things (IIoT) refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. This connectivity allows for data collection, exchange, and analysis, potentially facilitating improvements in productivity and efficiency as well as other economic benefits. The IIoT is an evolution of a distributed control system (DCS) that allows for a higher degree of automation by using cloud computing to refine and optimize the process controls. The IIoT is enabled by technologies such as cybersecurity, cloud computing, edge computing, mobile technologies, machine-to-machine, 3D printing, advanced robotics, big data, internet of things, RFID technology, and cognitive computing.

2. COMPETENCY

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

- Design & Development of Industrial IoT 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:

- To understand about various application areas of IOT.
- To understand the architecture, operation and IoT advantages.
- Explore the relationship between IoT, cloud computing, and big data.
- To understand network building blocks of Internet of Things and characteristics.
- To Design and develop the IoT systems using various wireless communication protocols.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory								Practical				Grand Total
				Paper Hrs.	ESE		PA		Total		ESE		PA			
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
3		2	5	3	70	28	30	15	100	40	25	10	25	10	150	

(*): 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 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. SUGGESTED PRACTICALS/ EXERCISES

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

Sr. No.	PRACTICALS	Unit No.	Approx. Hrs. Required
1	To understand the basic operation of IC with TinkerCad I. To verify the function tables of CD4027 and CD4081 ICs II. 2. Illustrate the pin configuration and verify the truth table of IC 74HC08. III. Illustrate the pin configuration and verify the truth table of IC 74HC73.	V	2
2	To understand arduino programming by RGB interfacing LED I. Write a program to blink single LED. II. Write a program to control LED using switch program III. Write a program to blink RGB LED. IV. Write a program to blink RGB LED.	IV	2
3	To interface temperature sensor and display readings on LCD I. Write a program to display “NIELIT AUR” Word on LCD. II. Write a program to display Temperature sensor data on serial monitor	IV	2
4	To understand interfacing motion sensor and 7 segment display I. Write a program to display numbers on 7 segment display. II. Write a program to use PIR Sensor.	IV	2
5	Interfacing 4 x 4 matrix keypad and display information on suitable display devices.	II	2
6	Familiarization with setting up of Raspberry Pi board with OS and configuring the system.	II	2
7	Working with GPIO Pins and blink an LED.	II	2
8	Writing Python program to blink an LED.	II	2
9	Interfacing DHT11 sensor and Reading Temperature, humidity data and display them using python.	II	2
10	Developing web interface using python Bottle.	V	2
11	Measuring Distance with using with with infrared (IC 74HC73) and Ultra sonic sensor	V	2

12	To control motor using Arduino and Transistor.	V	2
13	Publish DHT11 data onto the cloud and subscribe it using Raspberry PI	V	2
14	Case Studies	I-IV	2
Total			28

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 judicious mix of minimum 12 or more practical need to be performed, out of which, the practical's 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:

Sr. No.	Performance Indicator	Weightage in %
1	Selection of suitable component, apparatus/instrument	20
2	Preparation of experimental set up:	10
3	Setting and operation	10
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	Submission of report in time	10
TOTAL		100

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

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.
- 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.

6. 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.

Sr. No	Equipment Name with Broad Specifications	Pro. s.no.
1	ARM Cortex M4 board from STM Electronics: STM32RBT6 Board, Raspberry pi-3 model B-64 Quad Core 1.2 GHz arm ,CPU with Wifi and Bluetooth, Arduino UNO, Xbee Module, Xbee Explorer, Xbee shield V03 Module wireless control for Xbee Zigbee Arduino, LoRa Module for Arduino, Raspberry pi and Intel Galileo-868, 37 in 1 Sensor Module Kit for Arduino and Raspberry pi and MCU, Ethernet W5100 Shield network expansion board W/Micro SD card Slot for Arduino, ESP 8266 ESP-12E UART WIFI Wireless shield TTL Converter for Arduino UN0R3 Meg, SIM900 GPRS/GSM Development Extension board shield quad band kit for Arduino, Keil MDK-PLUS-ED10 software: MDK-ARM microcontroller development kit – 10 user license	All
2	Cathode Ray Oscilloscope Dual Trace 20Mhz, 1Mega ohm Input Impedance , Digital Oscilloscope. Function Generator 0-2 MHz with Sine, square and triangular output with variable frequency and amplitude	6,7,8,9,10
3	PC , Laptop , Internet & Cell Phone .	1,2,3,4,5
4	Digital Multimeter: 3 1/2-digit display, .19999 counts digitalmultimeter measures: Vac, Vdc (1000V max). Adc.), Resistance (0 - 100 MQ), Capacitance and Temperature measurement	6,7,8,9,10
5	Connecting wires , male connectors , female connectors, A to B usb cables , HDMI cables , Relay Boards , Switches , LED , RGB , Pi camera.	6,7,8,9,10
6	Electronic Work Bench: Bread Board 840 -1000 contact points: Positive and Negative power rails on opposite side of the board , 0-30 V, 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO: 0-30 MHz, Digital Multimeter	6,7,8,9,10

7. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) in cognitive domain)	Topics and Sub-topics
Unit - I Introducti on to Internet of Things	1a. Describe the principle of the IoT characteristics. 1b. Describe IoT Networks 1c. Describe Various emerging technology. 1d. Describe various IoT protocols	1.1 Definition and characteristics of IoT, Physical design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT functional blocks, IoT communication Models, IoT communication API's 1.2 IoT enabling Technologies Wireless sensor networks, Cloud Computing, Big Data Analytics, Communication protocols, embedded systems. 1.3IoT Levels and Deployment templates – IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4,IoT Level-5, IoT Level-6
Unit- II Domain specific IoT	2a. Describe the working principal of Home automation. 2b Describe the Smart parking , Smart lighting and Health monitoring application using internet 2c. Describe the difference between traditional and conventional IoT difference with help of emerging technology 2d. Describe agriculture based IoT applications.	2.1 Introduction, Home automation- Smart lighting, smart appliances, intrusion detection, smoke for gas detectors; Cities- Smart Parking, Smart lighting, Smart Roads, Structural Health Monitoring, surveillance, Emergency Response; 2.2 Environment- Weather monitoring, air pollution monitoring, noise pollution monitoring, forest fire detection, river flood's detection; Energy- Smart grids, renewable energy systems, prognostics; Retail- Inventory management, smart payments, smart vending machines; Logistics- Route generation and scheduling, Fleet tracking, Shipment monitoring, Remote vehicle diagnostics; 2.3 Agriculture- Smart Irrigation, Green house control; Industry- Machine diagnosis and prognosis, indoor air Quality Monitoring; Health and Life Style- Health and fitness monitoring, Wearable electronics.
Unit- III Internet protocols	3a. Describe the working principle of internet 3b. Describe the working principle of Business case for IP 3c. Justify the various IoT application protocols 3d. Describe the IoT based various Compliances and its profiles.	3.1 The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances 3.2 IP as the IoT Network Layer, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

Unit- IV IoT Data Analytics	4a. Analyze the data for various IoT application 4b. Explain the History of IoT security and common challenges 4c. Justify the use of emerging technology between various technology 4d. Analyze the network for various technology changes.	4.1 Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, 4.2 Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of IOT Security, Common Challenges in OT Security 4.3 How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment
Unit- V IoT Physical Devices and Endpoints	5a. Describe working of various board used for IoT application , 5b. Describe the Embedded system used for IoT 5c. Design and develop the various IoT devices. 5d. Describe the various sensor used in the Embedded system and IOT	5.1 IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. 5.2 IoT Physical Devices and Endpoints – RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi with Python, 5.3 Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to RaspberryPi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture

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.

8.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 Internet of Things	8	3	4	6	13
II	Domain specific IoT	10	3	5	6	14
III	Machine to Machine Networking	10	4	5	6	15
IV	IoT Data Analytics	10	4	4	6	14
V	IoT Physical Devices and Endpoints	10	4	4	6	14
Total		48	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 leachers 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.

9. 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 course (MOOCs) may be used to teach various topics/subtopics.
- b) in item No. 4 does not mean only the traditional lecture method, but differenttypes 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.8, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- e) Guide student(s) in undertaking micro-projects.
- f) Use PPTs to explain the construction and working of rectifier.
- g) Use PPTs to explain the construction and working of wave shaping circuits.
- h) Guide students for using data manuals.

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 portfolio which will be useful for their placement interviews:

- a) Prepare detailed safety and measures of using Arduino board Rasberry Pi boards.
- b) Prepare journals based on practical performed in laboratory.
- c) Prepare library/internet/physical survey report of two current IoT use cases in India.
- d) Prepare Power point presentation or animation for understanding IoT architecture.
- e) List a report on any available app for reading and listening while taking scan of a document.
Suggest 5 points for improvements in the report.
- f) Suggest an idea of any IoT solution to replace an existing manual system describing the pros and cons f both the systems.

11. SUGGESTED MICRO PROJECTS:

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the year. In the first two years, the micro project is the

group-based. In the third year, 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 student will have to maintain a 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.

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

- a) Prepare a report on existing automation in an industry and suggest improvements.
- b) Prepare a report on Smart City.
- c) Build arduino based project for smart home.
- d) Build arduino based project for smart city.
- e) Prepare a report on Smart City surveillance systems.
- f) Prepare a report on systems in Disaster Management.
- g) Present a power point presentation on upcoming 5G technology.
- h) Prepare a report on automatic electronic components assembly machines.
- i) Conduct a survey and prepare a report on various EDA tools.
- j) Prepare an application report on AR and VR technologies.
- k) Prepare a report on Artificial Intelligence.
- l) Prepare a report on Machine Learning.
- Prepare a report on electronic home security system.
- m) Prepare report on fire and gas deluge systems.
- n) Prepare report on ATM security systems.

12. SUGGESTED LEARNING RESOURCES:

S No	Title of Book	Author	Publication
1	Sustainable Smart Cities in India: Challenges and Future Perspectives	Poonam Sharma, Swati Rajput	Spinger ISBN 978-3-319-47145-7
2	IoT Fundamentals: Networking Technologies, protocols and use cases for IoT	David Hanes, Gonzalo Salguein	Cisco Press ISBN 13:978-1-58714-456-1
3	Raspberry Pi Cookbook	Dr Simon Monk	ISBN: 978-1-491-93910-9
4	Arduino Development cookbook	Cornel Amariei	ISBN 978-1-78398-294-3
5	Internet of Things: Do-it-Yourself projects with Arduino, Raspberry Pi and BeagleBone Black	Donald Norris	ISBN: 978-0-07-183521-3

13. SUGGESTED SOFTWARE LEARNING WEBSITES:

Sl No	Theory topic/subtopic	Website
1	Unit - I Introduction to Internet of Things	https://profile.iiita.ac.in/bibhas.ghoshal/IoT_2019/Lecture_Slides/Chapter-1_Introduction.pdf
2	Unit - I Introduction to Internet of Things	http://www.hands-on-books-series.com/iot.html
3	Unit - I Introduction to Internet of Things	https://www.hindawi.com/journals/jece/2017/9324035/
4	Unit- II Domain specific IoT	https://www.ulectzbooks.com/books/uLektz-Learning-Solutions-Private-Limited/INTERNET-OF-THINGS-MTExNQ
5	Unit- IV IoT Data Analytics	https://www.hindawi.com/journals/jece/2017/9324035/
6	Unit- IV IoT Data Analytics	file:///C:/Users/Th%20Sunilkumar/Downloads/COMPNW6240_RevisedFile%20(1).pdf
7	Unit- V IoT Physical Devices and Endpoints	https://www.researchgate.net/publication/317617290_The_role_of_big_data_analytics_in_Internet_of_Things
8	Unit- V IoT Physical Devices and Endpoints	https://www.raspberrypi.org/
9	Unit- V IoT Physical Devices and Endpoints	https://www.arduino.cc/

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Printed Circuit board-I
Course Code : 21D57

1. RATIONALE

The Printed Circuit Board (PCB) is very important in all electronic gadgets, which are used either for domestic use, or for industrial purpose. PCBs are the core component in almost all the electronic gadgets including the cell phones and the computers and laptops. PCB as a subject not only enables students to make their own schematics but also, they can fabricate their own PCB by generating their own documents required for fabrication. After completion of this course students can design and fabricate their own PCB.

2. COMPETENCY

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

- **Design and fabricate of PCB**

3. COURSE OUTCOMES

The theory, practical experiences and relevant documents 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:

- Students will acquire the basic level knowledge. and will understand the packages of Electronic components, types of PCBs and history of PCBs.
- Will be able to prepare all the documents required for PCB design.
- Acquire the basic level knowledge required to understand Artwork & Film Master generation.
- Understand the methods of soldering of PCBs., material used in soldering process.
- Understand the component Assembly Techniques.

4. TEACHING AND EXAMINATION SCHEMES

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper His.	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*	15	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. 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	Design the current mirror circuit in schematic editor using Autodesk Eagle software and Run the operating point analysis simulation.	III	02*
2	Design the basic diode circuit in schematic editor using Autodesk Eagle software and Run the Transient Analysis simulation.	III	02*
3	Design the basic MOSFET circuit in schematic editor using Autodesk Eagle software and Run the DC Sweep Analysis simulation.	III	02*
4	Design the BJT Oscillator circuit in schematic editor using Autodesk eagle software and Run the Transient Analysis simulation.	III	02*
5	Create the library component resistor with the following dimensions and specifications using Autodesk EAGLE software.	I	02*
6	Create the library component for 555 timer IC with the given dimensions and specifications using Autodesk EAGLE Software.	I	02*
7	Create the library component for G5LE OMRON RELAY with the given dimensions and specifications using Autodesk EAGLE Software.	I	02*
8	Create the library component for NCP716B LDO with the given dimensions and specifications Autodesk EAGLE Software.	I	02*
9	Design the USB TO TTL/CMOS Programmer circuit using FTDI232 IC into schematic editor and draw the PCB layout for the same in Autodesk EAGLE software, run the Electrical Rule Check(ERC) in schematic editor.	II, IV	02*
10	Design the Astable Multivibrator circuit using 555 timer ic into schematic editor and draw the PCB layout for the same in Autodesk EAGLE software, generate BOM, netlist and run design rule check	II, IV	02*
11	Design the DC-TO-DC 5V Voltage regulator circuit using LM317 IC into schematic editor and draw the PCB layout for the same in Autodesk EAGLE software, generate gerber files for top electrical and bottom electrical.	II, IV	02*
12	To learn the process of generating files(HPGL, ISEL, Excellon) for CNC drilling and milling machine	II	02*
13	To learn the process of generating 3D files format and observe the DXF view.	II	02
14	Study the various format settings done in photoplotter machine. Learn about artwork generation software, the concept of importing PCB Gerber file and converting files to photoplotter format.	II	02

15	To learn the process of generating legends(silkscreen) for Top electrical/ bottom electrical (SSB) Or both (DSB).	II	02
Total			30

Note:

- A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each PrOs 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.	Designing the PCB and conclusion	20
f.	Answer to sample questions	10
g.	Submission of report on 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:

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

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

- 'Valuing Level' in 1st year
- 'Organizing Level" in 2nd year
- 'Characterizing Level' in 3rd year

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Namewith Broad Specifications	PrO.S. No.
1	Digital Multimeter with R, V, I measurements, diode and BJT testing.	1 to 4
2	CRO : Dual Channel, 4Trace CRT / TFT based Bandwidth 20 MHz/30 MHz XIO magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	1to 4
3	Adjustable dual channel DC power supply (0-30V)	1 to 4
4	PCB design software/EDA tool(any).	All
5	Photoplotter machine ^(A)	14

6	Photo films for film master generation ^(^)	14
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Note: For equipment with (^) requires Dark room for proper development of film.

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 and overview of printed circuit board design	1a. Define types of PCB 1b. Define standards for PCB design 1c. Define various applications of PCB 1d. Select proper semiconductor packages. 1e. Able to understand the use of Grid and scaling 1f. Understand layout considerations. 1d. Able to make manufacturing documents	1.1 History & Definition of printed circuit board design. 1.2 Classification of PCBS- SSB, DSB (PTH & Non PTH), Multilayer PCB. 1.3 Application of various PCBs, 1.4 Introduction to Semiconductor Packing Technology, Role of scale & Grid in PCB design, PCB mounting method and PCB standards, 1.5 Layout Considerations-Land Requirement, Layout Methodology, 1.6 Design Elements & Performance Parameters, 1.7 Manufacturing Documentation like role of Block Diagram, Schematic drawing, Netlist generation Assembly Drawing, Mechanical Drawing.
Unit- II Layout Planning, Artwork and Film master generation	2a. Define electrical considerations 2b. Define how to provide thermal and heat sink in PCB design 2c. Learn how to lay components on PCB and how to save space on PCB. 2d. Define useful standards for layout planning 2e. Perform Layout design check. 2e. Understand how to design artwork 2f. Understand tape laydown techniques. 2g. Acquire the knowledge of importance of spacing in PCB 2h. Define diameter for holes and solder pads 2i. Will be able to check self-made art works 2j. Able to differentiate between various types of film masters. 2k. Will be able to select proper film.	2.1 Electrical Design Considerations - Resistance in general, Capacitance in general, Inductance of Conductor and Conductor Pattern, 2.2 Component placement approach with respect to conductor width, conductor shapes, 2.3 Thermal Consideration, Mounting consideration, requirement of heat sink, 2.4 Layout check with respect to mechanical and electrical consideration, Layout Methodology, 2.5 Layout Design Checklist and inspection, Useful standards. 2.6 Artwork approach and design guidelines for SSB & DSB design 2.7 Artwork Preparation Methods-Taping UP: Laying down the tapes and drafting material using appropriate

	2l. Will be able to use reprographic camera. 2m. Understand how to find faults in film master.	methods, 2.8 Design Guidelines for Artwork Preparation - Conductor Orientation, Conductor, Routing, Spacing .Importance of hole diameter and solder Pad diameter, Advance methods of Artwork generation, 2.9 Artwork Inspection and checks. 2.10 Introduction parameters of Photographic film like film emulsions, dimensional stability of film master, types of films. 2.11 Types of Reprographic Cameras, Dark Room setup and procedure of film processing, Film Registration, Faults related to film processing and remedies.
Unit-III Design rules For PCBs	3a. Learn to design analog circuits. 3b. Understand how to do proper layout in analog circuits. 3c. Acquire the importance of grounding. 3d. Understand rules for analog PCB design. 3e. Understand various issues in digital circuit design. 3f. understand various design rules for digital circuits. 3g. Learn to divide power circuits into high power and low power. 3h. Understand selection of copper clad laminate for power PCB. 3i. Understand calculation of track width for power PCB 3j. Able to apply thermal considerations.	3.1 Design rule for High frequency amplifiers & oscillators. 3.2 Design rule for Multistage amplifiers with high power o/p stage, 3.3 Design rule for feed-back amplifier. 3.4 Design rule for differential amplifier. 3.5 Supply and ground line conductors' considerations. 3.6 Design rules for TTL, CMOS & ECL circuits. 3.7 Reflection and Crosstalk, Ground to supply noise, E.M. Interference, 3.8 Problems in design & recommendations . 3.9 Dividing Circuit into High and Low Power Parts. 3.10 Copper Clad Laminates 3.11 PCB Terminal Connections & their Assembly. 3.12 Conductor Width & Thermal Consideration
Unit-IV Automation in PCB Design	4a. Able to handle various CAD tools. 4b. Learn to generate various documents using cad tools. 4c. Learn component placement using EDA tools. 4d. Understand how to route. 4e. Understand to make artwork in EDA tool.	4.1 Limitation of Manual Designing. 4.2 Introduction to various EDA tools, CAD operation, Schematic Capture & Layout. 4.3 Automation in component Placements, Routing Assignments and routing Procedures, 4.4 Post process and Gerber data generation,

DEPM V	SEMESTER	
	4f. Learn to generate Gerber files for film master generation.	4.5 Design rules check 4.6 Generation of film master using photoplotter, data transfer mechanisms.
Unit-V Design with Multi- layer Boards and Flexible PCB.	5a. Understand the different types of vias in Multilayer PCB. 5b. Understand the fabrication process of multilayer PCB. 5c. Understand useful standards in PCB 5d. Understand flexible PCB. 5e. Understand to manufacture flexible PCB. 5f. Understand design rules for Rigid and flex PCB. 5g. Learn the importance of flexible PCB. 5h. Learn how to use stencils for SMD component mounting. 5i. Learn how to solder SMD components. 5j. Understand the repair and rework of SMD components. 5k. Understand the advantages of SMT technology.	5.1 Techniques - PTH,Buried and blind via. 5.2 Materials for Multi- Layer boards 5.3 Mechanical & Electrical Design consideration for Multi-Layer Boards 5.4 Fabrication Process for Multi-Layer Boards. 5.5 Useful Standards for Multi-layer PCBs 5.6 Construction of Flexible PCBs - Types of films, Foils & Adhesives, 5.7 Design considerations for Flexible Circuits 5.8 Manufacture of Flexible Circuits, 5.9 Rigid Flex Printed Circuits Boards. 5.10 Advantages of Flexible Circuits 5.11 Special Applications of Flexible Circuits, 5.12 Stencil Printing of SMD. 5.13 Industrial SMT Assembly Process, 5.14 SMD Soldering - Manual and Reflow Soldering Techniques. 5.15 Repair and Rework of SMDs. 5.15 Advantages and Limitations of SMT.
Unit-VI PCB Technology Trends,Quality, Environmental Concerns in PCB Industry	6a. Learn the new trends in PCB design. 6b. Learn additive and semi additive process in PCB. 6c. Understand various quality standards in PCB design 6d. Understand various testing methods for PCB. 6e. Learn about various pollutants. 6f. Understand to recycle water and reuse it. 6g. Understand proper disposal of chemicals in PCB industry. 6h. Understand lead free soldering techniques.	6.1 Fine Line Conductor with Ultra - Thin Copper Foil, 6.2 Multi Wire Board 6.3 Metal Core PCBs 6.4 Additive and Semi additive Process, Mechanical Milling of PCBs. 6.5 Quality Assurance in PCB. 6.6 Testing for Quality Control Methods 6.7 Testing for Printed Circuits Boards. 6.8 Reliability Testing 6.9 Acceptability of PCBs 6.10 Useful Standards 6.11 Pollution Control in PCB Industry, Polluting Agents, 6.12 Recycling of water, Recovery Techniques, Air pollution. 6.13 Recycling of Printed Circuit Board,

		6.14 Environmental Standards: Safely Precaution for the Personal, Toxic Chemicals in PCB Fabrication, Lead - free Soldering, 6.15 Useful Standards.
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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 and overview of printed circuit board design	4	03	3	4	10
II	Layout Planning, Artwork and Film master generation	10	03	4	4	11
III	Design rules For PCBs	10	03	4	6	13
IV	Automation in PCB Design	8	03	3	6	12
V	Design with Multi- layer Boards and Flexible PCB.	10	03	4	6	13
VI	PCB Technology Trends Quality, Environmental Concerns in PCB Industry	06	03	4	4	11
Total		48	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 (he 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:

- Prepare the survey report on the applications of PCB.
- Compare technical specifications and applications of various types of electrical and electronics components
- Test various components for their values using Digital multimeter etc.
- Give seminar on any relevant topic.
- Conduct library / internet survey regarding different data sheet and manuals.

- f. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- '**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.
- 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).
- With respect to item No. 10, teacher need to ensure create opportunities and provisions for **co-curricular activities**.
- Guide student(s) in undertaking micro-projects.
- PPTs/Animations may be used to explain the relevant topics.
- Guide students for using data sheets / manuals for relevant 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 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. Micro project report may be of four to five pages.

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

- Design and develop circuit for Automatic night lamp.
- Design and develop rain drop detector circuit.
- Water level indicator
- Develop a PCB based on 555 timer circuit
- Design and fabricate Power supply circuit(5v).
- USB mobile charger circuit.

13. SUGGESTED LEARNING RESOURCES

S.No	Title of Book	Author	Publication
1	Printed Circuit Boards: Design and Technology	Walter C Bosshart	Tata McGraw-hill ISBN-13:978-07-451549-5
2	Printed Circuit Boards: Design,	RS Khandpur	Tata McGraw-hill 1st edition (1 July 2017)

	Fabrication, Assembly & Testing		ISBN-13 : 978-0070588141
3	Printed Circuit Boards	Coombs Clyde F.	McGraw- hill
4	The Design & Drafting of Analog Printed Circuits Board	Darryl Lindsey	Bishop Graphics Inc
5	Printed Circuit Boards: Design Techniques For EMC Compliance	Montrose Mark I	IEEE Press Series of Electronics Technology

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <https://www.autodesk.com/solutions/pcb-design-software>
- b. <https://learn.sparkfun.com/tutorials/pcb-basics/all>
- c. <https://easyeda.com/>
- d. <https://circuitmaker.com/>
- e. <https://resources.altium.com/p/10-easy-steps-comprehensively-designing-circuit-board-altium-designer>
- f. <https://www.electronicdesign.com/technologies/embedded-revolution/article/21798594/the-engineers-guide-to-highquality-pcb-design>
- g. <https://circuitdigest.com/diy-pcb-projects>
- h. https://www.cadence.com/ko_KR/home/tools/pcb-design-and-analysis.html
- i. <https://www.pcbcart.com/article/content/PCB-introduction.html>
- j. <https://kicad.org/>
- k. <https://saturnpcb.com/>

Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Fifth
Course Title : Capstone Project – Planning
Course Code : 21D59

1. RATIONALE

According to the requirement of National Board of Accreditation (NBA), 'learning to learn' is an important Graduate Attribute (GA No. 11). It is required to develop this skill in the students so that they continue to acquire on their own new knowledge and skills from different 'on the job experiences' during their career in industry. An educational 'project' 'just does that and may be defined as 'a purposeful student activity, planned, designed and performed by a student or group of students to solve/ complete the identified problem/task, which require students to integrate the various skills acquired over a period to accomplish higher level cognitive and affective domain outcomes and sometimes the psychomotor domain outcomes as well'. Projects mainly serve this purpose of developing learning-to-learn skills with an aim to develop the following attributes in the students:

- a) Initiative, confidence and ability to tackle new problems
- b) Spirit of enquiry
- c) Creativity and innovativeness
- d) Planning and decision-making skills
- e) Ability to work in a team and to lead a team
- f) Ability of self-directed learning which is required for lifelong learning
- g) Persistence (habit of not giving up quickly and trying different solutions in case of momentary failures, till success is achieved)
- h) Resourcefulness
- i) Habit of keeping proper records of events and to present a formal comprehensive report of their work.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

• **Plan innovative/creative solutions independently and/or collaboratively to integrate various competencies acquired during the semesters to solve/complete the identified problems/task/shortcomings faced by industry/user related to the concerned occupation.**

3. COURSE OUTCOMES (COs)

The following could be some of the major course outcomes depending upon the nature of the projects undertaken. However, in case of some projects few of the following course outcomes may not be applicable.

- a) Write the problem/task specification in existing systems related to the occupation.
- b) Select, collect and use required information/knowledge to solve the problem/complete the task.
- c) Logically choose relevant possible solution(s).
- d) Consider the ethical issues related to the project (if there are any).
- e) Assess the impact of the project on society (if there is any).
- f) Prepare 'project proposals' with action plan and time duration scientifically, before; beginning of project.
- g) Communicate effectively and confidently as a member and leader of team.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
L	T	P		Theory								Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
-	-	3	3	-	-	-	-	-	-	-	25 @	10	25	10	50	20	

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

5. Capstones Project

One of the dictionary meaning is the 'crown' or the stone placed on top of the building structure like 'kalash on top of Temples and Mosques' or 'Cross on top of churches. Capstone projects are culminating experiences in which students synthesize the competencies acquired over whole programmed. In some cases, they also integrate cross-disciplinary knowledge. Thus, Capstone projects prepare students for entry into a career and can be described as a 'rite of passage' or 'minimal threshold' through which participants change their status from student to graduate. A capstone project therefore should serve as a synthesis — reflection and integration— to bridge the real-world preparatory experience to real life. Thus, capstone project should have emphasis on integration, experiential learning, and real-world problem solving and hence these projects are very important for students. To develop the highly essential industry-oriented skills and competencies in the students, the capstone projects are offered in the last two semesters to serve for following purposes:

- Integrate the competencies acquired by the students in the previous and current semesters.
- Provide opportunities for interdisciplinary work in tackling problems likely to be faced by them in industry which are exciting and challenging.

6. Capstone Project Planning

Students are supposed to find out a suitable project and prepare a detailed plan in fifth semester so that it can be executed smoothly in sixth semester. The main characteristic of any project whether small or big is that it requires simultaneous application of various types of skills in the different domains of learning. Moreover, project normally do not have a predefined single solution, in other words for the same problem different students may come up with different but acceptable solutions. Further, in the process of arriving at a particular solution, the student must be required to make a number of decisions after scrutiny of the information s/he has accumulated from experiments, analysis, survey and other sources.

The projects will have a detailed project proposal, which must be executed or implemented within the time allocated, simultaneously maintaining a logbook periodically monitored by the teacher. A detailed project report is to be prepared as project progresses, which has to be submitted after the project is over. For self-assessment and reflection students have to also prepare a portfolio of learning.

During the guidance and supervision of the project work, teachers should ensure that students acquire following learning outcomes (depending upon the nature of the project work some of these learning outcomes may not be applicable):

- Show the attitude of enquiry.
- Identify the problems in the area related to their programme.
- Identify the information suggesting the cause of the problem and possible solution,
- Assess the feasibility of different solutions and the financial implications.
- Collect relevant data from different sources (books/internet/market/suppliers/experts etc. through surveys/interviews).

V

- f) Prepare required drawings and detailed plan for execution of the work.
- g) Work persistently and participate effectively in group work to achieve the targets.
- h) Work independently for the individual responsibility undertaken.
- i) Ask for help from others including guide, when required.
- j) Prepare portfolio to reflect (chintan-manan) on experiences during project work,
- k) Prepare seminar presentations to present findings/features of the project.
- l) Confidently answer the questions asked about the project,
- m) Acknowledge the help rendered by others in success of the project.

If students are able to acquire these learning outcomes, then they would be able to acquire the COs as discussed in section 3.

7. Scopes of Projects

Scope of the project work should be decided based on following criteria:

- a) **Relation to diploma programme curriculum:** When students intend to select topics for the project work, they need to choose a project which relates well to their curriculum (It may be beyond curriculum, but it should relate to it) and requires implementation of theories already learnt and skills already possessed by them from the previous semesters.
- b) **Abilities possessed by the group of students:** Projects should be chosen so that it can be completed mainly using students' problem-solving capabilities and depth of learning. It is natural that highly motivated students or high achievers may come out with projects which are more complex and challenging. Teachers should guide students to choose challenging projects according to the students' ability.
- c) **Resources Available:** Students and Guides should keep in mind the availability of resources while deciding the topic and the scope of the project. Some of the important resources which need consideration are:
 - i. Time available
 - ii. Raw Material/Components required
 - iii. Manufacturing/Fabrication equipment and tools required
 - iv. Testing/Measuring equipment and instruments required
 - v. Access to Journals (Library/Digital)
 - vi. Expertise for theoretical guidance (available in polytechnic, nearby institutes or nearby industries)
 - vii. Expertise and technology required for fabrication (if required)
 - viii. Software required.

An important aspect to be considered is to decide who will choose a project. The best practice is that teacher should guide students about the above factors to be considered for choosing the project and based on these factors' students should do the ground work and identify the possible projects and teachers should work as only facilitator and Guide in final selection of the project title and its scope.

d) Suggested Type of Capstone Projects In general, the projects that the students can take up could be of the following types;

- i. Feasibility studies.
- ii. Design projects
- iii. Market surveys about raw material, components or finished products.
- iv. Prototype (design, make, test and evaluate).
- v. Advanced experimental work requiring the development of existing equipment to be used and developed.
- vi. Field works: This could include surveys, using equipment, charting data and information from visual observation.

V

- vii. Comparative Studies: Theoretical study of two systems/mechanisms/ processes in detail and comparing them on the basis of cost/energy conservation/impact on environment/technology used etc.
- viii. Application of Emerging technology: Theoretical study of some emerging technology and feasibility of its application in some real-life situation in detail.
- ix. Fabrication of some equipment/machine etc.
- x. Construction of some structure.
- xi. Development of software or use of software for solving some broad-based problem.

8. GUIDELINES FOR UNDERTAKING A PROJECT

The selection of the Capstone Project title must have emphasis to the Elective courses/ Elective Group taken for the study and exam for 5th and 6th semester. The students will then work on the identified problem/task through a rigorous process of understanding and analyzing the problem, conducting a literature search, deriving, discussing (monitored by the guide every fortnight) and designing the Semester V 'Project Proposal' with the following sub-titles:

- a) Rationale (one page)
- b) Introduction
- c) Literature Survey
- d) Problem Definition
- e) Proposed Methodology of solving Identified problem
- f) In-case some prototype has to be fabricated then its tentative design and procedure for making it should be part of the proposal.
- g) Resources and consumables required.
- h) Action Plan (sequential list of activities with probable dates of completion)

As soon as the 'Project Proposal' is approved by the teacher, the student will begin to maintain a dated 'Project Logbook' for the whole semester. This is a sort of a 'weekly diary' indicating all the activities conducted by the student every week in the semester to complete the project. This 'project logbook' should be got signed by the teacher at regular intervals for progressive assessment to match the project proposal. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the 'Project Report' at the end of the semester by him/her.

9. PORTFOLIO FOR SELF-DIRECTED LEARNING

To ensure that students acquire these outcomes, students should also be guided to prepare a '**Portfolio**', so that they may reflect on their weaknesses/mistakes and learn from them. **Students should also be encouraged to discuss with their guide and record not only technical problems but also problems related to group work, planning, execution, leadership in the team etc., so that students can also identify their weaknesses in affective domain and take remedial actions to overcome the same.** If they wish, the students can also show their portfolio to their teachers (whom they trust) for obtaining teachers' comments on their reflection for pointing out their mistakes so that they can improve their performance.

'**Portfolio**' is the record of the reflection (thinking or *chintan-manan*) on experiences to which students undergo during the different stages of the project. In a portfolio, students record their critical experiences and reflect (think or do *chintan-manan*) on them in writing. This process of reflecting on the experiences make them learn from their mistakes and build on their strengths. To help students in reflection, a Portfolio format with reflective prompts (simple thought-provoking questions) for different stages of the project is given as annexure B.

12.1 Purposes of Portfolio Preparation

Reflection by self is important since group work is so complex that it is difficult for teachers to appreciate the real problems amongst the students. In a portfolio, prompts (simple thought-provoking questions) are given to trigger reflection on different aspects of project work. Prompts help the students to ask questions from themselves regarding different aspects of the project work and interpersonal relationships. Process of answering these questions forces students to think about behavioral problems and possible remedies/solution to deal with those problems. Portfolio preparation therefore helps in reflection on building the strengths and elimination of the weaknesses of the students pertaining to following qualities which the industry also needs.

- a) Plan properly for execution of given work.
- b) Take appropriate decisions.
- c) Arrange resources.
- d) Work as member and leader of team.
- e) Communicate properly.
- f) Resolve the conflicts.
- g) Manage the time well.
- h) Have concern for ethical, societal and environmental issues.
- i) Learn-to-learn from experiences.

It may be seen that these qualities are not directly related with the theoretical subject knowledge and can be developed only through real life experiences. Project work is one such type of experience where opportunity is available to develop all these qualities.

However, even during project work, emphasis of most of the students and teachers remains on development of the technical knowledge and skills while development of above qualities is neglected. Students can develop these qualities if they reflect (do thinking or *Chintan-Manan*) on their experiences from the point of view of these qualities and find out their own weaknesses and strengths. Because if somebody wants to improve his/her abilities then first step for that person is to have self-awareness about his/her weaknesses and strengths.

Though portfolio preparation requires considerable time, it is essential, if we want to learn from the experiences and develop these qualities. Writing down reflections helps in better reflection as it is well known that when a person starts writing something, he/she becomes more cautious about his/her view and evaluate those views before writing. Thus, process of writing improves the quality of reflection or thinking. Moreover, if reflections on different stages of work are written down, over a period of time a large amount of reflection can be generated, and if this reflection is looked back, it may help in identifying some pattern of behavior in individual which may be improved or rectified latter on as per requirement.

12.2 Guidelines for Portfolio Preparation and assessment

The main purpose of portfolio preparation is learning based on self-assessment and **portfolio is not to be used for assessment in traditional sense.**

- a) Each student has to prepare his/her portfolio separately. However, he/she can discuss with the group members about certain issues on which he/she wants to write in the portfolio.
- b) For fifth semester and sixth semester, there will be only one portfolio but it will have two separate parts, first part for project planning (having two sections A and B) second part for project execution, (having two sections C and D)
- c) Whatever is written inside the **portfolio is never to be used for assessment**, because if teachers start giving marks based on whatever is written in the portfolio, then students would hesitate in true self-assessment and would not openly describe their own mistakes or shortcomings.

V

- d) Some marks are allocated for portfolio, these marks are to be given based on how sincerely portfolio has been prepared and not based on what strengths and weaknesses of the students are mentioned in the portfolio.
- e) Portfolio has to be returned back to the students after assessing it (assessment is only to see that whether portfolio is completed properly or not) by teachers. Because student is the real owner of the portfolio.
- f) Students mainly learn during portfolio preparation, but they can further learn if they read it after a gap. And hence they are supposed to keep the portfolios with them even after completion of the diploma because it is record of their own experiences (it is like diary some people write about their personal experiences), because they can read it again after some time and can revise their learning (about their own qualities)

Even after completion of Diploma programme, students can continue to prepare portfolio related to different experiences in their professional and personal life and by refereeing back to old portfolios after a gap of some years, they can learn that how their personality has evolved over the years. They can also see a pattern of behavior in their own personality which may be source of their weaknesses or strengths and they can take remedial measures based on this study of their portfolios. **Note** Since some sections of the portfolio are related with interpersonal relationships and student may find it difficult to write these experiences in English. Language should not be the barrier in reflection and hence students should be allowed to prepare the portfolio in their preferred language such as Marathi or Hindi if they find it difficult to write in English.

The amount and type of mistakes identified by students would not affect the marks received by the students. The total 7 Marks allocated for portfolio (4 marks for PA and 3 for ESE) are only for proper completion of the portfolio.

10. PROJECT REPORT

At the end of fifth Semester, the student will prepare a Semester V 'Project Report' with the following sub-titles:

- Certificate (in the Format given in this document as annexure A)
- Acknowledgements
- Abstract (in one paragraph not more than 150 words)
- Content Page
- Chapter-1 Introduction and background of the Industry or User based Problem
- Chapter-2 Literature Survey for Problem Identification and Specification,
- Chapter-3 Proposed Detailed Methodology of solving the identified problem with action plan
- References and Bibliography

Note: The report should contain relevant diagrams and figures, charts.

11. ASSESSMENT OF CAPSTONE PROJECT - PLANNING

Like other courses, assessment of Project work also has two components, first is progressive assessment, while another is end of the term assessment. The mentor faculty will undertake the progressive assessment to develop the COs in the students. They can give oral informal feedback about their performance and their interpersonal behavior while guiding them on their project work every week. The following characteristics/ qualities informally or formally should be considered during different phases of the project work which will be assessed thrice as discussed in sub-section.

(A) Initial Phase

i. Definition of the Problem

- a) Accuracy or specificity
- b) Appropriateness with reference to desired course outcomes.

V

ii. **Methodology of Conduction the Project**

- a) Appropriateness
- b) Flexibility
- c) Clarity

iii. **General Behavior**

- a) Initiative
- b) Resourcefulness
- c) Reasoning ability
- d) Imagination/creativity
- e) Self-reliance

(B) Intermediate Phasei. **Performance of Student**

- a) Ability to follow correct procedure
- b) Manipulative skills
- c) Ability to collect relevant information
- d) Ability to observe, record & interpret
- e) Ingenuity in the use of material and equipment
- f) Target achievement

ii. **General Behavior**

- a) Persistence
- b) Interest
- c) Commitment
- d) Confidence
- e) Problem solving ability
- f) Decision making ability
- g) Initiative to act
- h) Team spirit.
- i) Sharing of material etc.
- j) Participation in discussion
- k) Completion of individual responsibilities

(C) Final Phasei. **Quality of Product**

- a) Dimensions
- b) Shape
- c) Tolerance limits
- d) Cost effectiveness c)
- Marketability f) Modernity

ii. **Quality of Report**

- a) Clarity in presentation and organization
- b) Styles and language
- c) Quality of diagrams, drawings and graphs

- d) Accuracy of conclusion drawn
- e) Citing of cross references
- f) Suggestion for further research/project work

iii. Quality of presentation

- a) Understanding of concepts, design, methodology, results, implications^
- b) Communication skills
- c) Ability to draw conclusions and generalization

12. PROGRESSIVE ASSESSMENT (PA) GUIDELINES

15 Marks are allocated for the formal progressive assessment. However, following points need consideration during the three times of formal progressive assessment of the students at the end of 4TH, 12th and 14th week.

- a) **Fortnightly monitoring** by the mentoring teachers is necessary and marks given progressively (even the gradual chapter preparation) so that that students will not copy earlier reports or get things done or reports from the market. The **students should not be awarded marks** if they have not done on their own.
- b) For progressive assessment at the end of 14th week, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the capstone project work they have to carry out in future).
- c) Although marks for portfolio preparation is to be given at the end of 14th week, students should be asked to bring their partly prepared portfolio (relevant sections prepared) also during their assessment at the end of 4th week and 12th week.
- d) Marks for portfolio preparation should be based only on proper preparation of portfolio by writing answers to most of the prompts (self-questions to students) in the portfolio. These marks should not be based on the mistakes indicated by students in their working (while answering the prompts) and corrective actions taken by them.
- e) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)
- f) **Originality of the report** (written in own words) would be given more importance rather than use of glossy paper or multi-color printing.

12.1 Progressive Assessment (PA) Criteria

Allocation Criteria of the **25 marks** are for the Progressive Assessment (PA).

S.no.	Criteria	Marks
1	Problem Identification/Project Title (Innovation /Utility of the Project for industry/ User/Academia) marks to be also given based on (i) Accuracy or specificity of the scope and (ii) Appropriateness of the work with reference to desired course outcomes.	02
2	Industrial Survey and Literature Review: marks to be given based on extent/volume and quality of the survey of Industry / Society / Institutes/Literature/Internet for Problem Identification and possible solutions	02
3	General Behavior: initiative, resourcefulness, reasoning ability, imagination/creativity, self-reliance to be assessed. Note: Oral feedback on general behavior may also be given whenever relevant/ required during day-to-day guidance and supervision	00
	Only written feed-back/suggestions	
	Second Progressive Assessment at the end of 12th week	

4	Project Proposal: Marks to be given also based on appropriateness, flexibility, detail and clarity in methods/planning. (In case of working models, detailed design and planning of fabrication/assembly of the prototype has to be also assessed). This proposal should include whole project including work to be done in sixth semester	
5	Execution of Plan in fifth semester (Since project is to be fully completed in sixth semester, the part of the project which is planned to be completed in fifth semester is only to be evaluated: marks to be also given based on ability to collect relevant information, ability to follow correct procedure, manipulative skills, ability to observe, record & interpret, ingenuity in the use of material and equipment, target achievement) In case of working models, quality of workman ship (including accuracy in dimensions, shape, tolerance limits), appropriateness of raw materials/components/ technology being used, functioning of the prototype, cost effectiveness, marketability, modernity etc. has to be also assessed.	02
6	Log book (for work done in fifth semester, detailed and regular entry would be basis of marks)	02
7	General Behavior (persistence, interest, confidence, problem solving ability, decision making ability, initiative to act, team spirit, sharing of material etc., participation in discussions, completion of individual responsibilities, leadership) Note: Oral feedback on general behavior should also be given whenever relevant/ required during day-to-day guidance and supervision. Only written feed-back./suggestions	00
Third Progressive Assessment at the end of 14th week		
8	Portfolio for Self-learning and reflection (marks based on amount of reflection and completion of the portfolio for work done in fifth semester)	04
9	Final Report writing including documentation, (marks based on: clarity in presentation and organization; styles and language; quality of diagrams, drawings and graphs; accuracy of conclusion drawn; citing of cross references; suggestion for further research/project work) Report has to be prepared for work done in fifth semester and planning for sixth semester work.	06
10	Presentation (presentation skills including communication skills to be assessed by observing quality of presentations and asking questions during presentation and viva/voce) Report has to be prepared for work done in fifth semester and plan for sixth semester.	02
11	Defense (ability to defend the methods/materials used and technical knowledge, and involvement of individual to be assessed by asking questions during presentation and viva/voce)	02
Total		25

13. END-SEMESTER-EXAMINATION (ESE) ASSESMENT GUIDELINES The **remaining 25 marks** are for the end-semester-examination (ESE). And marks would be given according to following criteria. Moreover, the suggested evaluation scheme can be changed slightly by the external faculty according to nature of problem / project following University guidelines.

- a) For each project, the one or two students from the concerned group of students should be asked to present the power point presentation before the external and internal (for about 10 minutes) and then external should ask the questions from each member of the group separately to ascertain the contribution made by each student.

- b) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or components some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate commensurate with their efforts.)
- c) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).
- d) Originality of the report (written in own words, even if there are grammatical and spelling mistakes) would be given more importance rather than quality of printing and use of glossy paper (and preparing report by copy pasting from other reports).

Note: It is very common that people are not able to complete the project in time despite best of their efforts. (Please recall that how many times people are able to complete in time, personal projects such as building own house or professional projects such as developing the lab in the institute). So, if students have put in enough genuine efforts but could not complete the project in time then we should consider it sympathetically and they should be given marks based on their efforts and they should get more marks as compared to students who have got their projects completed by taking major help from others/market.

13.1 End-Semester-Examination (ESE) Assessment Criteria.

Allocation Criteria of the **25 marks** are for the end-semester-examination (ESE)

s. No.	Description	Marks
1	Problem Identification/Project Title (innovation /utility of the project for industry/ user/academia) marks to be also given based on (i) accuracy or specificity of the scope and (ii) appropriateness of the work with reference to desired course outcomes.	02
2	Industrial Survey and Literature Review (marks to be given based on extent/volume and quality of the survey of industry / society / institutes/literature/internet for problem identification and possible solutions)	02
3	Project Proposal: Marks to be given also based on appropriateness, flexibility, detail and clarity in methods/planning. (In case of working models, detailed design and planning of fabrication/assembly of the prototype has to be also assessed). This proposal should include whole project including work to be done in sixth semester.	02
4	Execution of Plan in fifth semester (Since project is to be fully completed in sixth semester, the part of the project which is planned to be completed in fifth semester is only to be evaluated: marks to be also given based on ability to collect relevant information, ability to follow correct procedure, manipulative skills, ability to observe, record & interpret, ingenuity in the use of material and equipment, target achievement) In case of working models, quality of workman ship (including accuracy in dimensions, shape, tolerance limits), appropriateness of raw materials/components/ technology being used, functioning of the prototype, cost effectiveness, marketability, modernity etc. has to be also assessed.	02
5	Log book (for work during fifth semester, marks to be given based on detailed and regular entry	03
6	Portfolio for Self-learning and reflection (for work during fifth semester) Marks based on amount of reflection and completion of portfolio	03

7	Project Report including Documentation (for work during fifth semester and planning for sixth semester) (marks based on: clarity in presentation and organization; styles and language; quality of diagrams, drawings and graphs; accuracy of conclusion drawn; citing of cross references; suggestion for further research/project work)	04
8	Presentation (presentation skills including communication skills to be assessed by observing the quality of presentations and asking questions during presentation and viva/voce) Presentation should be based on work done in fifth semester and planning for sixth semester.	03
9	Defense (ability to defend the methods/materials used and technical knowledge, and involvement of individual to be assessed by asking questions during presentation and viva/voce)	04
Total		25

14. SPECIAL TEACHING STRATEGIES (If any)

- Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be in initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator
- Teachers should guide students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.
- Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.
- Teachers should motivate students to maintain log book and prepare portfolio. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.
- Teachers should also encourage students to openly discuss their weaknesses and shortcomings in portfolio and teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them and their marks would not be affected by revealing their mistakes. Marks related to portfolio are awarded based only on the sincerity with which it is prepared and not based on strengths and weaknesses of students.
- Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.
- Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Annexure A

CERTIFICATE

This is to certify that Mr./Ms.

From.....College having Enrolment No:

has completed **Report on the Problem Definition/ Semester VProject Report/Final Project**

Report having title

individually/ in a group consisting of. persons under the guidance of the Faculty Guide.

The mentor from the industry for the project

Name:

Telephone:

Annexure B

Portfolio for Self-Directed Learning for Major Project Work

Name of Student:.....

Semester:..... Programme/Branch:

Roll Number:

Title of the Project:

Name and Designation of Project Guide:

Name of Polytechnic:

Part A: Selecting the Project and Team (Answers to the following questions to be included in 'Portfolio' as Reflection related to formation of group and finalization of project topic).

Note: This section has to be prepared just after the finalization of the Project topic and formation of the Project Team .

1. How many alternatives we thought before finalizing the project topic?
2. Did we consider all the technical fields related to branch of our diploma programme?
3. Why we found present project topic as most appropriate?
4. Whether all the group members agreed on the present project topic? If not? What were the reasons of their disagreements?
5. Whether the procedure followed in assessing alternatives and finalizing the project topic was correct? If not, discuss the reasons.
6. What were the limitations in other alternatives of project topic?

V

7. How we formed our team?
8. Whether we faced any problem in forming the team? If yes, then what was the problem
9. Am I the leader of our project team? If yes, then why was I chosen? If not, why I could not become the project team leader?
10. Do I feel that present team leader is the best choice available in the group? If yes, then why? If not, then why?
11. According to me who should be the leader of the team and why?
12. Can we achieve the targets set in the project work within the time and cost limits?
13. What are my significant good/ bad sharable experiences while working with my team which provoked me to think? What I learned from these experiences?
14. Any other reflection which I would like to write about formation of team and finalization of project title, if any?

Part B: Reflection related to project planning (Answers to the following questions to be included in 'Portfolio' as reflection on planning)

Note: This section has to be prepared just after the finalization of the 'Project Proposal'.

1. Which activities are having maximum risk and uncertainty in our project plan?
 2. What are most important activities in our project plan?
 3. Is work distribution is equal for all project group members? If not? What are the reasons? How we can improve work distribution?
 4. Is it possible to complete the project in given time? If not, what are the reasons for it? How can we ensure that project is completed within time?
 5. What extra precaution and care should be taken in executing the activities of high risk and uncertainty? If possible, how such risks and uncertainties can be reduced?
 6. Can we reduce the total cost associated with the project? If yes, then describe the ways?
 7. For which activities of our project plan, arrangement of resources is not easy and convenient?
 8. Did we make enough provisions of extra time/expenditure etc. to carry out such activities?
 9. Did we make enough provisions for time delays in our project activity? In which activities there are more chances of delay?
 10. In our project schedule, which are the days of more expenditure? What provisions we have made for availability and management of cash?
- Any other reflection which I would like to write about project planning?

**Teacher Evaluation Sheet
(ESE) for
Capstone Project Planning**

Name of Student:

Name of Programme..... Semester:

Course Title and Code:

Title of the Capstone Project:,

A. POs addressed by the Capstone Project (Mention only those predominant POs)

V

- b)
- c)
- d)

B. COs addressed by the Capstone Project (Mention only those predominant POs)

- a)
- b)
- c)
- d)

C. OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT

a) Unit Outcomes (Cognitive Domain)

- i
- ii
- iii
- iv

b) Practical Outcomes (in Psychomotor Domain)

- i
- ii
- iii
- iv

c) Affective Domain Outcomes

- i
- ii
- iii
- iv

D. SUGGESTED RUBRIC FOR ASSESSMENT OF CAPSTONE PROJECT

(please tick below the appropriate rating i.e., poor, average etc., for each characteristic to be assessed and give marks in the respective cell according to performance of student)

Sr. No.	Characteristic to be assessed	Poor	Average	Good	Excellent	Max. Marks	marks obtained

DEPM						SEMESTER	
V							
1	Problem/Task Identification (Project Title)	Relate to very few POs Scope of Problem not clear at all	h. Related to some POs ii.Scope of Problem/Task vague	i. Take care of at-least Three POs ii.Scope of Problem/task not very specific	i.Take care of more than three POs ii. Scope of problem/task very clear	02	
2	Literature Survey /Industrial Survey	Not more than ten sources (primary and secondary), very old reference	At-least 10 relevant sources, at least 5 latest	At-least 15 relevant sources, latest	About 20 relevant sources, latest	02	
Second Progressive Assessment (at the end of 12 week)							
3	Project proposal	Methods are not appropriate, all steps not mentioned, Design of prototype not started (if applicable).	Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete, (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable)	02	
4	Execution of Plan in fifth semester (please write by hand about students' performance in appropriate column)					02	
5	Log book	Entries for most weeks	Entries for some weeks	Entries were made every	Entries were made every	03	

		are missing. There is no proper sequence and details are not correct.	are missing, details are not appropriate, not signed regularly by the guide.	week but are not in detail. Signed and approved by guide every week	week in detail, signed and approved by guide every week		
Third progressive Assessment at the end of 14 ' week							
6	Portfolio Preparation	Answer to only few of the 'questions from self (prompts) written. Answers are not in much detail	Answer to only about 50% of the 'questions from self (prompts) written. Answers are	Answer to most of the 'questions from self (prompts) written. Some not in much detail answers are not in much detail	Answer to nearly all the 'questions from self (prompts) written in detail	03	
7	Final Report Preparation	Very short, poor quality sketches, Details about methods, material, precaution and conclusions omitted, some details are wrong Nearly sufficient and correct details about methods, material, precautions and conclusion, but clarity is not there in presentation, not enough graphic description.	Detailed, correct and clear description of methods, materials, precautions and	Conclusions Sufficient Graphic Description.	Very detailed, correct, clear description of methods, materials, precautions and conclusions. Enough tables, charts and sketches.	04	
8	Presentation	Major information is not	Includes major information	Includes major information and well	Well organized, includes major	04	

		included; information is not well organized.	but not well organized and not presented well	organized but not presented well	information, well presented		
9	Defense	Could not reply to considerable number of questions.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of questions.	Replied to most of the questions properly	04	
Total Marks						25	

Any other comment:

Name and designation of the Faculty

Member **Signature**

National Institute of Electronics & Information Technology, Aurangabad
Teaching and Examination Scheme for Diploma in Electronics Production and Maintenance

Program Name: Diploma in Electronics Production and Maintenance

Program Code: DEPM

With Effect from Academic Year: 2021-2022

Duration of Program: 6 Semesters

Duration: 16 Weeks

Semester: Six

Sr No	Course Title	Abbreviation	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
			Sub. code	Theory			Practical												
L	T	P	Paper Hrs.	ESE Max	ESE Min	PA Max	PA Min	Total Max	Total Min	ESE Max	ESE Min	PA Max	PA Min	Total Max	Total Min				
1	Costing and Management	CMG	21D61	3	-	0	3	70	28	30	12	100	40	-	-	-	100		
2	Computer networking and Data Communication	CND	21D62	3	-	2	5	70	28	30	12	100	40	25	10	25	20	150	
3	Emerging Trends in Electronics	ETE	21D63	3	-	0	3	70	28	30	12	100	40	-	-	-	100		
4	Printed Circuit Board-II	PCB2	21D64	3	-	2	5	70	28	30	12	100	40	25	10	25	20	150	
Elective																			
5	Mechatronics	MEC	21D65	3	-	2	5	70	28	30	12	100	40	25	10	25	20	150	
	Optical Networks and Satellite communication	OSC	21D66	3	-	2	5	70	28	30	12	100	40	25	10	25	20	150	
6	Entrepreneurship development	EDE	21D67	2	-	2	4	-	-	-	-	-	-	25	10	25	20	100	
7	Capstone Project execution and Report writing	CPE	21D68	-	-	4	4	-	-	-	-	-	-	25	10	25	20	100	
8	VLSI with VHDL	VWV	21D69	2	-	2	4	-	-	-	-	-	-	25	10	25	20	50	
Total			19	0	14	33	-	-	-	-	-	-	-	-	-	-	-	-	

Student Contact Hours Per Week: 33 Hrs. Medium of Instruction: English

Theory and practical periods of 60 minutes each.

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

• Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

For the courses having ONLY Practical Examination, the PA has two parts, marks for : (1) Practical Part - 60% of total marks (ii) Micro-Project Part - 40% of total marks.

- Candidate remaining absent in practical examination will be declare as Absent in Mark List and has to reappear for examination. The marks of the part for which candidate was present will not be processed or carried forward.


Head
 Department of Electronics
 Dr Babasaheb Ambedkar Marathwada University
 Aurangabad-431004


Associate Professor
 Dept. of Electronics & Tele. Engineering
 Govt. College of Engineering
 Aurangabad (M.S.)



TECHNICAL ACADEMICS
 NIELIT, Aurangabad.

Program Name : **Diploma in Electronics Production and maintenance**
Program Code : **DEPM**
Semester : **Six**
Course Title : **Costing and Management**
Course Code : **21D61**

1. RATIONALE

Cost and management delivers early awareness of costs associated with engineering decision. An engineer has to work in industry with human capital and machines. Therefore, managerial skills are essential for enhancing their employability and career growth. This course is very important and useful for optimum utilization of existing resources, therefore designed to provide the basic concepts in management principles, safety aspects and Industrial Acts.

2. COMPETENCY

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

- Use relevant managerial skills for ensuring efficient and effective management.

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:

- Solve problems relevant to cost management systems using ideas and techniques some of which are at the forefront of the discipline..
- Use principles of planning and organizing for accomplishment of tasks.
- Determination of products and service cost.
- Apply principles of safety management in all activities.
- Understand various provisions of industrial acts.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit	Examination Scheme														
L	T	P		(L+T+P)	Paper Hrs.	Theory						Practical						
						ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
3	-	-	3	3	70	28	30	12	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 assessment of cognitive domain UOs required for the attainment of the Cos(*#): Online examination

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

5. SUGGESTED PRACTICALS/ EXERCISES- Not applicable –

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED- Not applicable –

7. 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 management concepts and managerial skills, Introduction to Estimating, costing and Engineering economics	1 a. Differentiate the concept and principles of management for the given situation, 1b. Explain functions of management for given situation, 1c. Compare the features of the given types of planning 1d. Suggest the steps in organizing in the given situation, 1e. Suggest suitable type of organization for the given example. 1 f. Identify the functional areas of management for the given situation 1g. Suggest suitable managerial skills for given situation with justification 1h.Explain the concept of estimating ,costing and engineering economics in an organization.	1.1 Definitions of management, role and importance of management. 1.2 Management characteristics and principles, levels of management and their functions; management, administration and organization, relation between management and administration. 1.3 Functions of management: planning, organizing, leading/directing, staffing and controlling. 1.4 Types of planning and steps in planning 1.5 Types of organization, Steps in organizing 1.6 Functional areas of management. 1.7 Managerial skills. 1.8 Definition of estimation. 1.9 costing and differences between them 1.10 Qualities of an estimator 1.11 Sources of errors in estimation. 1.12 Relation between costing and estimation. 1.13 Avoidable & unavoidable errors in estimation. 1.14 various time allowance 1.15 Disadvantages of over and estimation 1.16 Importance of the subject in relation to manufacturing process.
Unit - II Planning and organizing at supervisory level, Estimation	2a. Differentiate the nature of planning and planning activities for the given situation. 2b. Suggest the step wise procedure to complete the given activity in the shop floors. 2c. Prepare materials and manpower budget for the given production activity. 2d. Describe with block diagrams the organization of the physical resources	Planning at supervisory level 2.1 Planning by supervisor. 2.2 Planning activities, detailing and following of each step. 2.3 Prescribing standard forms for various activities. 2.4 Budgeting for materials and manpower. Organizing at supervisory level 2.5 Organizing the physical resources. 2.6 Matching human need with job

	required for the given situation. 2e. Describe the human needs to satisfy the job needs for the specified situation. 2f. List the tasks to be done by the concerned individuals for completing the given activity. 2g. Describe the concepts of price estimation for electronic equipment's in an organization.	needs. 2.7 Allotment of tasks to individuals and establishing relationship among persons working in a group 2.8 Elements of costs: Main elements which are Important for the total cost. 2.9 Cost: Components of cost that lead to selling price. 2.10 Estimation of selling price of PCB's 2.11 PCB assembly, Black and White TV assemblies 2.12 Power supplies including sheet metal box. Equipment Assemblies etc.
Unit- III Directing and Controlling at supervisory level, Industrial Management	3a. Justify the chosen need of directions and instructions to the subordinates to complete the specified task. 3b. Select the feasible set of instructions to complete the given simple task, with justification 3c. Predict the possible mistakes for completing the given simple activity. 3d. Describe the managerial control actions and remedial measures required to be taken for completing the given task successfully. 3e. Explain the fundamental concepts of industrial management.	Directing at supervisory level 3.1 Needs for directions and instructions to subordinates; Completeness and feasibilities of instructions 3.2 Personal counselling advanced predictions of possible mistakes. 3.3 Elaborating decisions, laying disciplinary standards in overall working Controlling at supervisory level 3.4 Managerial control; Understanding team and link between various departments in respect of process and quality standards; Steps in control process 3.5 Controlling methods; Control over the performance in respect of quality, quantity of production, time and cost. Measuring performance, comparing with standards, correcting unfavorable deviations. 3.6 General principals of management 3.7 Principal of management 3.8 Role of Administrations, Planning, organization, Direction, control, Decision making, problem solving, communication and motivation, Importance of Data and information. 3.9 Conflict Resolution and Human relations in the context of management 3.10 Structure of Organization : organizational structure, statutory regulations to start Industry, Business etc.
Unit - IV Safety Management, Personal	4a. State the general safety norms required to be taken in the given case. 4b. Suggest preventive measures of plant	4.1 Need for safety management measures 4.2 General safety norms for an industrial unit; Preventive measures. 4.3 Definition of accident, types of

Management	activities in the given situation. 4c. Describe the safe procedural steps required to be taken to prevent the given the type of accident. 4d. Prepare a work permit in to conduct the given maintenance activity. 4e. Explain the causes of the specified type of accident in the given situation. 4f. Prepare the specifications of the firefighting equipment required for the given type of fire. 4g. Explain the concept of personal management.	industrial accident; Causes of accidents; 4.4 Fire hazards; Fire drill. 4.5 Safety procedure 4.6 Work permits. 4.7 Overview of various types of actions that constitute personal management. 4.8 Role in personal management. 4.9 Identification of major principals, relation to the main elements of personal management. 4.10 Analysis of the major problems of and evolution of solutions.
Unit-V Legislative Acts, Purchase and Stores Control	5a. Explain the purpose of the act 5b. Explain the main provisions of the various acts and important definition. 5c. Explain the purpose of purchase and stores control in an organization.	5.1 Necessity of acts, Important definition and Main provisions of acts. 5.2 Industrial Acts: a) Indian Factory Act b) Industrial Dispute Act c) Workman Compensation Act d) Minimum Wages Act 5.3 Methods of purchases 5.4 procedures adopted in store, organization. 5.5 Minimization on of IV inventory cost. Supervision 5.6 Concept of Unity of Commands 5.7 scalar chains and functional. Responsibility 5.8 Analysis of component, 5.9 Functions of supervision 5.10 Identification of ways and means of Insuring effective supervision.

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'

8. 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 management concepts and managerial skills, Introduction to Estimating, costing and Engineering economics	12	06	06	04	16
II	Planning and organizing at supervisory level, Estimation	08	04	06	04	14
III	Directing and controlling at supervisory level, Industrial Management	08	04	06	04	14
IV	Safety Management, Personal Management	08	04	06	04	14
V	Legislative Acts, Purchase and Stores Control	12	02	06	04	12
Total		48	20	30	20	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.

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom teaching 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 6 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a. Write assignments based on the theory taught in classrooms. Assignments consist of ten questions having long answers including charts, symbols, drawing, observations etc.
- b. Prepare/Download information about various industrial acts.
- c. Visit to any Manufacturing industry and prepare a report consisting of:
 - i. Organization structure of the organization/ Dept.
 - ii. Safety measures taken in organization.
 - iii. Mechanism to handle the disputes.
 - iv. Any specific observation you have noticed.
- d. Give seminar on relevant topic.
- e. Undertake micro-projects.

10. 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. Demonstrate students thoroughly before they start doing the practice.
- g. Encourage students to refer different websites to have deeper understanding of the subject.

Observe continuously and monitor the performance of students in Lab.

11. 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 he/she 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. Study of management principles applied to a small-scale industry.
- b. Study of management principles applied to a medium scale industry.
- c. Study of management principles applied to a large-scale industry.
- d. Prepare case studies of Safety measures followed in different types of organization.
- e. Study of measures to be taken for ensuring cyber security.

12. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Management and entrepreneurship	Veerabhadrapa, Havinal	New age international publishers, New Delhi, 2014: ISBN: 978-81224-2602-1
2	Principles of management	Chaudhry omvir Singh prakash	New Age international publishers, 2012, New Delhi ISBN: 978-81224-3039-4
3	Industrial Engineering and management	Dr. O. P. Khanna	Dhanpath ray and sons, New Delhi
4	Industrial Engineering and management	Banga and Sharma	Khanna Publication, New Delhi

13. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <https://www.versesolutions.com/>
- b. <https://www.educba.com> > Courses > Business > Management

Program Name : Diploma in Electronics Production and maintenance
 Program Code : DEPM
 Semester : Six
 Course Title : Computer Networking and Data Communication
 Course Code : 21D62

1. RATIONALE

Data communication deals with the transmission of digital data through a network. Many applications like Airline Reservations, Railway reservations, e-banking, e-governance, Online Shopping, e-learning can be managed by a single click. Data communication allows businesses to reduce expenses and improve efficiency by sharing data and common equipment among different computer. Diploma Engineers should be able to select, classify, install, troubleshoot and maintain different industrial data communication networks. This course gives the important concepts and techniques related to data communication and enable students to maintain and troubleshoot computer networks.

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 computer network 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:

- Evaluate data communication link considering elementary concepts of datalinklayer protocols for error detection and correction .
- Apply various network layer techniques for designing subnets and supernets.
- Maintain relevant transmission medium and modem for data transmission.
- Maintain wired computer network topologies..
- Configure the network component and assign IP address.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
L	T	P		Theory								Practical					
				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*	12	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. SUGGESTED PRACTICALS/ EXERCISES

The practical's 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.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Analyze the type of network topology used in your lab and prepare technical specifications for it.	I	02*
2	Connect computers in bus topology and transfer the data.	I	02
3	Connect computers in star topology and test the performance.	I	02*
4	Install/configure/Test Peer to Peer LAN and sharing of resources.	I	02*
5	Configure Point to Point network in laboratory.	I	02
6	Prepare patch cord and cross connection cables, use to connect the devices on the LAN.	III	02*
7	Using a Hub/ Switch Install a LAN network consisting of 6 computers	III	02
8	Locate the error bit in the given data stream by applying the different error detection methods.	IV	02*
9	Correct the error in a given data stream by applying the different error correction methods.	IV	02*
10	Use route command to test the performance of the given network.	V	02
11	Install and test Router, Repeater and Bridge	V	02*
12	Assign IP address to the PC connected to the internet.	V	02*
13	Configure/Test Internet connectivity.	V	02*
14	Use FTP protocol to transfer file from one system to another system.	V	02*
15	Install and configure a Firewall for the network security.	V	02
16	Interconnect two PCs using RS232 cable and transfer data as null modem configuration.	V	02
Total			32

Note

- A suggestive list co/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 practical's marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

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

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

- Follow safety practices.

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

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

6. 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.

Sr. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Client Machines (Computers with windows / Linux and latest configuration) with Printer: Laser jet	1 to 15
2	Network Tool kit: clamping, crimping tool, network tester, line tester	1 to 15
3	Network Accessories: RJ 45, UTP cable, T connector, Optical Fiber, Coaxial Cable, Modem, various connectors, 1000Mbps NIC.	1 to 15
4	UPS system 6KVA online.	1 to 15
5	Router, Repeater, Bridges: Latest configuration	10,11
6	Computer Hub 8/ 16 node with console port	1 to 15
7	Modem - Latest configuration	13
8	Ethernet Switch 4/8/16/24/32	1 to 15
9	LAN Cable (CAT6, CAT5)	1 to 15
10	Coaxial Cable, UTP Cable, STP Cable, Fiber Optic Cable	1 to 15
11	Firewall with high security and high storage	14,15
12	MS office latest version	1 to 15
13	Antivirus Software (online protection with firewall securities)	1 to 15
14	RS 232 cable and connector	16

7. 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 Data Communication and network topology	1a. Explain the function of the given component in the process of data Communication, 1b. Describe the given data transmission method with its frame format 1c. Explain the given source of noise and its effect 1d. Design	1.1 Data communication and its characteristics 1.2 Components of data communication Transmitter, Receiver, Medium, Message, Protocol. Standards, Standard organizations. Basic block diagram of data communication system

	computer network considering particular topology. 1 e. Classify networks on the basis of the given parameter.	1.3 Data Transmission: Serial, Parallel Synchronous, Asynchronous, Isochronous transmission 1.4 Transmission characteristics: Signaling rate, data rate, bit rate, baud rate 1.5 Need of computer networks, Network criteria, advantages of networking 1.6 Network topologies: Mesh, Star, Bus, Tree, Ring and Hybrid topologies - Schematic diagram, working, advantages disadvantages and applications 1.7 Network Classification: Based on Transmission Technologies: Point to-point, Multipoint, Broadcast Based on physical size(scale): PAN, BAN, LAN, MAN, WAN, VPN Based on Architecture: Peer to Peer, Client Server, advantages of Client Sever over Peer-to-Peer Model.
Unit- II Network Models	2a. Describe the function of the given layer of TCP/IP Reference model. 2b. Explain the relationship of layers with addresses in TCP/IP. 2c. Differentiate between various addressing schemes in TCP/IP. 2d. Describe the functions of the given layer of OSI Reference model.	2.1 TCP/IP protocol suite with define protocols in respective Layers: Physical layer, Data Link Layer, Network Layer, Transport Layer, Application Layer 2.2 Addressing in TCP/IP: Physical, logical, Port and specific 2.3 The ISO-OSI model: Physical layer, Data Link Layer, Network Layer, Transport Layer, Session Layer, Presentation Layer, Application Layer.
Unit- III Physical layer	3 a. Describe the principle of given multiplexing technique. 3b. Select the transmission media for transmitting given signal for the given application. 3c. Describe the construction of the given cable with labeled sketches.	3.1 Multiplexing: Basic concept, Frequency-Division Multiplexing, Wavelength-Division Multiplexing, Synchronous Time-Division Multiplexing, Statistical Time-Division Multiplexing 3.2 Transmission medium: classification based on electromagnetic wave spectrum 3.3 Guided Media -Twisted pair

	3d. Compare different types of Transmission medium on the basis of given parameter 3e. Explain with sketches the working of the given type of modem 3f. Compare different Multiplexing/Switching techniques on the basis of the given <u>parameters</u>.	(UTP,STP) cable -connector, Coaxial cable - connector, Fiber-optic cable -connector, performance and applications 3.4 Unguided Media- Radio waves, microwaves, Infrared and their applications 3.5 Modems: classifications: Broadband modem, DSL -ADSL, HDSL, VDSL 3.6 Switching: Circuit-switched networks, Packet switched networks -Datagram approach, virtual circuit approach.
Unit- IV Data link layer	4a. Describe the services provided by Data Link Layer. 4b. Describe the technique of the given error control method with examples. 4c. Explain with sketches the given type of flow control used in the data link layer with justification. 4d. Compare characteristics of given type of Protocol. 4e. Select the appropriate protocol for error free transmission of given data	Data link layer: Flow and Error control Error control: Types of errors : single bit and Burst errors Error detection and correction - Hamming code, linear block code, CRC, checksum Flow control: Framing, Flow and Error control, Noiseless and Noisy Channels <u>stop-and-wait protocol</u>, <u>Stop and ARQ</u> protocol 4.4 Sliding window protocol: One bit sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ 4.5 Point to point Protocol: service provided by PPP, Frame format PPP and Transition phases of PPP.
Unit-V Network, Transport and Application layer	5 a. Justify the function of the given network device. 5b. Select appropriate class for given network size. 5c. Differentiate between class full and class less addressing 5d. Explain the role of NAT in address depletion. 5e. Explain the given type of Routing. 5f. Describe the services provided by transport layer/ network layer/Application layer. 5g. Describe the given type of network security technique	5.1 Network devices: Repeater, Hub, Bridge, Switches, Router, Gateway 5.2 Network layer Logical addressing: IPv4 Addresses: address space Notations, classful and classless addressing, Network address translation NAT), IPv6 addresses, Need for IPv6, Structure and address space 5.3 Network Layer-Multicast Routing

		Protocols: Unicast, Multicast and Broadcast routing and applications Transport Layer: Process to process delivery, UDP, RTP and SCTP: ports, format, operation and uses 5.4 Application Layer services: Concept of DNS, FTP, 5.5 Network security: Cryptography: it's Components, Block diagram of symmetric and asymmetric cryptography 5.6 Security services: concepts of message and entity security services, Firewall.
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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'

8. 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 Data Communication and network topology	12	02	08	06	16
II	Network Models	08		04	08	12
III	Physical layer	08	04	04	06	14
IV	Data link layer	08	-	04	08	12
V	Network, Transport, Application layer	12	02	06	08	16
Total		48	08	26	36	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.

9. 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:

- Prepare journals based on practical performed in laboratory.

- b. Follow the safety precautions.
- c. Prepare specifications of a given communication medium.
- d. Test the performance of HUB, Switches, router and Servers.
- e. Library / Internet survey of computer network and data communication.
- f. Prepare power point presentation or animation for understanding different switching networks.
- g. Prepare a presentation on TCP/IP reference model and the OSI reference network model.
- h. Visit to any near by industry to observe the different networks.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

- a. Massive open online courses (**MOOCs**) may be used to teach various topics and subtopics.
- b. '**L' in item No. 4** does not mean only the traditional lecture method, but also 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 easy 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. 9, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e. Video lectures may be used to teach various topics and sub topics.
- f. Demonstrate students thoroughly before they start doing the practice.
- g. Encourage students to refer different text book and websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in Lab.
- i. Encourage students to use front/rear panel control of electronic instruments.
- j. Encourage students to visit nearby electronic instruments repair workshop units or manufacturing industries, Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

11. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the in the beginning of the semester. In the first four semesters, the micro-project, tire group-based. However, in the fifth and sixth semesters, it should be preferably be **infinitively** undertaken to build up the skill and confidence in every student to become problem solver that he/she contributes to the projects of the industry. In special conditions where groups have to be formed for micro-projects, the number of students in the group should **not exceed 3**.

The micro-project could be industry application based, web-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 need to submit micro-project by the end of the semester to develop the industry-oriented COs.

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

- a. A network proposal has to be developed for a bank. The bank has a main office, which is located in London, and has 5 branch offices located at washington, California, delhi, Dubai and Singapore. The bank has an application server, which is used by its customers across the

world for online transactions. All the branches have high speed internet connection. There are approximately 100 users in each of the branch offices and 200 users in the main office.

- b. Prepare a proposal to develop a network system that links two branch offices of an organization. The two branches are separated by a distance of 10 Km. Make appropriate assumption while preparing the proposal.
- c. Interconnect two PCs using RS232 cable. Write the step-by-step procedure to transfer a file from one computer to another computer through RS232 link and implement.
- d. Prepare a hardware specification required to develop a wireless LAN for a cyber-cafe for 20 users.
- e. Develop a Bluetooth network of 5 devices namely laptop, mobile phone, speaker, keyboard, printer (piconet) and transfer files from one device to another. Configure your laptop / mobile as a hot spot for internet access.
- f. Prepare a detailed report on application of computer network in a Mall / railway reservation system.
- g. Visit a CISCO based laboratory/ any other networking laboratory and prepare a report of the various networking equipment's and the networking facility

12. SUGGESTED LEARNING RESOURCES

S. No	Title of Book	Author	Publication
1.	Computer Networks	Tanenbaum, A.S	Pearson Education, New Delhi, India, Fourth Edition, 2011 ISBN : 9788131787571
2.	Data Communication and Networking	Forouzan, Behrouz A	McGraw Hill, Education New Delhi, 2015; ISBN 9780072967753
3.	Introduction to Data Communications and Networking	Tomasi, W	Pearson Education, New Delhi, India, 2007 ISBN : 9788131709306
4.	Data and Computer Communications	Stallings, W.	Prentice Hall India, 10 th Edition, 2013 ISBN : 9780133506488
5.	Data Communications and Networks	Godbole, A.S.; Kahate, A.	Tata McGraw Hill, New Delhi, India, Second Edition, 2011 ISBN (13) : 9780071077705
6.	Computer Networks	Kurose, James F.; Ross, Keith W.	Pearson Education, New D Third Edition, 2011 ISBN : 9788177588781
7.	Data Communications and Computer Networks	ISRD Group	Tata McGraw Hill, New Delhi, India, First Edition, 2006 ISBN (13) : 9780070616820

13. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. nptel.ac.in/courses/106105081/2
- b. https://www.ics.uci.edu/~magda/Courses/netsys270/ch1_vl.pp
- c. https://www.youtube.com/watch?v=gJ5h4_0mllI
- d. https://www.ics.uci.edu/~magda/Courses/netsys270/ch7_vlt
- e. nptel.ac.in/courses/106105082/19
- f. <http://www.nptel.iitm.ac.in/courses>
- g. nptel.ac.in/courses/106106157/52

Program Name : Diploma in Electronics Production and maintenance
 Program Code : DEPM
 Semester : Six
 Course Title : Emerging Trends in Electronics
 Course Code : 21D63

1. RATIONALE

For many years silicon remained the only option in electronics. But recent developments in materials-engineering and nanotechnology have introduced new pathways for electronics. New applications are coming up and it is important for all technologists to be well versed in these developments to survive and provide satisfactory and quality services to the society and industry. The goal of this course is to prepare the diploma graduates to be conversant with such emerging trends in electronics. The main areas in which such developments are encompass Smart systems, Digital Factory and Communication. The course gives an introduction of these areas and helps the students to apply emerging trends.

2. COMPETENCY

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

- Use the trending practices in Electronics fields.

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:

- Design and analyze of components of new emerging applications.
- Suggest the relevant components for the emerging application/s.
- Suggest different telecom network for given application.
- Suggest the relevant IOT technologies for Digital Factory.
- Suggest the different electronic systems for smart world.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	-	3	3	70*	28	30*	12	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(*): On Line ESE

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

5. SUGGESTED PRACTICALS/ EXERCISES: Not Applicable

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: Not Applicable

7. 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-1 Advance Processors	1a. Describe the given advancement in the processor architecture 1b. Describe the given characteristics of Arduino board, 1c. Describe the given function in Arduino IDE. 1d. Describe the given feature of the ARM7 processors, 1e. Compare the given salient features of ARM 7 and ARM 7TDM1 processors.	1.1 Advances in processor architecture: RISC, Pipelining and Superscalar concepts, advantages and Applications. 1.2 Arduino: Introduction, Compatible R2/R3 Uno board Features. Atmega 328: Introduction, pin description. 1.3 Arduino IDE: Features, Sketch: C,C++ functions setup(), loop(), pinMode(), digitalWrite(), digitalRead() and delay() 1.4 Arduino Interfacing: LED , Relay, DC motor. 1.5 ARM: Introduction, Features of ARM7 and ARM7TDMI, advantages, applications. Versions of ARM processor only features.
Unit-II Recent Electronic Components	2a. State features of given component. 2b. Explain the advantages of given component. 2c. Explain the concept of SMD and soldering method	2.1 Flexible PCB: Features and Applications 2.2 Battery [Li-ion, nuclear] :Concepts and Applications 2.3 Memristor, Organic LED: Concepts, Features and Applications 2.4 Surface Mount Device: Concepts, advantages, Applications and Reflow soldering method.
Unit-III Next Generation telecom Network	3a. Explain the function of given Network components. 3b. Describe the Spectrum in Telecom sector. 3c. Compare given Mobile Network with respect to given parameter. 3d. Explain the given component used in FTTH. 3e. Explain the Multi-Protocol Label Switching in NGN	3.1 NGN architecture: Features, Functional block diagram, Network components: Media Gateway, Media Gateway Controller, and Application Server. 3.2 NGN Wireless Technology: Telecom network Spectrum: Types [licensed and unlicensed], Mobile Network Evolution (2G to 5G), Comparative features, 3.3 Fiber to the Home (FTTH): Features,

	core. 3f. Describe the features of OTN and PON.	Architecture and Components: Optical Line Termination (OLT), Optical Network Unit (ONU).
		3.4 NGN Core: Features, Multi-Protocol Label Switching (MPLS): Concepts, Features and Advantages. 3.5 Next generation transmission system: Optical Transport Network variants: Synchronous Transfer Module STM1, STM4, STM16, STM64 and STM256 Features: bit rates and capacity .Passive Optical Network: BPON, Ethernet PON, Gigabit PON features.
Unit- IV Digital Factory	4a. Explain the principle of IoT used in given application. 4b. Explain the architecture of IoT. 4c. Explain the importance of Industrial revolution 4.0.	4.1 Internet of Things IoT: Introduction, principles and features of Cyber Physical system Components [Sensors, Edge-Gateways, Cloud]. 4.2 Architectures [Sensor to cloud various data routes: sensor-PLC-SCADA-cloud, sensor-server-cloud, sensor- edge gateway-cloud], Applications in Automotive/ Discrete Manufacturing; Telecom Industry; Agro Industries 4.3 4.0/IoT/ Smart Manufacturing: Introduction/ Evolution from 11.0 to 14.0, Applications and benefits of 14.0, Compare 13.0 with 14.0, Architecture of 14.0

Unit- V Smart World	5a. Explain the working principle of given electronic system in smart home. 5b. Explain the relevant features of smart city. 5c. Explain the mechanism of city surveillance in smart city. 5d. Explain the given Network component functions.	5.1 Evolution of smart home. 5.2 Basic requirements and components for Smart Home: Video Monitoring, Security and Alarm, Door control, Heating Ventilation and Air Conditioning control (HVAC), Smart lighting, Smart metering and Web controlling appliances. 5.3 Basic requirements for Smart City: Smart Transportation, Smart Healthcare, Smart waste, Smart physical safety/Security (IP based CCTV, Fire and Gas detection, Fire extinguishers) and Smart education. 5.4 IOT/M2M Network architecture: Conceptual diagram Domains for operation: Application domain, Network domain, M2M device domain. Network components: functions of Sensors, Access devices, Gateways, Access Protocols, Communication Network and Application server.
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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'.

8. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total
			Level	Level	Level	Marks
I	Advance Processors	10	02	06	08	16
II	Recent Electronic Components	08	02	04	04	10
III	Next Generation Telecom Network	12	04	04	08	16
IV	Digital Factory	10	04	06	06	16
V	Smart world	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

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom teaching 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 perform following activities in group and prepare reports of about 5

pages (one activity by each group), also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare a report on proposed features of Smart city.
- Prepare a power point presentation on IoT/IoT applications.
- Prepare report on visit to nearby telecom exchange/industry.
- Perform Group discussion on new Electronic Components.
- Prepare a comparative chart of recent processors.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- '**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.
- 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).
- With respect to item No. 9, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide student(s) in undertaking micro-projects
- Show video demonstration on safety precautions.
- Monitor the actions of students and care to be taken.
- Arrange a visit to Electronic industry.
- Arrange expert lecture of industry person.

11. 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 year. In the first two years, the micro-project is group-based. In the third year 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 as applicable. 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:

- Prepare a report on existing automation in an industry and suggest improvements.
- Prepare a report on Smart City.
- Build Arduino based project for smart home.
- Build Arduino based project for smart city.
- Prepare a report on Smart city surveillance systems.
- Prepare report on electronic systems in Disaster Management.
- Present a power point presentation on upcoming 5G technology.
- Prepare a report on automatic electronic components assembly machines.
- Conduct a survey and prepare a report on various EDA tools,
- Prepare an application report on AR VR Technologies.
- Prepare a report on Artificial Intelligence.
- Prepare a report on Machine Learning.
- Prepare report on electronic home security systems.
- Prepare report on fire and gas detection and deluge systems.
- Prepare report on ATM security systems

12. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Sustainable Smart Cities in India: Challenges and Future Perspectives	Poonam Sharma, Swati Rajput,	Springer; ISBN 978-3-319-47145-7
2	The ABC of Fiber Optics Communication	Sudhir Warier	Artech House Boston London ISBN 13: 978-1-63081-414-4
3	IoT Fundamentals: Networking Technologies Protocols and use cases for IoT	David Hanes, Gonzalo Salguein	Cisco Press. ISBN 13:978-1-58714-456-1
4	The AVR Microcontroller and Embedded Systems using Assembly and C.	MuhammadAli Mazidi	MicroDigitalEd.com ISBN-13:078-0997925968
5	ARM Assembly Language Programming & Architecture	Muhammad Ali Mazidi, Sarmad Naimi	MicroDigitalEd.com ISBN-13: 978-0997925906

13. SUGGESTED SOFTWARE/LEARNING WEBSITES:

Sr No	Theory topic /sub topic	Web site
1	Unit- I Advance Processors (Advances in processor architecture)	https://slideplayer.com/slide/8290583/
2	Unit- I Advance Processors (Arduino)	http://www.hobbytronics.co.uk/arduino-uno-r3
3	Unit- I Advance Processors (Arduino)	https://www.arduino.cc/en/Guide/HomePage
4	Unit- Advance Processors(ARM)	http://www.microdigitaled.com
5	Unit- Advance Processors (ARM)	https://en.wikipedia.org/wiki/ARM7
6	Unit – II Recent Electronic Components (Flexible PCB)	https://en.wikipedia.org/wiki/Flexible_circuit
7	Unit – II Recent Electronic Components (SMT)	https://www.electronics-notes.com/articles/electronic_components/surface-mount-technology-smd-smt/what-is-smt-primer-tutorial.pl_p
8	Unit- III Next Generation telecom Network	TRAI official website: www.trai.gov.in

9	Unit- III Next Generation telecom Network	https://www.itu.int/rec/dologin pub.asp?lang=e&id=T-REC-Y.2012-200609-S! !PDF-E&type=items
10	Unit- IV Digital Factory (IoT)	https://en.wikipedia.org/wiki/Internet of things
11	Unit- IV Digital Factory	http://dot.gov.in/sites/default/files/National%20Telecom%20M2M%20Roadmap.pdf
12	Unit- IV Digital Factory	http://www.tec.gov.in/technical-reports/
13	Unit- IV Digital Factory(14.0/IoT)	http://i40today.com/
14	Unit- V Smart World	http://tec.gov.in/pdf/M2M/Design%20Planning%20Smart%20Cities%20with%20IoT%20ICT.pdf

PRINTED CIRCUIT BOARD TECHNOLOGY-II

1. RATIONALE

The PCB manufacturing process is very important for anyone involved in the electronics industry. Virtually all circuits use printed circuit boards and they are designed and used in quantities of millions. Technology in this area of electronics is moving forward. Track sizes are decreasing, the numbers of layers in the boards are increasing to accommodate for the increased connectivity required, and the design rules are being improved to ensure that smaller SMT devices can be handled and the soldering processes used in production can be accommodated. With the completion of this course students will get knowledge of various trends/ techniques followed in PCB manufacturing industries and will also learn various EDA tools to design complex PCBs.

2. COMPETENCY

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

- **Design PCB using industry identified EDA tools and manufacture PCB/PCBA.**

3. COURSE OUTCOMES

The theory, practical experiences and relevant documents 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:

- Understand how to design PCB using CAD tools.
- Understand the flow of computer aided design packages.
- Understand the mechanical method in manufacturing.
- Understand the material used in soldering process.
- Understand Methods of soldering of PCBs.
- Understand the concepts of Via in Multilayer PCB design
- Understand the concept of Flexible PCB design.
- Understand how to design with surface mount technology.

4. TEACHING AND EXAMINATION SCHEMES

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper His.	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*	12	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. 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	Draw the basic electronic component footprints on given Grid sheet in 2x dimensions and study the datasheets for all given components.	IV	02*
2	Study the datasheets of Through hole Resistor and LED. Draw the Basic LED circuit on the Given Grid sheet along with component footprints and route manually	IV	02*
3	Study the datasheet of LM317M Voltage regulator IC. Draw 5V Voltage regulator circuit on the given grid sheet along with component footprints and route manually.	IV	02
4	Study the datasheet of 555 TIMER IC. Draw the Astable Multivibrator circuit using 555 Timer IC on the given grid sheet along with component footprints and route Manually.	IV	02
5	Learn about PCB cleaning Process, study the operation and working of PCB brushing machine and perform brushing operation on FR-4 copper clad.	I	02
6	Learn about CNC milling and drilling process, study the operation and working of CNC milling and drilling and perform drilling operation on FR-4 copper clad for SSB and DSB.	II	02
7	To learn the process of galvanic plated through hole machine, and study the operation and working of through hole plating machine and perform operations on double sided PCBs.	III	02*
8	To develop the artwork on photo films using photo plotter machine, installation of films on machine and developing of the photo films using developer bath and fixer bath.	IV	02
9	To learn about PCB lamination Process, study the operation and working of PCB laminator machine, laminate Single sided board using PCB laminator machine on FR-4 copper clad	IV	02*
10	To laminate Double Sided Board (DSB) using PCB laminator machine on FR-4 copper clad.	IV	02*
11	Learn about PCB Ultraviolet exposing process, study the operation and working of Ultraviolet exposing machine and perform Artwork film Exposure operation on FR-4 Single Sided Board.	IV	02*
12	To learn Artwork film exposure on Double Sided Board (DSB) using PCB UV exposing machine.	IV	02*
13	To learn about PCB developing Process, study the operation and working of PCB developing machine, develop the UV exposed artwork on Single sided board.	IV	02*
14	To learn about developing UV exposed artwork on Double Sided Board (DSB) using PCB developing machine.	IV	02*
15	To learn about PCB etching process, study the operation and working of PCB etching machine for SSB and DSB.	III	02*
16	To learn about PCB stripping process, study the operation and working of PCB stripping machine for SSB and DSB.	IV	02*

17	To learn about PCB soldering techniques and perform soldering and de-soldering process for through hole PCBS.	V	02*
18	To learn about PCB soldering techniques and perform soldering and de-soldering process for Surface Mount Device (SMD) components PCBS.	V	02
19	To perform PCB cutting operation using PCB shearing machine.	II	2
Total			38

Note:

- A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 10 or more practical need to be performed, out of which, the practical marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each PrOs 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.	Designing the PCB and conclusion	20
f.	Answer to sample questions	10
g.	Submission of report on 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:

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

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name/ Material name with Broad Specifications	PrO.S. No.
1	Digital Multimeter with R, V, I measurements, diode and BJT testing.	17,18
2	Adjustable dual channel Power DC supply(0 to 30V)	17,18
3	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz XIO magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	17,18

4	PCB design software/EDA tool(any).	6-16
5	PCB Drilling and Milling machine/ CNC drilling machine.	6
6	PCB etching resist laminator machine.	9,10
7	Vacuum controlled Ultraviolet exposure machine.	11, 12
8	Photoplotter machine ^(^)	8
9	PCB Spray developing machine ^(*)	13,14
10	PCB Spray etching machine.	15,16
11	PCB Photoresist stripping machine.	16
12	PCB Brushing and cleaning machine.	5-16
13	Galvanic through-hole plating machine.	7
14	PCB photoresist and solder mask dry laminator films ^(*)	16
15	Photo films for film master generation ^(^)	8
16	Measuring Flask, measuring mug of 1000ml.	All
17	PCB Etching chemicals Ferric chloride/ ammonium chloride in liquid/powder form.	15
18	Caustic soda for stripping operation	16
19	Water for rinsing purpose	5-16

Note: For equipment with (*) requires Yellow light room, and (^) requires Dark room for proper development of films

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 Properties of Copper Clad Laminates and Surface Preparation	1a. Acquire knowledge to select proper copper clad laminate. 1b. Will be able to define Prepreg and CCL(copper clad laminate) 1c. Acquire knowledge of various CCL. 1d. Acquire knowledge physical and electrical properties 1e. Understand how to prepare surface for lamination	1.1 Properties of Copper Clad Laminates: Anatomy of Laminates, Types of Laminates with application, 1.2 Manufacturing Process of copper Clad, 1.3 Physical and Electrical properties of Laminates, Evaluation of Laminates and test methods like peel strength, flexural strength. 1.4 Surface Preparation: Need of Surface Preparation, Manual Cleaning Process, Mechanical Cleaning Process, Trends in cleaning processes.

Unit-II Mechanical Operation	2a. Understand various mechanical operations. 2b. Understanding various classification of drill bits. 2c. Understand the use of LASER in PCB technology.	2.1 Need for Mechanical Operations 2.2 Cutting Methods - Shearing, Sawing, Blanking, Milling & Routing, Hole Punching, 2.3 Drilling - Classification of drill bits, Drill details. Drilling machines, Drilling Problems, Micro vias , 2.4 Use of UV laser for Drilling PCB , Hybrid Laser Drilling Process, Useful Standards
Unit-III Plating and Etching Process	3a. Able to decide plating process requirements. 3b. Understand various plating techniques. 3c. Understand how to do plating. 3d. Understand quality standards for plating. 3e. Learn about various etching solution. 3f. Able to select etching solution. 3g. Understand problems related to etching and resolve them. 3h. Understand various etching methods.	3.1 Need for Plating, 3.2 Types of Plating 3.3 Plating Techniques: Immersion plating for Tin and Gold, Electroless Copper plating & Electroplating in detail. 3.4 Special Plating Techniques ,Alternative Finishes. 3.5 Plating Defects & Plating Quality Control, 3.6 Consideration for shop floor, Useful standards 3.7 Etching Solution and Chemistry 3.8 Equipment for etching, 3.9 Facilities for Etching Area, 3.10 Problems in Etching 3.11 Electrochemical Etching 3.12 Mechanical Etching
Unit- IV Screen Printing and Photo printing in PCB Fabrication	4a. Will be able to select material for screen printing. 4b. Understand various mesh used for screen printing like 120T. 4c. Acquire knowledge of pattern transfer. 4d. Acquire knowledge of photoresist 4e. Acquire knowledge of various types of photoresist 4f. Acquire knowledge on light condition for photoresist film	4.1 Introduction, Material required for screen printing -screen Frames 4.2 Screen fabrics Squeegees 4.3 Printing Inks and curing methods. 4.4 Direct and Indirect Methods of Pattern transfer, Manual Screen printing, Automatic Screen-Printing process 4.5 Troubleshooting. 4.6 Photo resist in general 4.7Characteristic of photo resist 4.8Types of Photoresist and coating/lamination methods 4.9 Manufacturing process of SSB and DSB using wet film process 4.10 Dry film Resist - Features & categories. Processing of Dry - Film Resist, Trouble shooting
Unit-V Component Assembly and Soldering Techniques	3a. Understand various assembly techniques. 3b. Acquire knowledge of various mounting techniques 3c. Acquire knowledge of repair and rework	3.1 Classification of component assembly Techniques, 3.2 Formation and mounting Techniques 3.3 PCB Repair and rework. 3.4 Introduction & Theory of Soldering, 3.5 Types of solder alloys and fluxes,

	3d. Understand the material used in soldering process. 3e. Understand Methods of soldering. 3f. Acquire knowledge of soldering SMD components 3g. Acquire knowledge on Quality control in soldering like AOI(Automated optical Inspection)	3.6 Solder Paste for SMDS, 3.7 Tools. Soldering Techniques - Manual soldering, Mass soldering, 3.8 Role of solder mask, Solder mask application methods 3.9 Quality Control of solder Joints, Solder Joint Defect & cause
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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	Properties of Copper Clad Laminates and Surface Preparation	10	4	4	6	14
II	Mechanical Operation	10	4	4	6	14
III	Plating and Etching Process	10	3	5	6	14
IV	Screen Printing and Photo printing in PCB Fabrication	8	3	5	6	14
V	Component Assembly and Soldering Techniques	10	4	4	6	14
Total		48	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

9. 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:

- Prepare report on the various trends in PCB design.
- Prepare report on PCB industry pollutants and how to overcome them
- Give seminar on any relevant topic.
- Conduct library / internet survey regarding different data sheet and manuals.
- Prepare power point presentation on multilayer and flexible circuits PCB design.
- Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

10. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

- 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, teacher need to ensure create opportunities and provisions for **co-curricular activities**.
- e. Guide student(s) in undertaking micro-projects.
- f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
- g. Guide students for using data sheets / manuals.

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. Micro project report may be of four to five pages.

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

- a. Design and develop circuit for Atmega328p.
- b. Design and develop motor driver for Arduino.
- c. Design and develop a PCB for 24V power supply.
- d. Design a Double-sided PCB of any open-source development board/ module.

13 SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Printed Circuit Boards: Design and Technology	Walter C Bosshart	Tata McGraw-hill
2	Printed Circuit Boards: Design, Fabrication, Assembly & Testing	R S Khandpur	Tata McGraw-hill
3	Printed Circuit Boards	Coombs Clyde F.	McGraw- hill
4	The Design & Drafting of Analog Printed Circuits Board	Darryl Lindsey	Bishop Graphics Inc
5	Printed Circuit Boards: Design Techniques for EMC Compliance	Montrose Mark I	IEEE Press Series of Electronics Technology

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <https://www.autodesk.com/solutions/pcb-design-software>
- b. <https://learn.sparkfun.com/tutorials/pcb-basics/all>
- c. <https://www.electronicdesign.com/technologies/embedded-revolution/article/21798594/the-engineers-guide-to-highquality-pcb-design>
- d. <https://circuitdigest.com/diy-pcb-projects>
- e. https://www.cadence.com/ko_KR/home/tools/pcb-design-and-analysis.html
- f. <https://www.pcbcart.com/article/content/PCB-introduction.html>
- g. <https://kicad.org/>
- h. <https://saturnpcb.com/>
- i. <https://resources.pcb.cadence.com/blog/2020-an-introductory-multilayer-pcb-design-tutorial>

Program Name : Diploma in Electronics Production and maintenance
 Program Code : DEPM
 Semester : Six
 Course Title : Mechatronics
 Course Code : 21D65

1. RATIONALE

Mechatronics is a rapidly developing interdisciplinary field of engineering, which comprises the development of various computers integrated electro-mechanical systems. It is an integration of mechanical engineering, electrical engineering and electronics engineering, computer engineering, control and instrumentation engineering. This integration facilitates the production of complex engineering systems with a high level of performance, reliability at affordable price. Due to these aspects, industrial sector is rapidly adopting such integrated systems. To adopt such systems, industries are in need of the diploma engineers to install, operate and maintain these 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:

- **Install, Operate and Maintain various types of mechatronic 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) Install and Maintain the sensors and transducers of mechatronics systems.
- b) Install and Maintain CNC Machine.
- c) Install and Maintain pneumatic components in mechatronic systems.
- d) Install and Maintain hydraulic components in mechatronic systems.
- e) Install and Maintain different components of robotic systems.

4. TEACHING AND EXAMINATION SCHEME

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

				Hrs.	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	12	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. SUGGESTED PRACTICALS/ EXERCISES

The practical's 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 types of proximity and position sensors.	I	02
2	Choose the appropriate sensors for the given applications.	I	02*
3	Use relevant transducer for velocity, motion, acceleration and torque sensors for the specified applications.	I	02
4	Measure the speed of the given motor using stroboscope sensor.	I	02*
5	Identify various components of translational mechanical system	II	02
6	Identify various components of rotational mechanical system	II	02
7	Identify various components of electrical system.	II	02*
8	Develop simple programs for CNC using G code and M code.(open-source software)	II	02*
9	Troubleshoot pneumatic system of mechatronic systems.	III	02
10	Test the pneumatic system available in your Lab.	III	02*
11	Troubleshoot hydraulic system of mechatronic systems.	IV	02
12	Test the hydraulic system available in your Lab.	IV	02*
13	Trouble shoot different mechanical actuators of mechatronic systems	IV	02
14	Simulate the working of cylindrical, spherical and Cartesian robot showing different degree of freedoms.	V	02
15	Simulate the working of pick and place robot. (MATLAB / Simulink software)	V	02*
16	Demonstrate the working of Automated Guide Vehicle (Virtual Lab / Demonstration in Industry/Videos).	V	02
17	Demonstrate the working of Anti-lock Braking System (ABS) (Virtual Lab / Demonstration in Industry/Videos).	V	02*
	Total		34

Note

- A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practical's marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

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 he/she 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
- 'Organization Level' in 2nd year
- 'Characterization Level' in 3rd year.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Sensors, transducers and signal conditioners demonstration boards.	01,02 ,03 and 04
2	Small physical models of different types of system (if not available use virtual labs or any other relevant sources).	05 to 07
3	CNC machine.	08
4	Pneumatic system component trainer kit.	09, 10
5	Hydraulic system component trainer kit.	11, 12,13
6	Small robotics model/prototype/ (or virtual lab).	14, 15
7	AGV and ABS simulation (small physical model or virtual lab)	16, 17

7. 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-1 Sensors for Mechatronics system.	1a. Describe with sketches the function of the given type(s) of sensors and transducers, 1b. Compare the given types of sensors based on given criteria, 1c. Explain with sketches the working of the given type(s) of sensor. 1d. Justify the need for the signal conditioning circuits in the given mechatronics system, 1e. Describe the troubleshooting procedure for the specified problem of the given type of sensor or transducers.	1.1 Mechatronics system architecture: Sensors, signal conditioners, PLC/ Embedded controllers, pneumatic, hydraulic and electrical actuators. 1.2 Introduction to Real Time Mechatronics System: Block diagram & Functions: Real time mechatronics system (Flexible Manufacturing System: FMS), Computer Integrated Machines: CIM)) 1.3 Sensors: Construction, principle of operation and application) i. Proximity and position Sensors: Photo electric sensors, Hall Effect sensors, optical encoder, eddy current proximity sensor, inductive sensor, capacitive sensor. ii. Velocity Sensors: Electromagnetic transducers, Techo generators iii. Motion Sensors: Stroboscope, pyro electric sensors.

		iv. Acceleration sensors: strain gauge accelerometer. Piezoelectric v. Pressure sensors: Load cells vi. Torque sensors: Torque measurement using strain gauge, torque measurement using torsion bar (optical method, capacitive method, proximity sensor method, stroboscope method). 1.4 Signal conditioners: Need of isolators, filters, amplifiers, fluid amplifiers, optical amplifiers and data converters in mechatronics
Unit-II Basic Mechatronics systems	2a. Describe with building blocks system model. 2b. Built a model from given system component. 2c. Develop simple CNC programs for given problem. 2d. Describe with sketches general configuration of CNC systems.	2.1 Basic System Models: Introduction, mechanical system building blocks - Translational and Rotational system building up a mechanical system model, Electrical system building blocks -building up a model for an electrical system. 2.2 System Models: Introduction, rotational-translational systems, electromechanical systems - System components & function. (No mathematical modelling) 2.3 CNC Machines: General configuration of CNC system, advantages of CNC, part programming of CNC machines, G codes and M codes, small application programs, CNC based drilling machine.
Unit-III Pneumatic System	3 a. Explain the working of given type of pneumatic system components. 3b. Explain the working principle of given type(s) of pneumatic actuator. 3c. Identify the use of given type(s) of pneumatic component. 3d. Describe the procedure to maintain the given type(s) of pneumatic system component	3.1 Basic Pneumatic Systems: Basic, Pneumatic system circuit, Air compressors, filters and regulators, air treatment, valves 3.2 Actuators: Principle of operation of linear actuators (single acting cylinder, double acting cylinder) rotary actuators(rotating vane, gear type) and direction control valves (poppet valve, spool valve) 3.3 Pneumatic System: Applications, Advantages and Limitations.
Unit-IV Hydraulic System	4a. Explain the working of given type of hydraulic system components. 4b. Explain the working principle of given type(s) of	4.2 Actuators :Principle of operation of linear actuators (single acting cylinder, double acting cylinder) rotary actuators(rotating vane, rack and pinion type)

	hydraulic actuator. 4c. Explain with sketches the working of the given mechanical actuating system. 4d. Identify the use of given type(s) of Hydraulic system components. 4e. Describe the procedure to maintain the given type(s) of Hydraulic system components.	4.3 Mechanical Motion Element: cams, gear, belt, rack and pinion and bearings (principle of operation and application) 4.4 Hydraulic System: Applications, Advantages and Limitation
Unit - V Robotics and Mechatronics Applications	5 a. Describe with sketches the functions of the given element of the Robotic systems. 5b. Explain with sketches the given degree of freedom for a robot. 5c. Explain with sketches the working of the given robotics application. 5d. Compare the given types of robot on the basis of degree of freedom, construction, end effectors used and applications. 5e. Describe the procedure to maintain the given robotic system for the specified application	5.1 Robotics: Block diagram and function of each component (sensors, drive system, control system, end effectors), construction and degrees of freedom of cylindrical, spherical and Cartesian robots, applications of robot. 5.2 Microcontroller based antilock brake system. 5.3 Microcontroller based pick and place robot. 5.4 Microcontroller based car park barrier system. 5.5 AGV (Automated Guided Vehicle): Basic concept, block diagram, role of mechatronic in guided vehicle

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'.

8. 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	Sensors for Mechatronics system.	14	06	08	06	20
II	Basic Mechatronics systems.	06	02	04	04	10
III	Pneumatic System	10	04	06	04	14
IV	Hydraulic System	10	04	06	04	14
V	Robotics & Mechatronics Applications	08	04	04	04	12
Total		48	20	28	22	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.

9. SUGGESTED STUDENT ACTIVITIES

Other than the classroom teaching 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 6 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) Give seminar on relevant topic.
- c) Library/Internet survey regarding different data books and manuals.
- d) Prepare power point presentation on "Mechatronic Systems".
- e) Undertake a market survey of different manufacturer of "Mechatronic Systems".

10. 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. 9, 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 of pneumatic, hydraulic system.

11. 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) Design a microcontroller-based robot arm to pick and place ferrous material from one place to another place (zero to 180 degree).
- b) Design a microcontroller based AVCS for speed control and mirror adjustment for car. (Use relevant speed measurement sensor for speed control and simple small dc motor for mirror adjustment)
- c) Design a controller-based ABS (Use of linear actuator).
- d) Design a small model for hydraulic system.
- e) Design a small model for pneumatic system.

- f) Design a model to demonstrate the use of any one velocity sensor.
- g) Demonstrate the use of any one motion sensor using simulation.
- h) Demonstrate the use of any one pneumatic actuator using simulation.
- i) Demonstrate the use of any one mechanical actuator using simulation.

Note: To implement above micro project actual physical model or simple computer simulation is expected.

12. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Mechatronics - Integrated Mechanical electronic systems.	Ramachandran, K. P.; Vijayaraghavan, G. K.; Balasundaram, M.S.	Wiley-India, New Delhi First edition, 2008 ISBN: 978-81-265-1837-1
2	Mechatronics	Bolton, W.	Pearson Education, New Delhi, 2003, 3 rd Edition, ISBN: 0131216333
3	Mechatronics	Rajput, R. K.	S. Chand & Co. Ltd. New Delhi, 1 st Edition, ISBN: 81-219-2859-1
4	Mechatronics	Singh, M. D.; Joshi, J. G.	PHI Learning Private Limited, New Delhi, 2006, ISBN: 8120329864

13. SOFTWARE/LEARNING WEBSITES

- a) www.nptel.ac.in/downloads/112103174/
- b) Basics of Mechatronics - https://www.youtube.com/watch?v=Ro_tFvI_iH6g.
- c) Simulation of Mechatronics systems - www.youtube.com/watch?v=DbGTwvyT_Co.
- d) Understanding control system - www.youtube.com/watch?v=pVAY2zOy0vU.
- e) AVCS - Cruise Control - <https://www.youtube.com/watch?v=zqlRSDNRh3Q>.

Program Name : Diploma in Electronics Production and maintenance
 Program Code : DEPM
 Semester : Six
 Course Title : Optical Networks and Satellite communication
 Course Code : 21D66

1. RATIONALE

Fiber optic communication is a method of transmitting information from one place to another by sending pulses of infrared light through an optical fiber. Cost trends for fiber vs copper, better transmission quality, high data rate, better bit rate, large band width and reduction in fiber maintenance expense are the major reasons for fast adaptation of this mode of communication. Today in different communication scenarios satellite applications play an important role. The knowledge of satellite communication systems and equipment is very essential. This course will facilitate students to apply the basic principles of optical communication system and satellite communication system to maintain different types of applications based on it.

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 optical communication networks.**
- **Maintain satellite 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:

- Apply the fundamental principle of optic and light waves to design optical fiber communication system.
- Apply different network access schemes and packet switching in OFC system.
- Select relevant architecture of optical networks for the given application.
- Select uplink and downlink frequencies for various satellite communications.
- Maintain Satellite services.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P))	Examination Scheme												
L	T	P		Theory						Practical						
				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*	12	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. SUGGESTED PRACTICAL/EXERCISES

The practical's 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 layers and parts of an optical fiber cable.	I	02*
2	Test the performance of Pulse width modulator and demodulator (PWM) where optical fiber cable is used as transmission media.	I	02*
3	Test the performance of the given photo-diode (Detector) use LED as an optical source.	I	02
4	Test performance of given photo-diode (Detector) use LASER as optical source.	I	02*
5	Calculate bandwidth of optical fiber for Analog Link.	II	02
6	Observe the change in power level of optical fiber due to cleaning effects in the fiber.	II	02
7	Calculate Numerical Aperture (NA) and acceptance angle for the given optical fiber cable.	II	02*
8	Connect the given Optic cable with relevant optical connector and test the performance of cable.	II	02
9	Measure attenuation losses for the given length of optical fiber cable.	II	02
10	Measure bending losses of the given optical fiber optic cable.	II	02*
11	Demonstrate attenuation losses for the given length of optical fiber cable with the help of OTDR. (Virtual lab/ Demonstration in industry/videos can be used in case of non-availability of the splicing machine in the lab)	II	02
12	Join optical fiber cables using Splicing machines. (Virtual lab/ Demonstration in industry/ videos can be used in case of non-availability of the splicing machine in the lab)	II	02
13	Demonstrate the working of OTN. (Virtual lab/ Demonstration in industry/ videos can be used in case of non-availability in the lab)	III	02*
14	Test the performance of audio satellite link for the specified uplink and downlink frequency.	IV	02*
15	Develop a program using a relevant simulation tool to calculate the time period of a satellite for the given velocity and altitude based on Kepler's third law.	IV	02
16	Detect the satellite link fail operations and re-establish the link.	V	02
17	Establish a link to transmit and receive three separate signals (audio, video, tone) simultaneously through satellite link.	V	02
TOTAL			34

Note

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

- Follow safety practices.
- Practice good housekeeping.
- Practice energy conservation.
- Work as a leader/a team member,
- 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
- 'Organization Level' in 2nd year
- 'Characterization Level' in 3rd year

6. 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.	CRO/Digital storage oscilloscope: 60MHz/100MHz/200MHz bandwidth, 500MS/s to 1 GS/s real-time sample rate, 50GS/s sample rate for repetitive waveforms, High resolution color LCD display	2,3,4,5
2.	DMM: DC, 0-1.5/3Amp, 0-2.5/5 Amp, 0-5/10Amp, 0-150/300V, 0-250/500V, 0-75/150V AC-0-1000V,0-10A	2,3,4,5
3.	Power Supply Type: DC, 0- 30 V, 0 - 3A	2,3,4,5
4.	Fiber Optic Trainer kit	1,2,3,4,5,7
5.	Fiber optic cable tester	2,3,4,5
6.	Optical fiber Power meter	6,8,9
7.	Lux meter: Display: 3 1/2-digit 18mm (0.7") /LCD 'Ranges: 1 to 50,000 LUX /Over-input: indication of " 1 " /Sampling Time: 0.5 second /Repeatability: $\pm 2\%$ /Temperature Characteristic: $\pm 0.1\%$ /? 'Accuracy: $\pm 4\%$ rdg $\pm 0.5\%$ f.s	3,4,5
8.	OTDR-Attenuation resolution-0.001 dB, Attenuation measurement linearity 0.05 dB, Distance measurement accuracy $\pm (0.5 + \text{resolution} + 5 \times 10^{-5} \times L)\text{m}$	8,9,10, 11,12
9.	PC - Processor - dual core @ 2.4 GHz (i5 or i7 Intel processor or equivalent AMD),RAM - 4 GB, Hard Drive - 320 GB 5400 RPM hard drive, OS- win7/10	11,12,13
10.	Spectrum Analyzer- frequency range- 2.4 to 2.495GHz, Resolution - 26KHz to 3MHz, resolution BW-58.036 to812.500KHz	14,15,16,17
11.	Splicing, Cutting and trimming tool of plastic fiber optic cables	6,12
12.	Fiber optic cleaning kit	6
13.	Satellite Trainer Kit (ST2272)/ (STC 24): Up linking 2414 2432/2450/2468 MHz, 4 MHz clock frequency, PIC16F84 - 8 Bit RISC processor based PLL, 16 MHz Bandwidth, FM Modulation of Audio and Video 5/ 5.5/ 8 MHz	(Sjl6,17,18

	Audio and Video Modulation, Detachable Dish Antenna, Radiated Power output 25 mW (approx.), 4 downlink frequencies 2414 /2432/2450/2468 MHz	
14.	RF Signal Generator, 9 kHz to 3 GHz, Output Power @1 GHz, -127 dBm to +13 dBm AM, FM, PM Analog I/Q Input Pulse, Frequency Modulation-Maximum Deviation @\ GHz, 20 Hz to 100 kHz	2

7. 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 Fiber Optic Communication	1 a. Describe construction and features of Optical fiber, 1b. Compare working of optical fiber for given mode and index profile. 1c. Explain the block diagram of Optical fiber communication system. 1d. Explain the working principle of given optical source and detector. communication:	1.1 Optical fiber Advantages, applications 1.2 Construction of fiber optic cable 1.3 Classification based on modes of propagation of light and index profile. 1.4 optical fiber communication system: Block diagram. 1.5 Optical components: Sources and Detectors
Unit- II Optical Losses	2a. Explain the given terms related to optical theory. 2b. Calculate acceptance angle, critical angle and numerical aperture of the given optical fiber cable. 2c. Explain the step-by-step procedure of given splicing techniques 2d. Describe the different types of Optical fiber losses. 2e. Explain the operation of ODTR.	1.1 Reflection, refraction, Total internal reflection (TIR), Snell's law, critical angle, numerical aperture, acceptance angle and acceptance cone - (numerical on above concepts) 1.2 Splicing techniques- Fusion splice, V-groove splice and elastic tube splice 1.3 Losses in optical fiber: Absorption loss, scattering loss, dispersion loss, radiation loss, coupling loss. 1.4 OTDR: Working Principle, Block diagram, Specification, Application
Unit-III Optical network.	3a. Describe working principle of the optical network components. 3b. Explain the concept of WDM. 3c. Explain the architecture of SONET/SDH. 3d. Describe the given type of Ethernet standard.	3.1 Optical Network Components Use and Features: Amplifiers, Splitter, Optical Switches, 3.2 WDM: Basic Concept, Features. 3.3 SONET/SDH: Architecture and Hierarchy. 3.4 Ethernet standards of Optical network features: IEEE 802.3j, 802.3y, 802.3z

Unit -IV Overview of Satellite Systems.	4a. Describe with sketches the working principles of the given type of satellite. 4b. Explain with sketches the given terms related to satellite and orbit. 4c. Explain the parameters with respect to the given type of satellite orbit. 4d. Explain Kepler's law of planetary motion with respect to the given criteria.	4.1 Working principle, concepts and basic components of Satellite system : Earth segment, Space segment, active and passive satellite, geostationary and geosynchronous satellites 4.2 Frequency allocations for satellite services, Uplink and downlink frequency, satellite frequency bands 4.3 Basic terminologies used in satellite communication: latitude, longitude, look angle, elevation angle, station keeping, propagation delay time , velocity, look angle and footprint 4.4 Communication Satellite orbits and its types: LEO, MEO, elliptical orbit and GEO, parameters and characteristics of various orbits 4.5 Kepler's law, Apogee and Perigee Heights, Orbit Perturbations, Effects of a non-spherical earth, Atmospheric drag, effect of eclipse on satellite motion
Unit-V Satellite segments and Services	5a. Describe with sketches the functions of the given sub-system of the satellite earth station. 5b. Describe the given type of control systems associated with the Satellite. 5c. Describe with sketches given applications	5.1 Satellite earth station: Block diagram; Antenna subsystem, LNA, Power subsystem, Telemetry Tracking and Command (TTAC) subsystem, Attitude Control, Spinning satellite stabilization, Momentum wheel stabilization, Station Keeping, Thermal control Transponder: Single, double conversion and regenerative type 5.2 Space link: Equivalent Isotropic Radiated Power(EIRP), Transmission Losses : Free-space transmission loss, Feeder losses, Antenna misalignment losses, Fixed atmospheric and ionosphere losses 5.3 Satellite Applications: GPS: : Global positioning system (GPS) : concept, working principle, transmitter and receiver VSAT: Overview, architecture, working principle, applications

8. 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 Fiber Optic Communication	08	02	04	06	12
II	Optical Losses	12	04	06	06	16
III	Optical network	08	02	06	06	14
IV	Overview of Satellite Systems	08	02	04	06	12
V	Satellite segments and Services	12	02	06	08	16
Total		48	12	26	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.

9. 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:

- Visit any industry nearby to your house/college and observe the use of optical devices.
- List out the specification of various optical devices used in the industries.
- Undertake Internet survey for various optical fiber cables available in market.
- Observe various splicing techniques used in industries.
- Visit any earth station nearby to your house/college and observe the function of different components of satellite system and submit report on it.
- Write report on various antennas and modulation techniques used for television signal transmission.
- Visit ISRO website and collect the information related to satellite launching and submit report on it.
- Collect the information related to Indian satellites program.
- Prepare report on satellite applications.

10. 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:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- '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.
- 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).
- With respect to item No. 9, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide student(s) in undertaking micro-projects.
- Virtual lab or videos can be use in case of non-availability of equipment for mentioned experiments.

- g) Correlate subtopics with application of instrumentation.
- h) Use proper equivalent analogy to explain different optics concepts.
- i) Use Flash/Animations to explain the process of light transmission through various types of fiber optic cable
- j) Use open-source models to explain working of the fiber optic connectors.
- k) Use Flash/Animations to explain satellite communication.
- l) Use different websites to explain satellite communication systems

11. 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. For all semesters, the micro-project is group-based 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 3**.

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) Using LED as optical source, photodiode as optical detector and plastic fiber cable make prototype optical communication system.
- b) Make flow diagram of Fiber to Home (FTH).
- c) Test the performance of PWM using copper cable and compare it with result of experiment no 02.
- d) Prepared survey report to compare technical specification of different types of optical sources and detectors.
- e) Undertake a survey for different types of optical cables, give its specification and application.
- f) Undertake a survey of different OTDRs available in market, along with their specifications.
- g) Prepared report on splicing techniques used at RailTel, Reliance and BSNL or any other such organization.
- h) Monitor an optical networking used for cable service provider (TV and internet) and prepared report.
- i) Prepare an Internet based report on the different types of launch vehicles used for satellite launching.
- j) Prepare the chart to indicate applications of various satellite frequency bands (L, S, C, X, Ku and Ka band).
- k) Prepare a survey report on the different types of antennas used for Satellite communication.
- l) Conduct an Internet survey and prepare a detail report on GPS and its applications, m) Prepare a report on VSAT communication based on visit and Internet survey, n) Visit a satellite center/ pool lab having satellite set up and prepare a report on all the components and its functions.

12. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic communications Systems: Fundamentals	Tomasi, Wayne	Pearson Education India, New Delhi ISBN-13: 978-8131719534

	Through Advanced		
2	Fiber Optic Communication	Kolimbiris, Harold	Pearson Prentice Hall, New Delhi, 2004; ISBN 978-81-317-1588-8
3	The ABCs of Fiber Optic Communication	Warier, Sudhir	ARTECH HOUSE, Canton street Norwood, MA, ISBN 9781630814144
4	Fiber Optic Communication	Kieser, Gerd	Mc Graw Hill Higher Education, New Delhi, 2013, ISBN: 9781259006876,
5	Data Communications and Networking	Forouzan, Behrouz A.	Mc Graw Hill Higher Education, New Delhi, 2013, ISBN: 9781259064753,
6	Optical Fiber Communications Principles and practice	Senior, John M.	Pearson Education Limited, New Delhi, 2010, ISBN: 9788131732663,
7	Satellite Communications	Roddy Dennis	Tata McGraw-Hill, New Delhi, fourth edition, 2017 ISBN-13: 978-0070077850
8	Satellite Communication	Katiyar, Sapna	Katson publications, 3 rd edition 2013 ISBN-978-93-5014-481-7
9	Satellite communication concepts and applications	Rao Raja K. N.	PHI learning Private limited, New Delhi, second edition, 2012 ISBN-978-81-203-4725-0
10	Satellite communication systems, techniques and technology	Gerard Maral, Bousquet Michel, Zhili Sun	Wiley publication, New Delhi n 5th Edition, 2009 ISBN: 978-0-470-71458-4

13. SOFTWARE/LEARNING WEBSITES

- Optical wavelength bands:
http://www.bbcmag.com/2008issues/june08/BBP_June08_OtoL.pdf
- For virtual lab :- <http://iitg.vlab.co.in/?sub=59&brch=269>
- LED data sheet:-http://wwwl.futureelectronics.com/doc/EVERLIGHT%C2%A0/334-15_TICL-4WYA.pdf
- http://www.netes.com.tr/upload_x/dosyalar/93DA75C4C94A4B78E5E09EDBB038F0_AA.pdf
- <https://recommendedforyou.xyz/books/g4/25739?q=Satellite%20communication%201ab%20manual>

Program Name : Diploma in Electronics Production and maintenance
 Program Code : DEPM
 Semester : Six
 Course Title : Entrepreneurship development
 Course Code : 21D67

1. RATIONALE

Globalization, liberalization and privatization along with revolution in information and communication technology have opened up new opportunities transforming lives of masses. In this context, there is immense opportunity of establishing manufacturing, service, trading, marketing and consultancy enterprises by diploma engineer. Our fast-growing economy provides huge scope for diploma engineers to succeed as an entrepreneur. Entrepreneurship requires distinct set of skills which are attempted to be developed through this course. To begin with, this course aims to develop the competency and the related outcomes in order to start small enterprises.

2. COMPETENCY

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

- Develop project proposals to launch small scale enterprises.

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:

- Identify your entrepreneurial traits.
- Identify the business opportunities that suits you.
- Use the support systems to zero down to your business idea.
- Develop comprehensive business plans.
- Prepare plans to manage the enterprise effectively.

4. TEACHING AND EXAMINATION SCHEME

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

@: Internal examination

(~): For the **practical only courses**, the PA has two components under practical marks i.e., the assessment of practical (seen in section 6) has a weightage of 60% (i.e., 15 marks) and micro-project assessment (seen in section 11) has a weightage of 40% (i.e., 10 marks). This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: L-Lecture; T - Tutorial/Teacher Guided Theory Practice, PA '■' Practical: C- Credit, ESE - End Semester Examination; PA - Progressive Assessment

5. SUGGESTED PRACTICALS/ EXERCISES

The practical's 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	Submit a profile summary(about500words) of a successful entrepreneur indicating milestone achievements.	I	02*
2	Undertake SWOT analysis to arrive at your business idea of a product/service.	. 1	02
3	Generate business ideas(product/service) for intrapreneurial and entrepreneurial opportunities through brainstorming.	II	02*
4	Undertake self-assessment test to discover your entrepreneurial traits.	II	02*
5	Identify the business opportunity suitable for you.	II	02
6	Arrange an exhibition cum sale of products prepared out of waste.	II	02
7	Survey industries of your stream, grade them according to the level of scale of production, investment, turnover, pollution to prepare a report on it.	II	02*
8	Visit a bank/financial institution to enquire about various funding schemes for small scale enterprise.	III	02*
9	Collect loan application forms of nationalize banks/other financial institutions.	III	02*
10	Compile the information from financial agencies that will help you set up your business enterprise.	III	02*
11	Compile the information from the government agencies that will help you set up your business enterprise.	III	02*
12	Prepare Technological feasibility report of a chosen product/service.	III	02*
13	Prepare financial feasibility report of a chosen product/service.	III	02*
14	Craft a vision statement and enabling mission statements for your chosen enterprise.	III	02
15	Prepare a set of short term-, medium- and long-term goals for starting a chosen small-scale enterprise	III	02*
16	Prepare marketing strategy for your chosen product/service.	IV	02*
17	Compile information about various insurance schemes covering different risk factors.	IV	02
18	Organize a funfair of your class and write a report of profit/loss	V	02
19	Find the breakeven point for the business idea chosen by you.	V	02
20	Arrange a discussion session with your institute's pass out students who are successful entrepreneurs.	V	02
21	Prepare a business plan for your chosen small-scale enterprise	V	02*
Total			42

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 judicious mix of minimum 12 or more practical need to be performed, out of which, the practical's 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:

Sample Products that can be manufactured under SME

1. Badges cloth embroidered and metals
2. Bags of all types i.e., made of leather, cotton, canvas and jute etc. including kit bags, mail bags, sleeping bags and water-proof bag
3. Bandage cloth
4. Basket cane (Procurement can also be made from State Forest Corps. and State Handicrafts Corporation)
5. Bath tubs of plastic
6. Battery Charger
7. Belt leather and straps
8. Bolts and Nuts
9. Boot Polish
10. Brooms
11. Domestic Brushes of different types
12. Buckets of all types of plastic
13. Button of all types
14. Chappals and sandals
15. Cleaning Powder
16. Cloth Covers for domestic use
17. Cloth Sponge
18. Coir mattress cushions and matting
19. Cotton Pouches
20. Curtains mosquito
21. Domestic Electric appliances as per BIS Specifications: Toaster Electric, Elect. Iron, Hot Plates, Elect. Mixer, Grinders Room heaters and convectors and ovens
22. Dust Bins of plastic
23. Dusters Cotton all types except the items required in Khadi
24. Electronic door bell
25. Emergency Light (Rechargeable type)
26. Hand drawn carts of all types
27. Hand gloves of all types
28. Hand numbering machine
29. Hand Pump
30. Hand Tools of all types
31. Handles wooden and bamboo (Procurement can also be made from State Forest Corps. and State Handicrafts Corporation)
32. Haver Sacks
33. Honey
34. Invalid wheeled chairs.
35. Iron (dhobi)
36. Lamp holders
37. Letter Boxes
38. Nail Cutters
39. Oil Stoves (Wick stoves only)
40. Paper conversion products, paper bags, envelops, Ice-cream cup, paper cup and saucers and paper Plates

41. Pickles, Chutney and Pappads
42. Pouches for various purposes
43. Safe meat and milk
44. Safety matches
45. Safety pins (and other similar products like paper pins, staples and pins etc.)
46. Shoe laces
47. Sign Boards painted
48. Soap Liquid
49. Spectacle frames
50. Steel Chair
51. Umbrellas
52. Utensils all types

Sample Services that can be offered under SME

1. Marketing Consultancy
2. Industrial Consultancy
3. Equipment Rental & Leasing
4. Typing Centres
5. Photocopying Centres (Xeroxing)
6. Industrial photography
7. Industrial R & D Labs.
8. Industrial Testing Labs.
9. Desk Top publishing
10. Advertising Agencies
11. Internet Browsing/Setting up of Cyber Cafes
12. Auto Repair, services and garages
13. Documentary Films on themes like Family Planning, Social forestry, energy conservation and commercial advertising
14. Laboratories engaged in testing of raw materials, finished products
15. 'Servicing Industry' Undertakings engaged in maintenance, repair, testing or electronic/electrical equipment/ instruments i.e., measuring/control instruments servicing of all types of vehicles and machinery of any description including televisions, tape recorders, VCRs, Radios, Transformers, Motors, Watches.
16. Laundry and Dry Cleaning
17. X-Ray Clinic
18. Tailoring
19. Servicing of agriculture farm equipment e.g., Tractor, Pump, Rig, Boring Machines.
20. Weigh Bridge
21. Photographic Lab
22. Blue printing and enlargement of drawing/designs facilities
23. ISD/STD Booths
24. Teleprinter/Fax Services
25. Sub-contracting Exchanges (SCXs) established by Industry Associations.
26. Colored or Black and White Studios equipped with processing laboratory.
27. Ropeways in hilly areas.
28. Installation and operation of Cable TV Network:
29. Operating EPABX under franchises
30. Beauty Parlors
31. Creches.

S. No.	Performance Indicators	Weightage in %
National Institute of Electronics & Information Technology, Aurangabad		47 Page

1	Leadership skills	20
2	Team work	20
3	Lateral/creative thinking	10
4	Observations and recording	10
5	Self-learning	20
6	Answer the sample questions	10
7	Submission of report in time	10
Total		100

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

- Follow safe practices
- Practice good housekeeping
- Practice energy conservation
- Demonstrate working as a leader/a team member
- Maintain tools and equipment
- Follow ethical practices.

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

6. 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	Seminar Hall equipped with conference table, chairs and multimedia facilities	All
2	Modern desktop Computer with internet connection.	All

7. 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 (In cognitive domain)	Topics and Sub-topics
Unit -1 Entrepreneurship Development - Concept and Scope	1a. Describe the procedure to evaluate your entrepreneurial traits as a career option for the given product to be manufactured or services to be rendered, 1b. Explain the given terms related to Entrepreneurship 1c. Describe the salient features	1.1 Entrepreneurship as a career 1.2 Traits of successful intrapreneur/ entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking.

	of the resources required for starting the specified enterprise. Id. Identify the characteristics for a given type of enterprise.	1.3 Entrepreneurship: scope in local and global market. 1.4 Intrapreneur and entrepreneur 1.5 Types of enterprises and their features: manufacturing, service and trading. 1.6 Steps in setting up of a business.
Unit - II Entrepreneurial Opportunities and selection process	2a. Arrive at a business opportunity on the basis of given data/circumstances with justification. 2b. Describe the scheme(s) offered by the government for starting the specified enterprise. 2c. Suggest a suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. 2d. Suggest the steps for the selection process of an enterprise for the specified product or service with justification. 2e. Describe the market study procedure of the specified enterprise.	2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development. 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Industries Commission of KVIC]
Unit-III Support Systems	3a. Describe the support system required for the specified enterprise. 3b. Describe the help provided by the government agencies for the specified product/service. 3c. Describe the help provided by the nongovernmental agencies for the specified product/service. 3d. Compute the breakeven point for the specified business enterprise, stating the assumptions made	3.1 Categorization of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment and return on sales.
UNIT IV Business Plan Preparation	4a. Justify the importance of the business plan for the given product/service. 4b. Explain the key elements for the given business plan with respect to their purpose/size 4c Prepare the budget for the	4.1 Sources of Product for Business : Feasibility study 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project, feasibility report preparation and evaluation criteria 4.3 Business plan preparation

	given venture. 4d. Prepare the details of the given component of the given startup business <u>plan</u> .	
Unit -V Managing Enterprise	5a. Justify the USP of the given product/ service from marketing point of view. 5b. Formulate a business policy for the given product/service. 5c. Choose the relevant negotiation techniques for the given product/ service with justification. 5d. Identify the risks that you may encounter for the given type of business/ enterprise with justification. 5e. Describe the role of the	5.1 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 5.2 Preparing strategies of handling business: policy making, negotiation and bargaining techniques. 5.3 Risk Management: Planning for calculated risk taking, initiation with low-cost projects, integrated futuristic planning, angel investors, venture capitalist. 5.4 Incubation Centres: Role and procedure.

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

8. SUGGESTED STUDENT ACTIVITIES

Other than the classroom teaching 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

- Develop two products from household waste (attach photographs).
- Download product development and innovative films from internet.
- Prepare a collage for Traits of successful entrepreneurs.
- Invite entrepreneurs, industry officials, bankers for interaction,
- Identify your hobbies and interests and convert them into business idea.
- Convert you project work into business.
- Choose a product and design a unique selling preposition, brand name, logo, advertisement (print, radio, television), jingle, packing, packaging, label for it.
- Develop your own website. Share your strengths and weakness on it. Declare your time bound goals and monitor them on the website.
- Choose any advertisement and analyze its good and bad point.
- Decide any product and analyze its good and bad features.
- Select any product and prepare its cost sheet.
- Choose any product and study its supply chain.
- Arrange brainstorming sessions for improvement of any product.
- Study schemes for entrepreneurship promotion of any bank.
- Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
- Open a savings account and build your own capital.
- Organize industrial visit and suggest modifications for process improvement.
- Interview at least four entrepreneurs or businessman and identify Charms of entrepreneurship and traits of successful entrepreneurs,

- s. Analyze case studies of any two successful entrepreneurs.
- t. Perform a survey and identify local resources available for setting up of an enterprise, u. Engage in marketing of products.
- v. Carry out a demand supply gap analysis for a particular product.
- w. Organize a prototype development competition.
- x. Arrange fairs, events in the institute and try for sponsorships.
- y. Select any performance criteria and continuously compete with yourself.
- z. On any performance criteria continuously compete with others.
- aa. Foresee your dream and make a long-term plan for its accomplishment.
- bb. Dream for something unique and make a write-up.
- cc. Read articles, books on creativity.
- dd. Using morphological analysis technique, reduce cost or increase quality of a product,
- ee. Conduct a market survey for a project. Collect data on machinery specifications, price, output/hr., power consumption, manpower requirement, wages, raw material requirement, specification, price, competitor's product price, features, dealer commissions, marketing mix.
- ff. Prepare a business plan and organize a business plan competition, gg. Select a social cause, set objectives, plan and work for its accomplishment.
- hh. Videography as many as possible from the above and upload on your website, YouTube, Facebook.

9. 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/UOs through classroom presentations (see implementation guideline for details).
- d. With respect to item No. 8, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e. Use Flash/Animations to explain various maintenances techniques.
- f. Guide student(s) in undertaking micro-projects.
- g. Instructors should emphasize more on deductive learning. Students should learn to recognize, create, shape opportunities, and lead teams for providing economic-social value to society.
- h. Business simulations should be used to enhance behavioral traits of successful intrapreneurs and entrepreneurs amongst students. Emphasis should be on creating entrepreneurial society rather than only setting up of enterprise.
- i. They must be encouraged to surf on net and collect as much information as possible.
- j. Each student should complete minimum twenty activities from the suggested list. Minimum possible guidance should be given for the suggested activities.
- k. Students should be promoted to use creative ideas, pool their own resources, finish their presentation, communication and team skills.
- l. Alumni should be frequently invited for experience sharing, guiding and rewarding students.
- m. Display must be arranged for models, collages, business plans and other contributions so that they motivate others.

10. SUGGESTED MICRO-PROJECTS

One Business Plan as a micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he should submit it by the end of the semester to develop the industry-oriented COs. Each student will have to maintain dated work diary consisting of individual

contribution in the project work and give a seminar presentation in the middle of the semester and one at the end of the semester before submission of the project proposal incorporating the concepts taught during semester. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course.

- Choose any advertisement and analyze its good and bad points.
- Decide any product and analyze its good and bad features.
- Select any product and prepare its cost sheet.
- Choose any product and study its supply chain.
- Arrange brainstorming sessions for improvement of any product.
- Study schemes for entrepreneurship promotion of any bank.
- Visit industrial exhibitions, trade fairs and observe nitty-gritty of business.
- Open a savings account and build your own capital.
- Organize industrial visit and suggest modifications for process improvement.

S. No.	Title of Books	Author	Publication
1	The Entrepreneurial instinct: How Everyone Has the Innate Ability to Start a Successful Small Business	Mehta, Monica	McGraw-Hill Education, New Delhi, 2012, ISBN 978-0-07179742-9
2	Entrepreneurship	Hisrich, R. D.	McGraw-Hill Education, New Delhi, 2013 ISBN-13: 9781259001635
3	Part I Readings in Entrepreneurship Education	Sareen, S.B.	Entrepreneurship Development Institute of India(EDI), GOI Ahmedabad, 2016; ISBN: 978-0078029196
4	Reading Material of Entrepreneurship Awareness Camp	Gujral, Raman	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad,
5	Product Design and Manufacturing	Chitale, A K	PHI Learning, New Delhi, 2014; ISBN: 9788120348738
6	Entrepreneurship Development Small Business Entrepreneurship	Charantimath, Poornima	Pearson Education India, New Delhi; ISBN: 9788131762264
7	Entrepreneurship Development: Special edition for MSBTE	CPSC, Manila	Tata Mc-Graw Hill, New Delhi,
8	Entrepreneurship and Small Business Management	Khanka, S.S.	S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6
9	Entrepreneurship Development	S, Anil Kumar	New Age International, New Delhi, ISBN: 9788122414349

11. SUGGESTED SOFTWARE/LEARNING WEBSITES

Sr. No.	Title of book	Author
1	MCED Books links	http://www.mced.nic.in/UdyojakSpecial.aspx71 inkty pe=Udy oj ak
2	MCED Product and Plan Details	http://www.mced.nic.in/allproduct.aspx

3	The National Institute for Entrepreneurship and Small Business Development Publications	http://niesbud.nic.in/Publication.html
4	Courses : The National Institute for Entrepreneurship and Small Business Development	http://niesbud.nic.in/docs/1standardized.pdf
5	Entrepreneur.com	https://www.entrepreneur.com/lists
6	GOVT. SPONSORED SCHEMES	https://www.nabard.org/content.aspx?id=23andcatid=23andmid=530
7	NABARD - Information Centre	https://www.nabard.org/Tenders.aspx?cid=501andid=24
8	NABARD - What we Do	http://www.nabard.org/content.aspx?id=8andcatid=8andmid=488
9	Market Review	http://www.businesstoday.in/markets
10	Start Up India	http://www.startupindia.gov.in/pdf/file.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action
11	About - Entrepreneurship Development Institute of India (EDII)	http://www.ediindia.org/institute.html
12	EDII - Centres	http://www.ediindia.org/centres.html
13	EDII - Publications	http://www.ediindia.org/publication.html
14	Business Plans: A Step-by-Step Guide	https://www.entrepreneur.com/article/247574
15	The National Science and Technology Entrepreneurship Development Board (NSTEDB)	http://www.nstedb.com/Wtiadex.html
16	NSTEDB - Training	http://www.nstedb.com/training/training.htm
17	Tata Exposures	http://www.tatasocial-in.com/project-exposure
18	Ministry Of Micro, Small And Medium Enterprises	http://www.dcmsme.gov.in/schemes/TEQUPEtail.htm
19	List of Business Ideas for Small Scale Industry	https://smallb.sidbi.in/%20thinking-starting-business/big-list-business-ideas-small-business
20	Thinking of Entrepreneurship	https://smallb.sidbi.in/entrepreneurship-slage/lhinkinng-entrepreneurship
21	List of services for Small Scale Industry	http://www.archive.india.gov.in/business/Indus_services/illustrative.php

22	NSIC Schemes and Services	http://www.nsic.co.in/SCHSERV.ASP
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Program Name : Diploma in Electronics Production and maintenance
Program Code : DEPM
Semester : Six
Course Title : Capstone Project execution and Report writing
Course Code : 21D68

1. RATIONALE

This course on 'Capstone Project-Execution and Report Writing' is the continuation of the previous semester course on 'Capstone Project-Planning'. So, in this semester, the students are to implement the detailed Capstone Project Plan, which they have prepared in the preceding semester. Therefore, to successfully complete this Capstone Project by the end of this semester, it is necessary to incorporate the suggestions of the guide/examiners of the preceding semester. Hence, it is of utmost importance for the student to again re-capitulate and comprehend the importance, concept and need of the 'Capstone Projects' which are well explained in the 'Capstone Project-Planning' course in the previous semester.

Often, the jobs in the industry, which the diploma holders will come across when they join it and will be in the form of small or large projects. Such projects are generally an integration of the various types of skills which cut across the three major domains of learning

i.e. cognitive, psychomotor and affective domain which must have acquired during their journey from first semester to the last semester. Hence, it is essential that students are also given an opportunity to do large projects which require more time compared to the micro-projects in order to develop and integrate the highly essential industry oriented competencies and associated skills in the students. Therefore, in this semester the 'Capstone Project - Execution and Report Writing' will continue to integrate some more additional competencies along with those in the previous semester and hence build up greater confidence to face such situations in the world of work.

2. COMPETENCY

The course should be taught and implemented with the aim to develop the required course outcomes (COs) so that students will acquire following competency needed by the industry:

- **Implement the Capstone Project Plan to solve the identified problem/task faced by industry/user related to the concerned occupation by integrating the various types of skills acquired during the program.**

3. COURSE OUTCOMES (COs)

Depending upon the nature of the projects undertaken, the following could be some of the major course outcomes that could be attained, although, in case of some projects few of the following course outcomes may not be applicable.

- Implement the planned activity individually and/or as team.
- Select, collect and use required information/knowledge to solve the identified problem.
- Take appropriate decisions based on collected and analyzed information.
- Ensure quality in product.
- Incorporate energy and environment conservation principles.
- Consider the ethical issues related to the project (if there are any)
- Assess the impact of the project on society (if there is any). >
- Communicate effectively and confidently as a member of team.
- Prepare project report after performing due plagiarism check using appropriate tools.

- j) Prepare project report after performing due plagiarism check using appropriate tools.

4. TEACHING AND EXAMINATION SCHEME

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

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

5. Course details

As the implementation of the Capstone project progresses and which has to be submitted at the end of project work, one of the outputs of this course is a detailed **Project Report** that is continuously prepared by the student. There will also be regular progressive assessment by the teacher as per the criteria no 7 on the basis of rubrics mentioned in **Appendix -C** and in the formats as shown in **Appendix-B** and also for the end-of-semester examination.

5.1 Guidelines for Capstone Project-Execution and Report Writing

- The students would like to revise the 'Capstone Project - Plan' based on the feedback received in the fifth semester examination.
- This revised 'Capstone Project - Plan' would be again approved by the project guide. As soon as the revised plan is approved by the teacher, the student will begin to work according to it and would also continue to maintain a dated '**Project Diary**' for the whole semester. This is a sort of a 'weekly diary' indicating all the activities conducted by the student every week in the semester to complete the project. This 'Project Diary' should be got signed by the teacher at regular intervals for progressive assessment. If this is maintained sincerely and truthfully by the student, it will be very helpful in compiling the **Final Project Report** at the end of the semester by him/her.

6. Project report

During the final Semester, the student will prepare a 'Project Report' in continuation with the activities conducted in fifth semester under Project Planning having following sub-titles:

Suggested contents of the Project report

- Title page (with name of team members and mentor teacher)
- Certificate (in the Format given in this document as annexure A)
 - Acknowledgements (this may need revision at the end of the final semester)
- Abstract (in one paragraph not more than 150 words)
- Content Page

Chapters

- Chapter-1 Introduction (background of the Industry or User based Problem/Task)
- Chapter-2 Literature Survey (to finalize and define the Problem Statement)
- Chapter-3 Scope of the project
- Chapter-4 Methodology

5. Chapter-5 Details of designs, working and
6. Chapter-6 Results and Applications
7. Chapter-7 Conclusions And future scope
8. Appendix (if any)
9. References and Bibliography

Note:

- i. The report should contain as many diagrams, figures and charts etc. as relevant for the project.
- ii. Originality of the report (written in own words) would be given more importance rather than quality of printing and use of glossy paper or multi-color printing

7. ASSESSMENT OF PROJECT WORK

Project work has two components, first is Progressive Assessment (PA), while another is End Semester Examination (ESE).

7.1. Progressive Assessment (PA) Guidelines and Criteria

Project guide is supposed to carry out this assessment. It is a continuous process, during which for developing desired qualities in the students, faculty should orally give **informal feedback** to students about their performance and interpersonal behavior while guiding them on their project work every week. Following criteria should be considered while assessing students informally or formally during different stages of the project work.

The following factors need consideration for both Capstone Project-Planning and Capstone Project-Execution and Report Writing.

- a) Students should be assessed during the project work so that students can also get feedback for further improvement.
- b) It should be kept in mind that project work is mainly experiential learning and it is not the research work, so emphasis should be on work-based learning or learning from experience and development of attitudes and skills as mentioned in course outcomes. So, focus of assessment should also be on learning from the process of completing project work rather than on novelty or innovation in the project work.
- c) For progressive assessment at the end, students should be asked to give the power point presentation before group of teachers and junior students (so that junior students may also get awareness about the major project work they have to carry out in future)
- d) The students would be awarded marks for their efforts (In some cases it may happen that due to some reasons such as unavailability of some material or component or some other resources, students may not be able to complete the project, but they have tried their best, in such cases students would be given appropriate marks if they have done enough efforts.)
- e) The students would not be awarded marks if they have completed the project by getting done the work from market or some professionals (taking some help and guidance is different as compared to getting the work or maximum part of the work completed from others on payment basis).
- f) Originality of the report (written in own words) would be given more importance.

Criteria of Marks for PA for Capstone Project -Execution and Report Writing.

Sr. No.	Criteria	Marks
1	Project Proposal /Identification	
2	Punctuality and overall contribution	10
3	Project Diary	
4	Execution of Plan during sixth semester	20
5	Project Report including documentation	15
6	Presentation	05
Total		50

Criteria of Marks for ESE for Capstone Project -Execution and Report Writing

Sr. No.	Criteria	Marks
1	Project Proposal	
2	Punctuality and overall contribution	05
3	Project diary	
4	Execution of Plan during sixth semester	10
5	Project Report including documentation	10
6	Presentation	10
7	Question and Answer	15
Total		50

g) The Project Guide will assure the quality of project done by his group.

7.2 END SEMESTER EXAMINATION (ESE) Evaluation shall be carried out according to following criteria. For each project, students from the concerned group should be asked to make presentation of their project, in front of the external and internal examiners which should be followed by question answer session to ascertain the contribution made by each student.

SPECIAL TEACHING STRATEGIES (If any)

- Teacher's should not spoon feed the students and let them try on their own at different stages of the project work and even first let them strive hard and only when efforts of students have failed, then teacher should guide them. Guidance should be initially in the form of clues or hints rather than complete explanation, detailed explanation should be given only when students are not able to work based on clues/hints. The role of teacher should be limited to guide and facilitator
- Teachers should help students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.

Teachers should come out of the mindset that there should be compulsorily some innovation and novelty, in the project work. Because as discussed earlier, project is mainly opportunity for work based or experiential learning, the aim of which is to develop higher order cognitive skills and attitudes. Project at diploma level is not research or innovation. The main thing teachers have to ensure is that students choose a task or problem for their project work which is challenging but according to their capability i.e. a task which they can complete on their own without yelling it done from market.

- d) Teachers should ensure that students prepare the project plan in as much detail as possible, since this way only they would learn the importance of planning and how to do the detail planning. Teachers should allow students to proceed ahead only when they have detailed plan with them.
- e) Teachers should motivate students to maintain project document project diary and project report. They should explain benefits of these activities to students and also train them in these activities, because most of them may be doing this first time.
- f) Project Guide should ensure that students submit chapter of report one by one to him/her as per schedule and should check the content of the chapters. The Project guide should monitor that schedule is maintained and report writing is not left till last few weeks. It should not be a problem since first three chapters of the report should have been written in fifth semester itself.
- g) Teachers should also encourage students to openly discuss their weaknesses and shortcomings. Teachers should develop confidence in students that admitting mistakes and weaknesses helps in improving them.
- h) Teachers should continuously discuss with students about working of group and progress in the project and from this discussion should identify their personal qualities (both strengths and weaknesses) and suggest to them ways for improving those qualities.
- i) Internal as well as external examiners should reward students for original work and efforts of students even if they are not fully successful or not able to complete the project in comparison to those students who have taken paid help from others to complete their project.

Appendix-A

CERTIFICATE

This is to certify that Mr./Ms
from.....Institute having Enrolment No:.....
has completed project of final year having title..... during the
academic year 20 ____ -20 __ . The project completed by individually/ in a group consisting
of..... persons under the guidance of the Faculty Guide.

Name & Signature of Guide:

Telephone:..

Appendix-B

**PROGRESSIVE ASSESSMENT (PA) OF CAPSTONE PROJECT - EXECUTION
AND REPORT WRITING****Evaluation Sheet for Internal Assessment****Name of Student:**.....**Name of Programme:**..... **Semester: Sixth****Course Title:** Capstone Project: Execution and Report Writing **Code:**22060.**Title of the Capstone Project:****A. POs addressed by the Capstone Project (Mention only those predominant POs)**

- a)
- b)
- c)
- d)

B. COs addressed by the Capstone Project (Mention only those predominant POs)

- a)
- e)
- b)
- c)

C. OTHER LEARNING OUTCOMES ACHIEVED THROUGH THIS PROJECT**1. Unit Outcomes (Cognitive Domain)**

- a)
- b)
- c)
- d)

2. Practical Outcomes (in Psychomotor Domain)

- a)
- b)
- c)

3. Affective Domain Outcomes

- a)

PROGRESSIVE ASSESSMENT (PA) Sheet		
Sr. No.	Criteria	Marks
1	Project Proposal /Identification	
2	Punctuality and overall contribution	10
3	Project Diary	
4	Execution of Plan during sixth semester	20
5	Project Report including documentation	15
6	Presentation	05
Total		50

Appendix—B**Suggested Rubric for Capstone Project - Execution and Report Writing**

Sr. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
1	Problem/Task Identification (Project Title)	Relate to very few POs Scope of Problem not clear at all	i. Related to some POs ii. Scope of Problem/Task vague	i. Take care of at-least Three POs ii. Scope of Problem/task not very specific	• Take care of more than three POs ii. Scope of problem/task very clear
2	Literature Survey /Industrial Survey	Not more than ten sources (primary and secondary), very old reference	At-least 10 relevant sources, at least 5 latest	At -least 15 relevant sources, latest	About 20 relevant sources, latest
3	Project proposal	Methods are not appropriate, all steps not mentioned, Design of prototype not started (if applicable).	Appropriate plan but not in much detail. Plan B for critical activities not mentioned. Time line is not developed. Design of Prototype is not complete, (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, but clarity is not there in methods, time line is given but not appropriate. Design of prototype is not detailed (if applicable)	Appropriate and detailed plan with Plan B for critical activities mentioned, clarity in methods with time line, Detailed design of prototype (if applicable)
4	Project Diary	Entries for most weeks are missing. There is no proper sequence and details are not correct.	Entries for some weeks are missing, details are not appropriate, not signed regularly by the guide.	Entries were made every week but are not in detail. Signed and approved by guide every week	Entries were made every week in detail, signed and approved by guide every week
5	Final Report Preparation	Very short, poor quality sketches, Details about methods, material, precaution and conclusions omitted, some	Detailed, correct and clear description of methods, materials, precautions and	Conclusions. Sufficient Graphic Description.	Very detailed, correct, clear description of methods, materials, precautions and conclusions. 1 licnh tables, charts and sketches

		details are wrong			
6	Presentation	Major information is not included; information is not well organized .	Includes major information but not well organized and not presented well	Includes major information and well organized but not presented well	Well organized, includes major information ,well presented
7	Defense	Could not reply to considerable number of questions.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of questions.	Replied to most of the questions properly

Suggestive Project Diary format

Week no:

Activities planne

Program Name : Diploma in Electronics Production and maintenance
 Program Code : DEPM
 Semester : Six
 Course Title : VLSI with VHDL
 Course Code : 21D69

1. RATIONALE

In the present scenario of electronics technology, CMOS is a vital important and basic need in the design/development of almost all products in the range from consumer to industrial and telecommunication engineering area. Functional capabilities of this technology lead to advanced Very Large-Scale Integration, large density of components, high speed of operation, less area with less power dissipation. Therefore, imparting knowledge of VLSI and its tools is need of today. After completion of this course, students will be able to develop applications in the area of digital electronics using VLSI design tools.

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 VLSI based electronic circuits .

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:

- Develop design flow for the given application using VLSI tools.
- Interpret CMOS technology circuits with their specifications.
- Use relevant VHDL model for given application.
- Debug VHDL program for the given application.
- Maintain FPGA based circuits.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
2	-	2	4	--	-	-	-	--	~	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. SUGGESTED PRACTICAL/ EXERCISES

The practical's 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 internal block and pin configuration of FPGA & CPLD using datasheet.	I	02*

2	Develop flow chart of CMOS 1C fabrication using relevant website.	11	02*
3	Install EDA tool (VHDL) for VLSI application.	HI	02*
4	Implement any two gates using Data flow and Behavioral model.	IV	02*
5	Implement Half /full adder / subtracter using FPGA.	IV	02
6	Implement 8:1 multiplexer using FPGA	IV	02
7	Implement 1:8 Demultiplexer using FPGA	IV	02
8	Implement T& D-flip-flop using FPGA	IV	02
9	Implement 2:4 Decoder using FPGA	IV	02
10	Implement 8:3 Encoder using FPGA	IV	02
11	Implement up-counter using FPGA	IV	02
12	Implement synchronous counter using FPGA	IV	02
13	Implement binary to gray code converter using FPGA.	IV	02
14	Build /Test DAC using FPGA.	V	02*
15	Implement Stepper motor controller using FPGA.	V	02
16	Implement four Bit ALU or sequence generator using FPGA.	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 judicious mix of minimum 12 or more practical need to be performed, out of which, the practical's 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:

Sr. 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:

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

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

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

s. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Personal Computer with latest configuration.	All
2	FPGA trainer kit with accessories.	10-15
3	VLSI trainer kit along with peripherals such as switches, keyboard, LEDs, seven segment display.	1-15
4	VLSI trainer kit along with DAC, ADC trainer kit.	1-15
5	VLSI trainer kit along with stepper motor.	1-15
6	JTAG cable, DMM, Bread Board.	1-16
7	Xilinx/Altera or equivalent EDA tool.	13

7. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit- I Advanced Digital Design and ASIC, FPGA, CPLD.	1a. Differentiate between asynchronous and synchronous logic circuit for the given parameters. 1 b. Develop the state diagram, state table for the given sequential logic. 1c. Develop model of Moore and Mealy machine of the given Contents. Id. Describe the given ASIC, FPGA and CPLDs.	1.1 Review of Sequential Logic : Asynchronous and Synchronous, Metastability, Noise margins, Power Fan-out, Skew (Definitions only) 1.2 Moore and Mealy Models, state machine notation, 1.3 Examples on Moore and mealy: counter, sequence detector only 1.4 ASIC design flow 1.5 CPLD - Details of internal block diagram 1.6 FPGA - architecture, details of internal block diagram
Unit-II CMOS Technology concepts.	2a. Compare the performance of BJT and CMOS for the given parameters. 2b. Draw the simplified CMOS logic of the given gates. 2c. Explain CMOS inverter characteristics with relevant sketch. 2d. Describe the given MOS fabrication process.	2.1 Introduction of BJT and CMOS parameters 2.2 Basic gates using CMOS Inverter, NOR, NAND, MOS transistor switches, transmission gates, CMOS inverter characteristics. 2.3 Complex logic using CMOS 2.4 Estimation of resistance and capacitance layout. 2.5 Fabrication process: Overview of wafer processing, Oxidation, epitaxy, deposition, Ion-Implementation and diffusion, silicon gate process. 2.6 Basics of NMOS, PMOS and CMOS: nwell, pwell, twin tub process.
Unit- III Introduction to VHDL	3a. Describe Hardware description language, its components and programming syntax. 3b. Describe the	3.1 Introduction to HDL: History of VHDL, Pro's and Con's of VHDL 3.2 VHDL Flow elements:-Entity,

	given VHDL flow elements. 3c. Describe the use of given data type declaration in VHDL. 3d. Describe the given type of VHDL modeling.	Architecture, configuration, package, library only definitions. 3.3 Data Types, operators, operations. 3.4 Signal, constant and variables (syntax and use). 3.5 VHDL Modeling: - Data flow, Behavioral, Structural.
Unit-IV VHDL Programming	4a. Develop program using concurrent statements for the given application in VHDL. 4b. Develop program using sequential statements for the given application in VHDL. 4c. Develop program to implement the given combinational /sequential logic circuit using VHDL. 4d. Describe the test bench for the given application in VHDL.	4.1 Concurrent constructs (when, with). 4.2 Sequential Constructs (process, if, case, loop, assert, wait) 4.3 VHDL program to implement Flip Flop, Counter, shift register, MUX, DEMUX, ENCODER, DECODER, MOORE, MEALY machines . 4.4 Test bench and its applications.
Unit- V HDL Simulation and Synthesis.	5a. Describe VHDL simulation for the given application. 5b. Draw HDL design flow of synthesis for the given application. 5c. Describe use of efficient coding styles, optimizing expression, sharing of complex operator.	5.1 Event scheduling, sensitivity list, zero modeling, simulation cycle, comparison of software and hardware description language, delta delay. 5.2 HDL Design flow for synthesis 5.3 Efficient Coding Styles, optimizing arithmetic expression, sharing of complex operator.

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'.

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.

8. 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:

- Prepare the survey report on the VLSI based applications.
- Compare technical specifications and applications of various types of memory, CPLDs, FPGA and Prepare report.
- Refer basic requirement of PC configuration to install VLSI EDA tool.
- Give seminar on any course relevant topic.
- Conduct library / internet survey regarding different data sheet and manuals related CPLD, FPGA.
- Prepare power point presentation on VLSI and their applications.
- Undertake a market survey of companies' profile related to VLSI and prepare report.

- h. Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

9. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. 8, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e. Guide student(s) in undertaking micro-projects.
- f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
- g. Guide students for using data sheets / manuals.

10. SUGGESTED MICRO-PROJECTS

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

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

- a. Prepare report of CMOS fabrication process.
- b. Market Survey related to CMOS IC's and prepare report.
- c. Develop four-bit addition/subtraction.
- d. Develop square wave generator of Frequency = 1 Hz/ 100Hz.
- e. A shopkeeper requires an alarm system when a customer enters into the shop through exits door. Develop a VLSI based system.
- f. An indication for any maloperation in the given application is to be indicated by blinking of LEDs. Build a VLSI based system for the same.

Note: Use FPGA kit and general-purpose PCB for making micro projects

11. SUGGESTED LEARNING RESOURCES

s. No.	Title of Book	Author	Publication
1	VHDL Basics to programming	Gaganpreet Kaur	Pearson Education India, 2011 ISBN 10: 8131732118 ISBN 13: 9788131732113
	Digital Logic:	John M. Yarbrough	C.L Engineering,

2	Application and design		ISBN 10: 0314066756 ISBN 13: 978 0314066756
3	An engineering approach to digital design	William I. Fletcher	Prentice- Hall of India ISBN-13: 978-0132776998 ISBN-10: 0132776995
4	Principles of CMOS VLSI Design: A system perspective	Neil H. E. Weste Kamran Eshraghian	Pearson Education ISBN 10: 0201082225/ISBN 13:9780201082227
5	VHDL programming by example	Douglas Perry	Tata Mcgraw-hill; 4 edition (2002) ISBN-10: 0070499446 ISBN-13: 978-0070499447
6	Introduction to VLSI Design	Eugene D. Fabricus	McGraw Hill ISBN-13: 978-0070199484 ISBN-10: 0070199485
7	VLSI design and EDA tools	Sarkar & Sarkar	Scitech Publications (India) Pvt Ltd (December, 2013) ISBN-10: 8183714978 ISBN-13: 978-8183714976
8	Xilinx Manual	Xilinx	www.xilinx.com

12. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <http://www.vlsiencyclopedia.com/2012/12/loop-statement.html>
- b. <http://only-vlsi.blogspot.in/2007/12/vlsi-design-flow.html>