Maharashtra State Board of Technical Education, Mumbai

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

Program Name : Diploma in Instrumentation / Diploma in Instrumentation & Control

Program Code : IS / IC — **With Effect From Academic Year: 2017 - 18**

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

Semester : Sixth — **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Management	MAN	22509	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
2	Emerging Trends in Electronics	ETE	22636	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
3	Process Control	PCO	22644	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
4	Distributed Control System	DCS	22645	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
	Elective – II (Select any One)																				
5	Biomedical Instrumentation	BIN	22648	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
	Building Automation	BAU	22649	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Capstone Project – Execution & Report Writing	CPE	22060	-	-	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
			Total	**15**	**-**	**10**	**25**	--	**350**	--	**150**	--	**500**	--	**125**	--	**125**	--	**250**	--	**750**

Student Contact Hours Per Week: **25 Hrs.** Medium of Instruction: **English**

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

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

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

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

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

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

Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Sixth**

Course Title : **Process Control**

Course Code : **22644**

1. RATIONALE

In process industry Instrumentation technologists are expected to handle process control systems in different unit operations such as heat exchanger, evaporators, distillation column, boilers and others. The instrumentation technologists should be able to select proper control schemes such as feed forward, ratio, cascade etc for various processes to be controlled. This course is therefore designed such a way that s/he would be able to maintain different types of process control systems and the associated skills required to do the related jobs.

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 different types of process control 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) Interpret different process control elements.
b) Maintain the different types of control valves for different processes.
c) Choose relevant control strategy for various processes.
d) Maintain instrumentation in various unit operations.
e) Maintain the DCS system for different process applications.

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

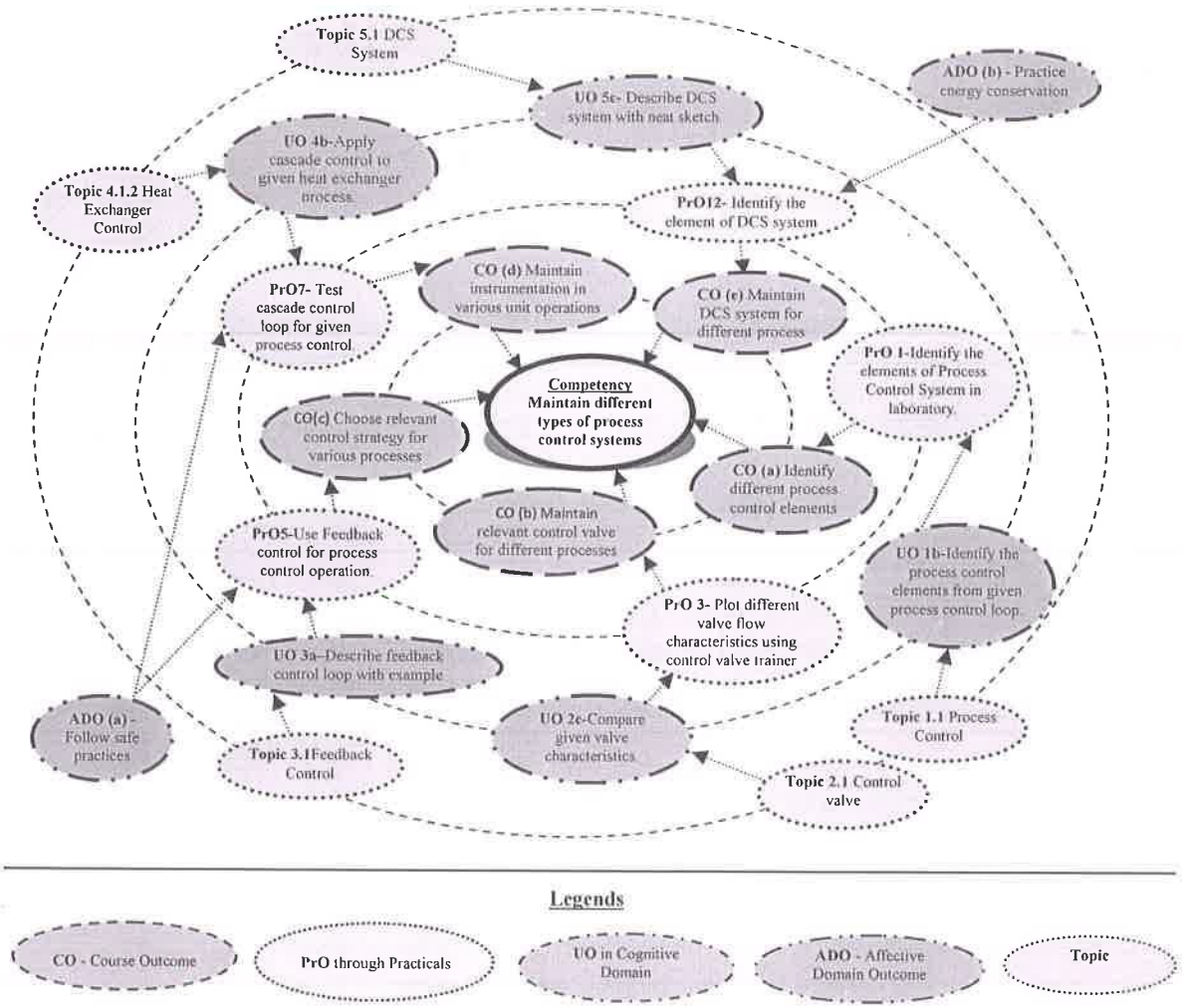

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the elements of Process Control System in laboratory.	I	02*
2	Use the process control loop to interpret the specified parameters of given application.	I	02
3	Use control valve cut section to distinguish various parts of the given control valve.	II	02*
4	Use control valve trainer setup to plot flow characteristics of different types of valves.	II	02*
5	Use valve sizing set up to calculate C_v for the given valve.	II	02*
6	Test the operation of control valve positioner	II	02*
7	Test Feedback control loop for given process control equipment.	III	02
8	Test cascade control loop for given process control.	III	02*
9	Test ratio control loop for given process control.	III	02*
10	Apply feedback control loop to heat exchanger or evaporation process.	IV	02*
11	Apply cascade control loop to heat exchanger or evaporation	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	process.		
12	Draw P and ID control scheme evaporation process.	I and IV	02*
13	Draw P and ID control scheme boiler process.	I and IV	02*
14	Draw P and ID control scheme distillation process.	I and IV	02*
15	Identify the element of DCS system in the video programme	V	02
16	Interpret the performance of process control using DCS trainer or simulator	V	02*
	Total		**32**

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental 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:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

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

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	Process control loop setup	1,2
2	Cut - Sections of different Control valves	3
3	Control Valve characteristics trainer set-up	4
4	CV Calculation Trainer Set-up.	5
5	Control Valve positioner	6
6	Feedback Control Trainer set up	7
7	Cascade or ratio Control trainer Set-up	8,9
8	Heat exchanger/Distillation/ Any other unit operations set up or simulator	10 to11
9	DCS trainer setup	15,16
10	DCS simulator software	16

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Process Control System	1a. Describe with sketch the given type of process control. 1b. Explain the functioning of the identified process control elements in the specified process control loop. 1c. Draw the P and ID symbol for given process instrument. 1d. Describe the preventive maintenance steps of the given type process control system	1.1 **Process Control:** Principle, Human aided control, Automatic control, Block diagram of process control system, Identification of elements, Benefits, Examples such temperature, level, flow, pressure. 1.2 **P and ID symbols:** most commonly used symbols in process loop.
Unit– II Process Control Valves	2a. Describe constructional features of given control valve. 2b. Select relevant control valve for given process conditions. 2c. Compare given valve characteristics. 2d. Explain the working principle of given type of control valve. 2e. Explain the role of given valve accessories in	2.1 **Control valve:** Construction, Operating Principle, Direct and Reverse acting control valve, Flow characteristics, control valve selection and sizing, noise-Cavitation and flashing, remedies, Proper installation guideline. 2.2 **Different types control valves :** Construction and working of Ball valve, Globe valve(single seated and double seated), Butterfly Valve, Solenoid Valve 2.3 **Control Valve Accessories:** Actuators-Electric and pneumatic type, Air Filter regulator.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	control valve functioning. 2f. Describe working of given valve positioner.	2.4 **Valve Positioner:** Need, Types, their Construction and working.
Unit– III Process Control Strategies	3a. Describe feedback control loop with example. 3b. Compare the given control strategies. 3c. Apply cascade control to given process. 3d. Differentiate various ratio control approaches. 3e. Explain concept of Selective control. 3f. Select override strategy for given process loop. 3g. Describe adaptive control strategy with relevant example.	3.1 **Feedback Control-** Block/schematic diagrams, Concept and Examples. 3.2 **Feed Forward Control-**Block/schematic diagrams, Concept and Examples, Comparison with feedback control. 3.3 **Cascade Control-** Block/schematic diagrams, Concept and Examples. 3.4 **Ratio Control-** Scaling, Direct and indirect approach of ratio control. 3.5 **Selective control-**Concept and Examples. 3.6 **Override Control-** Concept and Examples. 3.7 **Adaptive control-** Concept and Example. 3.8 **Split range control-** Concept and Example.
Unit-IV Unit Operations	4a. Explain with sketches the working of the given heat exchanger process. 4b. Apply cascade control to the given heat exchanger process. 4c. Compare given evaporator based on the given criteria. 4d. Choose relevant control strategy for the given evaporation process. 4e. Select relevant control strategy for given boiler process loop. 4f. Select the relevant interlocks for the given process dryer. 4g. Choose the relevant control strategy for the given process dryer. 4h. Explain with sketches the working of the distillation process.	4.1 **Heat Exchanger Process-** Principle, Operation, Type of Heat Exchanger-Shell and tube and Plate type 4.2 **Heat Exchanger Control -**Feedback Control, Cascade Control, Feedforward Control, Override Control 4.3 **Evaporation Process-** Principle, Single effect and multi effect evaporator 4.4 **Evaporator Control-** Feedback Control ,Cascade Control, Feedforward Control 4.5 **Boiler Process -**Principle, Operation ,Safety interlocks 4.6 **Boiler Control-** Feedback, Cascade Control, Feed Forward Control, Ratio Control, Feed Water and Drum Level Control –Three element boiler steam drum level control 4.7 **Drying Process-** Principle, Operation, Adiabatic Drying, Continuous Fluid-Bed Dryers, Direct-Fired/ Spray Dryers, Double drum dryer 4.8 **Drying Control-**Feedback Control, Cascade Control, Ratio Control 4.9 **Distillation Process -**Principle, Operation, Distillation Column equipment 4.10 **Distillation Control-**Feedback Control, Cascade Control, Feed forward Control

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Distributed Control System and Project Engineering	5a. Choose the DCS system for the given process with justification. 5b. Draw the display for the given group of variables. 5c. Differentiate the given communication method. 5d. Draw P and I diagram for the given process 5e. Prepare Instrument Index sheet for the given situation.	5.1 **DCS System:** Evolution, Architecture, Hierarchy, Selection Criteria, Merits of DCS over other controller. 5.2 **Process Displays:** Graphic, Group, Object, Trend, Alarm, and Event. 5.3 **Communication Method:** Features of Modbus, Profibus, Ethernet, Devicenet, Controlnet. 5.4 **Application:** Thermal power plant 5.5 **Project Engineering:** Process flow sheet, Instrument index sheet, control loop wiring diagram, Specification/Data sheet

***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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Process Control System	04	00	02	04	06
II	Process Control Valve	10	04	06	06	16
III	Process Control Strategies	12	04	06	08	18
IV	Unit operations	14	04	06	08	18
V	DCS and Project Engineering	08	04	04	04	12
Total		**48**	**16**	**24**	**30**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a) Prepare instrument index sheet for boiler application.
b) Prepare specification data sheets of distillation column instrument.
c) Draw control loop wiring diagram of any given process control loop.
d) Prepare technical specification of given valves.
e) Prepare charts for cut section given valve.
f) Prepare installation sketch of given valve.
g) Prepare technical specifications of various manufactures of DCS system.
h) Market survey for procurement of DCS System.
i) Calculate Input and Output from the given P and ID.

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:

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) Video programs/YouTube 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 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.
k) Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a) Compare technical specification of various valves.
b) Setup cascade loop for any given application.
c) Set up and Test ratio loop.
d) Develop process control loop for temperature control.
e) Develop process control loop for level control.
f) Use control valve for flow control in pipeline.
g) Use control valve for level control application.
h) Use feedback control for temperature control application.
i) Use cascade control for level control application.
j) Develop P and I diagram for boiler process.
k) Develop P and I diagram for distillation column.
l) Calculate number of I/Os from given P and I Diagram.
m) Develop instrument index sheet for given process application.

n) Develop instrument data sheet for different instruments used in given process application.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Process Control Instrumentation Technology	Johnson, Curties D.	PHI Learning, New Delhi, 2017 ISBN 978-0131194571
2	Industrial Instrumentation and Control	Singh, S. K.	McGraw Hill Publication, New Delhi, 2016 ISBN: 978-0070678200
3	Instrumentation Engineers Handbook Process Control	Liptak, Bela G	Chilton Book Company, New York 2016, ISBN: 978-0801982422
4	Applied Instrumentation in the Process Industries	Andrew, W. G; Williams, H. B.	Gulf Publication Company, ISBN-13: 978-0872013827
5	Process Automation Handbook	Love, Jonathan	Springer, verlag Londan Ltd, 2007 ISBN-13: 978-1846282812
6	Computer- based Industrial Control	Kant, Krishna	PHI Learning Private Ltd, New Delhi, 2010, ISBN: 978-81-203-3988-0
7	ISA Handbook of Control Valves	Hutchinson, James W.	Instrument Society of America (1976) ISBN 13: 9780876642344
8	Chemical Process Control	Stephanopoulos, George	Pearson India ISBN: 9789332549463

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) https://www.youtube.com/watch?v=XAItnsUcES0
b) https://youtu.be/ntvxIQPOav8
c) https://youtu.be/_w5SJ1NdKUQ
d) https://www.controleng.com/single-article/fundamentals-of-cascade-control/f25b1cb6548975a2adab1645f11d20d8.html
e) https://www.slideshare.net/haki517/industrial-process-control
f) https://www.youtube.com/watch?v=02p5AKP6W0Q.
g) https://www.youtube.com/watch?v=M7AL7-44YTc
h) https://www.slideshare.net/khalidnawaz754/distillation-column-61131518
i) https://youtu.be/mnbQ5dGjmbY
j) https://youtu.be/RyIBzJs-F-Q
k) https://www.youtube.com/watch?v=pq1C4IiU_aY
l) https://www.slideshare.net/SHIVAJICHOUDHURY/instrumentation-control-for-thermal-power-plant
m) https://youtu.be/I70jgRpf80o

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

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

Semester : **Sixth**

Course Title : **Management**

Course Code : **22509**

1. RATIONALE

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 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:

a. Use basic management principles to execute daily activities.
b. Use principles of planning and organising for accomplishment of tasks.
c. Use principles of directing and controlling for implementing the plans.
d. Apply principles of safety management in all activities.
e. Understand various provisions of industrial acts.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	

(*#) Online Theory Examination.

(*): *Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the Cos.(*#): Online examination*

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

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

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

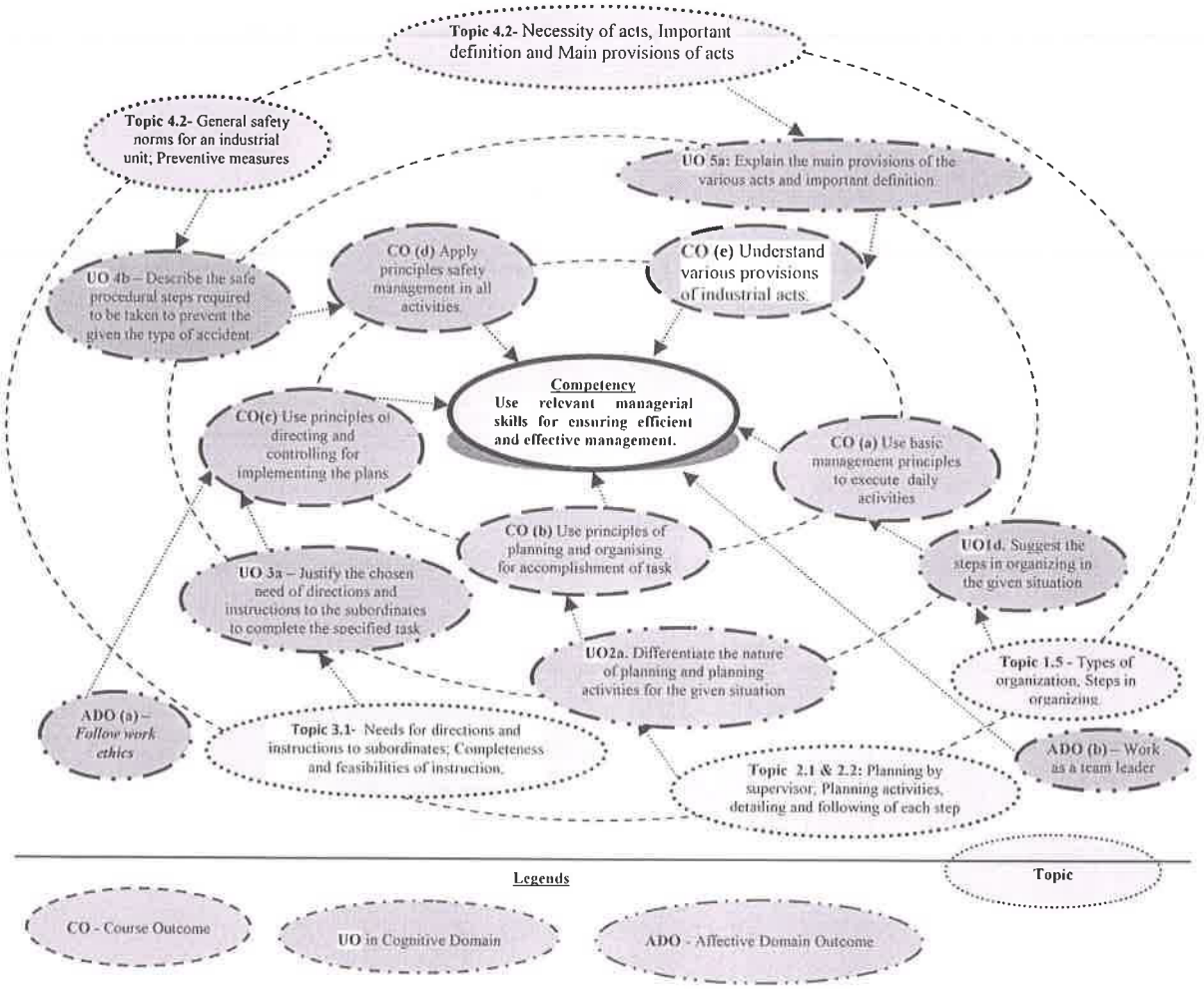

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

- Not applicable -

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

- Not applicable -

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to management concepts and managerial skills	1a. 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. 1f. Identify the functional areas of management for the given situation 1g. Suggest suitable managerial skills for given situation with justification	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.
Unit – II Planning and organizing at supervisory level	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 floor. 2c. Prepare materials and manpower budget for the given production activity. 2d. Describe with block diagrams the organization of the physical resources 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.	**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 needs. 2.7 Allotment of tasks to individuals and establishing relationship among persons working in a group
Unit– III Directing and Controlling at supervisory level	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	**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**

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	actions and remedial measures required to be taken for completing the given task successfully.	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.
Unit – IV Safety Management	4a. State the general safety norms required to be taken in the given case. 4b. Suggest preventive measures of plant 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.	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 industrial accident; Causes of accidents; 4.4 Fire hazards; Fire drill. 4.5 Safety procedure 4.6 Work permits.
Unit – V Legislative Acts	5a. Explain the purpose of the act 5b. Explain the main provisions of the various acts and important definition.	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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to management	12	06	06	04	16

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	concepts and managerial skills					
II	Planning and organizing at supervisory level	08	04	06	04	14
III	Directing and controlling at supervisory level	08	04	06	04	14
IV	Safety Management	08	04	06	04	14
V	Legislative Acts	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.*

10. SUGGESTED STUDENT ACTIVITIES

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

a. 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.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.

g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. 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.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Management and entrepreneurship	Veerabhadrappa, Havinal	New age international publishers, New Delhi, 2014: ISBN: 978-81-224-2602-1
2	Principles of management	Chaudhry omvir Singh prakash	New Age international publishers, 2012, New Delhi ISBN: 978-81-224-3039-4
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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.versesolutions.com/
b. https://www.books.google.co.in/books?isbn=817758412X
c. https://www. www.educba.com › Courses › Business › Management

Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Sixth**

Course Title : **Distributed Control System**

Course Code : **22645**

1. RATIONALE

Nowadays, process industries are being automated by advanced instrumentation devices/ systems to measure and control various process variables like temperature, pressure, flow and liquid level. In today's competitive production environment, process industries demand a totally integrated control and optimization solution that can increase productivity, reliability, and quality while minimizing cost. Distributed Control System (DCS) is designed to meet these customers' needs. The distributed architecture of DCS reduces impact from loss of system components and ensures production continuity. Instrumentation technologists should therefore be able to maintain DCS for automation and this course has been designed to fulfill that purpose.

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 Distributed Control Systems.**

3. COURSE OUTCOMES (COs)

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

a) Select the relevant DCS system for given process.
b) Maintain the hardware of given DCS system
c) Configure software for modern automation and communication systems.
d) Interpret displays, alarm and database for the given application
e) Use relevant network protocol for given DCS applications.

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

This course map illustrates an overview of the flow and linkages of the topics at various levels

of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

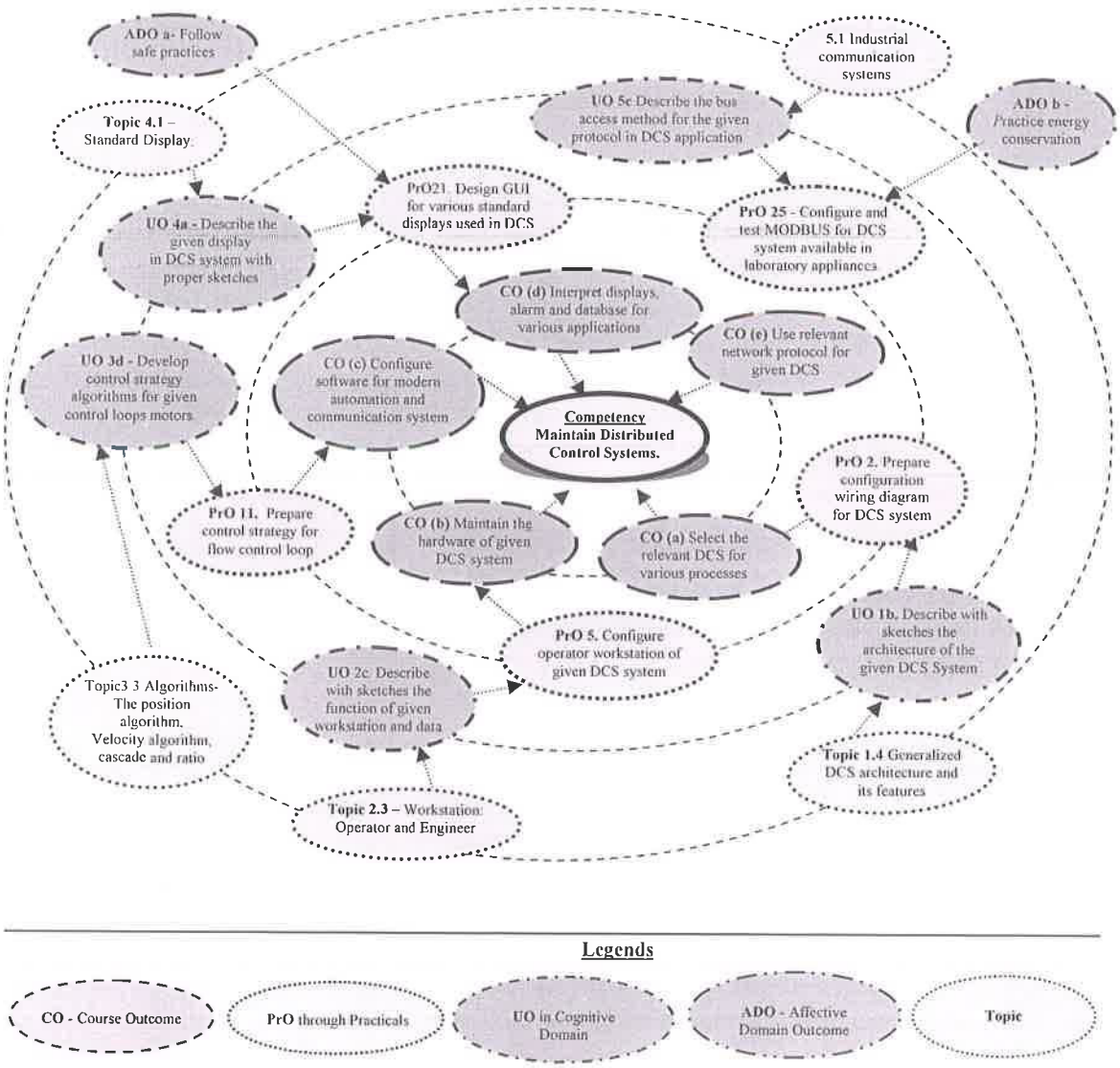

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Prepare URS (User requirement specification) and FRS (Functional requirement specification) for any small Automation project.	I	02
2	Prepare configuration wiring diagram for DCS system available in laboratory	I	02*
3	Interface the given IO devices with relevant IO module for the given DCS system	II	02*
4	Interface the communication modules with relevant communication protocol for the given DCS system to get the required result.	II	02
5	Configure operator workstation of given DCS system	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Configure engineering workstation of given DCS system	II	02
7	Configure the DCS software available in laboratory.	III	02*
8	Prepare control strategy for level control loop	III	02*
9	Prepare control strategy for temperature control loop	III	02
10	Prepare control strategy for pressure control loop	III	02
11	Prepare control strategy for flow control loop	III	02
12	Design control modules using FBD for level control loop.	III	02
13	Design control modules using FBD for temperature control loop.	III	02*
14	Design control modules using FBD for pressure control loop.	III	02
15	Design control modules using FBD for flow control loop.	III	02
16	Develop SFC algorithm for level control loop.	III	02
17	Develop SFC algorithm for temperature control loop.	III	02
18	Develop SFC algorithm for pressure control loop.	III	02*
19	Develop SFC algorithm for flow control loop.	III	02
20	Design graphical user interface for given process on DCS system.	IV	02*
21	Design GUI for various standard displays used in DCS system.	IV	02*
22	Design GUI for various user-defined display displays used in DCS system	IV	02*
23	Design GUI for any two alarms points for given process.	IV	02
24	Interpret the data from log report for given process.	IV	02*
25	Configure and test PROFIBUS for DCS system available in laboratory	V	02
26	Configure and test FIELDBUS for DCS system available in laboratory	V	02*
	Total		**52**

Note

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

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

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

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

a) Follow safety practices.
b) Practice good housekeeping.

c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

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

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	**Computer system;** Operating System: Windows 10 or higher **Memory:** minimum of 8 GB RAM, Processor Speed: minimum of Intel Core i5 or equivalent, Hard Drive: 320 GB or larger, DVD Drive: DVD +/- RW Dual Layer Burner or Mac Super Drive, Wireless: Any card that supports 802.11 g/n protocols and WPA2 Enterprise, Ethernet: 10/100/1000 (gigabit), Monitor (Desktop): 19" Monitor or larger	2-27
2	**Profibus PA starter KIT;** Profibus enable controller, devices, cable, connector, power supply.	26
3	**Modbus Trainer Kit;** Modbus enable controller/ PC, Modbus Enable device, Modbus cable, Power Supply	25
4	**Fieldbus Trainer Kit;** Controller with Ethernet enable module, Host computer and OPC server, Stratix 8000 switch, linking device, Power conditioner, Field devices, 24V DC power supply, Network terminator	27
5	**IO Devices:** Switches, Lamps, Relays, Potentiometers, Proximity sensor, DC motor, Fans, Solenoid Valve, Pneumatic valve etc.	3
6	Standard DCS system of reputed brand (such as DeltaV, Experion, Simatic PCS 7, Centum VP) with analog and digital IO modules, power supply module, communication module, controller module with compatible software	2-27
7	Level trainer kit: Level transmitter, Pneumatic control valve, compressor, motor, pneumatic tubes, water tank	8,12,16
8	Temperature trainer kit: Temperature transmitter, Pneumatic control valve, compressor, motor, pneumatic tubes, water tank, heater	9,13,17
9	Pressure trainer kit: Pressure transmitter, Pneumatic control valve, compressor, motor, pneumatic tubes, water tank	9,14,18
10	Flow trainer kit: Flow transmitter, Pneumatic control valve, compressor, motor, pneumatic tubes, water tank	11,15,19

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 Overview of distributed control system (DCS)	1a. Explain the given terminologies related to automation. 1b. Describe with sketches the architecture of the given DCS system 1c. Explain with sketches the functions of the given DCS hierarchical levels. 1d. Select the relevant DCS for the given application	1.1 Concept of PLC, SCADA and DCS. Direct Digital control, centralized computer system, Distributed control. 1.2 Hierarchical Control in automation: Hierarchical computer system for a large manufacturing process, overall task, detail task listing, lower level computer task, higher level computer task 1.3 Generalized DCS architecture and its features. 1.4 DCS brands: Delta V, Experion, Simatic PCS 7 – architecture, features, specifications
Unit– II DCS Hardware	2a. Classify the given input and output modules 2b. Explain with sketches the working of the given controller module. 2c. Describe with sketches the function of given workstation and data highway. 2d. Describe the routine maintenance of the given DCS	2.1 Input and output module: Local, Remote, rack mounted, Controller Module, Power supply module, Communication Module 2.2 Workstation: Operator and Engineer 2.3 Data Highway and local IO bus, Redundancy in the DCS 2.4 Maintenance considerations- Reliability, availability, Single loop integrity, backup systems and Fault tolerant systems.
Unit– III DCS software programming	3a. Configure the given DCS system 3b. Explain the given programming languages of DCS system. 3c. Describe the given algorithm for DCS system. 3d. Develop control strategy algorithms for the given control loops. 3e. Develop the program for given application using FBD. 3f. Develop the program for the given application using SFC.	3.1 Operating system configuration, controller function configuration, Algorithm libraries, 3.2 Process control programming: Types of program, Features of process control programs, 3.3 The executive program, Programming language for process control, 3.4 Algorithms- The position algorithm, Velocity algorithm, cascade and ratio control, Feed-forward control, Feed-back control 3.5 Functional Block Diagram programming for basic process control loops, Sequential Flow Chart programming for basic process control loops.
Unit– IV DCS Displays, Alarms And Database	4a. Describe with sketches the given display of a DCS system 4b. Explain with sketches the working of the alarm management system in the	4.1 **Standard Display**: Overview display, unit or area Overview display, Group display, Graphics display, trend display, Loop display. 4.2 **User-defined display**: Plant mimic display, area mimic display, Group

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given type of DCS. 4c. Describe with sketches the given types of logs and their reports in the specified DCS system. 4d. Justify the need of security at different levels of DCS	mimic diagram and batch control system diagram. 4.3 Alarm reporting, types of Alarm generated and acceptance of alarms 4.4 The different types of logs and report that can be configured on DCS system, Data history use in logs, reports and trend display 4.5 The need for different security levels to various operating parameters configuration (Operator, Engineer and supervisor).
Unit-V Network protocol in DCS	5a. Explain with sketches the given communication protocol in the specified DCS 5b. Compare between the given two protocols based on the specified criteria 5c. Describe the bus access method for the given protocol in DCS 5d. Describe the selection criteria for protocol for the given application	5.1 Industrial communication systems: Management system – MAP/TOP protocol. 5.2 **Field buses**- fieldbus standardization, bus access method, other features, acceptance 5.3 **MODBUS** - bus access method, application services, transmission modes, function, acceptance. 5.4 **PROFIBUS**- bus access method, data link services, application services, and acceptance. 5.5 Smart transmitters-Rackbus: Bus access method, transmitter, gateways, availability 5.6 **FIPBUS** - bus access method, other features, acceptance

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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Overview of distributed control system (DCS)	08	02	02	04	08
II	DCS Hardware	10	-	06	08	14
III	DCS software programming	10	02	04	10	16
IV	DCS displays, alarms and database	10	02	06	06	14
V	Network protocol in DCS	10	04	02	12	18
Total		**48**	**10**	**20**	**40**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual*

distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

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

a) Compare any three DCS brands based on various parameters.
b) Read an operating manual of available DCS and prepare report.
c) Prepare power point presentation on maintenance of DCS system
d) Read the safety precautions to be followed for installation of DCS system.
e) List different library objects available in DCS software
f) Download animated videos from the internet for any theory topic and make presentation on it.
g) Visit nearby automation industry and prepare a list of various IO devices.
h) Identify various components of Modbus network.
i) Identify various components of Profibus network.
j) Identify various components of Fieldbus network.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c) About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e) Guide student(s) in undertaking micro-projects.
f) Use Flash/Animations to explain working of DCS.
g) Use open source simulation softwaremodules to perform different applications using DCS.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a) Create HMI screen and tag database for bottle filling plant.
b) Create HMI screen and tag database for traffic control system.
c) Create HMI screen and tag database for any batch process.
d) Create HMI screen and tag database for elevator control.
e) Create HMI screen and tag database packaging process.
f) Develop SFC for bottle filling plant
g) Develop SFC for traffic control system
h) Develop SFC for any batch process
i) Develop SFC for elevator control
j) Develop SFC for packaging process.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Instrument Engineers' Handbook, Volume 3:	Bela G. Liptak, Halit Eren	CRC Press, 2016; ISBN 9781439863435
2	Industrial Process Automation Systems: Design and Implementation	Mehta, B.R.; Reddy, Y. Jaganmohan	Butterworth-Heinemann, 2014; ISBN, 9780128010983
3	Industrial Instrumentation & Control	Singh, S. K.	McGraw-Hill Education, New Delhi, 2009; ISBN 9780070262225
4	Distributed Computer Control Systems in Industrial Automation	Bhatkar , Vijay P.	Routledge, 2017; ISBN 9781351454698

14. SOFTWARE/LEARNING WEBSITES

a) www.ourinstrumentation.com
b) http://coep.vlab.co.in/index.php?sub=33&brch=93&sim=425&cnt=571
c) http://coep.vlab.co.in/?sub=33&brch=93&sim=440&cnt=575
d) www.profibus.com
e) https://w3.siemens.com/mcms/topics/en/simatic/pages/default.aspx
f) http://www2.emersonprocess.com/en-US/documentation/Pages/DocSearch.aspx
g) www.profibus.com/uploads/media/PROFIBUS_Planning_8012_V10_Aug09.pdf
h) https://www.youtube.com/watch?v=ZoAwTxZieHowww.fieldbus.org/
i) www.automation.com/pdf_articles/fieldbus.pdf
j) www.yokogawa.com
k) www.fieldbus-international.com
l) www.fieldbusinc.com

Program Name : **Electronics Engineering Programme Group**

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

Semester : **Sixth**

Course Title : **Emerging Trends in Electronics**

Course Code : **22636**

1. RATIONALE

Every technological area is developing at an exponential rate. New applications are coming up and it is mandatory for all technologists to be well versed in these developments to survive and provide satisfactory and quality services to the society and industry. This course aims to prepare the diploma graduates to be conversant with such emerging trends. 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:

a) Suggest the relevant computing systems/processor for specific type of application.
b) Suggest the relevant components for the emerging application/s.
c) Suggest different telecom network for given application.
d) Suggest the relevant IoT technologies for Digital Factory.
e) Suggest the different electronic systems for smart world.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--

(*): 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. COURSE MAP (with sample COs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

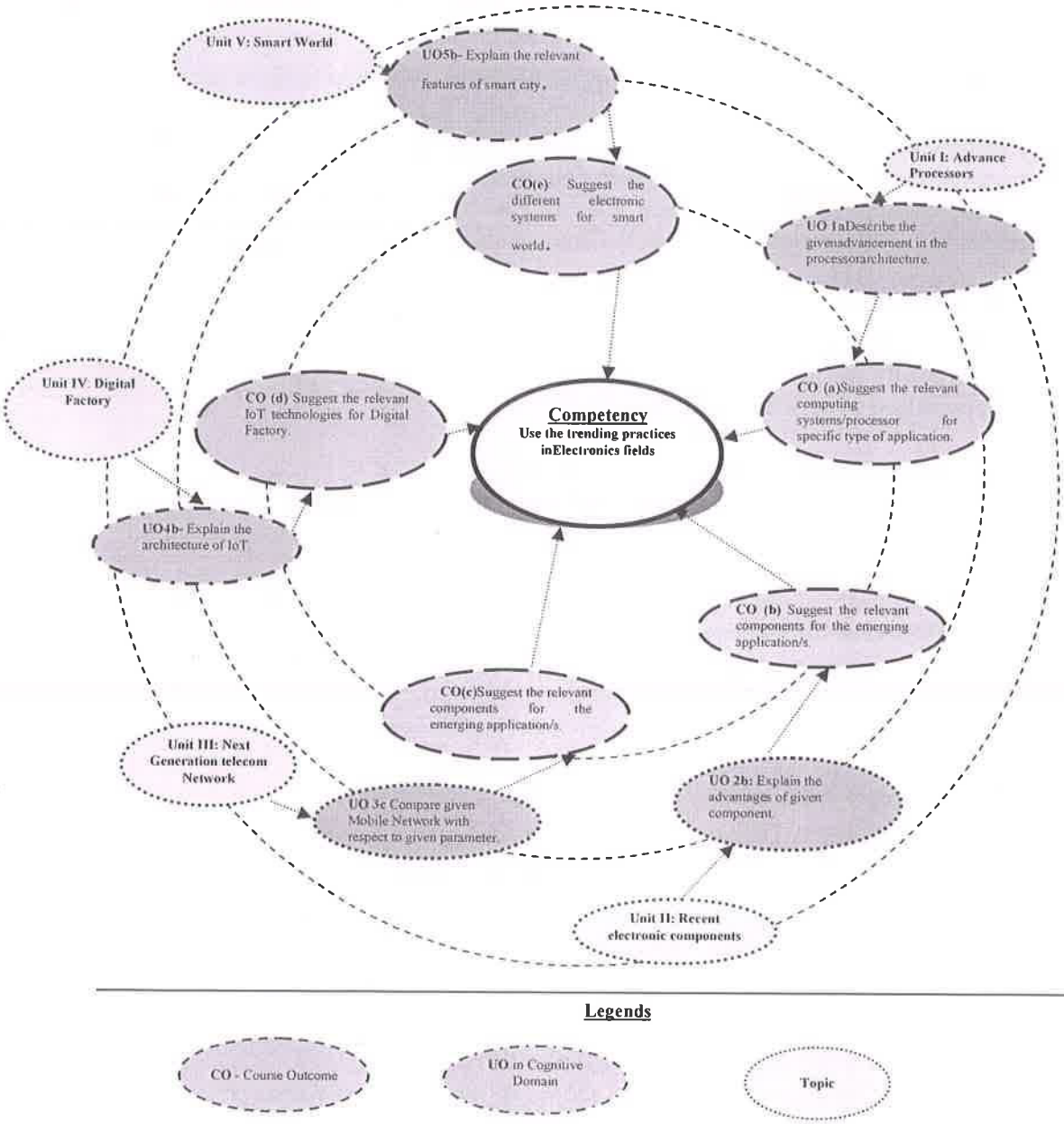

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES: Not Applicable

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: Not Applicable

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 Advance Processors	1a. Describe the given advancement in the processor architecture. 1b. Describe the given features 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 7TDMI 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 core. 3f. Describe the features of OTN and PON.	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, 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.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		3.5 Next generation transmission system: Optical Transport Network variants: Synchronous Transfer Module STM1, STM4, STM16, STM64 and STM256Features: 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 I4.0.	4.1 Internet of Things IoT: Introduction, principles and features of Cyber Physical system Components [Sensors, Edge-Gateways, Cloud]. 4.2 Architectures [Sensor to cloudvarious data routes: sensor-PLC-SCADA-cloud, sensor-server-cloud, sensor-edge gateway-cloud], Applications in Automotive/ Discrete Manufacturing; Telecom Industry; Agro Industries 4.3 I4.0/IIoT/ Smart Manufacturing: Introduction/ Evolution from I1.0 to I4.0, Applications and benefits of I4.0, Compare I3.0 with I4.0, Architecture of I4.0
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.

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 QUESTIONPAPER DESIGN

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

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

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

11. 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:

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. Show video demonstration on safety precautions.
g. Demonstrate the actions and care to be taken.
h. Arrange a visit to Electronic industry.
i. Arrange expert lecture of industry person.

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 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:

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 report on electronic 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 anapplication report on AR VR Technologies.
k. Prepare a report on Artificial Intelligence.
l. Prepare a report on Machine Learning.
m. Prepare report on electronic home security systems.
n. Prepare report on fire and gas detection and deluge systems.
o. Prepare report on ATM security systems.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Sustainable Smart Cities in India: Challenges and Future Perspectives	PoonamSharma, Swati Rajput,	Spinger; 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

Sr. No.	Title of Book	Author	Publication
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

14. SUGGESTED SOFTWARE/LEARNING WEBSITES:

Sr No	Theory topic /sub topic	Web site
1	Unit– IAdvance Processors (Advances in processor architecture)	https://slideplayer.com/slide/8290583/
2	Unit– IAdvance 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 – IIRecent Electronic Components (Flexible PCB)	https://en.wikipedia.org/wiki/Flexible_circuit
7	Unit – IIRecent Electronic Components (SMT)	https://www.electronics-notes.com/articles/electronic_components/surface-mount-technology-smd-smt/what-is-smt-primer-tutorial.php
8	Unit– IIINext 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– IVDigital Factory (IoT)	https://en.wikipedia.org/wiki/Internet_of_things
11	Unit– IVDigital Factory	http://dot.gov.in/sites/default/files/National%20Telecom%20M2M%20Roadmap.pdf
12	Unit– IVDigital Factory	http://www.tec.gov.in/technical-reports/
13	Unit– IVDigital Factory(I4.0/IIoT)	http://i40today.com/
14	Unit– VSmart World	http://tec.gov.in/pdf/M2M/Design%20Planning%20Smart%20Cities%20with%20IoT%20ICT.pdf

Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Sixth**

Course Title : **Biomedical Instrumentation**

Course Code : **22648**

1. RATIONALE

The use of biomedical instruments is increasing day by day in health care. Now- a- days advanced, complex and precision biomedical instruments are used in most of the hospitals. Instrumentation engineering diploma pass outs have to know about the biomedical instrumentation fundamentals to understand physiology of human body as well as construction, working, application of different biomedical instruments. Hence this course has been designed to develop some of the basic skills in operation, testing and maintenance of various biomedical instruments.

2. COMPETENCY

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

- **Maintain biomedical instrumentation systems.**

3. COURSE OUTCOMES (COs)

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

a) Identify the functions of anatomy and physiology of human body.
b) Maintain the biomedical instruments /electrodes for relevant applications.
c) Select the relevant biomedical instruments for biomedical parameters measurement.
d) Maintain life support biomedical instruments for specified applications.
e) Maintain biomedical imaging instrument for specified applications.

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

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

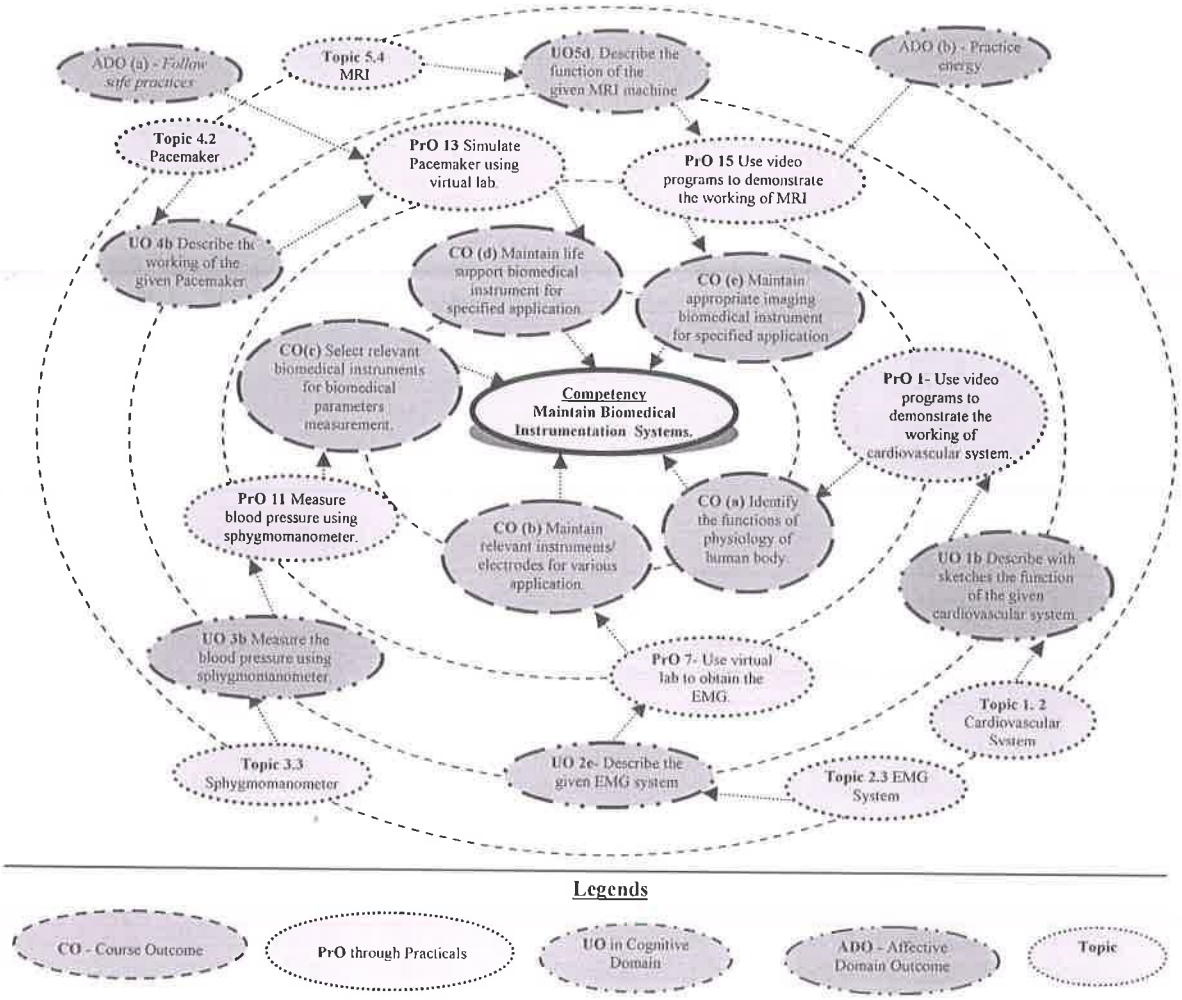

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use video programs to identify the parts and working of cardiovascular system.	I	02*
2	Use video programs to identify the parts and working of Respiratory system.	I	02*
3	Use video programs to identify the parts and working of nervous system.	I	02*
4	Use video programs to identify the parts and working of excretory system.	I	02*
5	Use video programs to identify the parts and working of different electrodes.	II	02*
6	Use ECG machine safely to measure electrocardiogram.	II	02*
7	Use ECG machine to obtain the Electromyogram with the help of	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	virtual lab.		
8	Simulate 12 Lead electrocardiogram Signals using virtual lab.	II	02
9	Use phonocardiograph to obtain phonocardiogram.	III	02
10	Use Spirometer to measure respiration rate.	III	02
11	Use sphygmomanometer to measure blood pressure.	III	02*
12	Use Defibrillator machine to defibrillate the fibrillated heart with the help of virtual lab.	IV	02*
13	Use artificial Pacemaker to simulate heart with the help of virtual lab.	IV	02
14	Use Hemodialysis Machine to dialyze the kidney with the help of virtual lab.	IV	02*
15	Use video programs to identify the parts and the working of MRI machine	V	02*
16	Use video programs to identify the parts and working of X-RAY machine.	V	02*
17	Use video programs to identify the parts and the working of CAT machine.	V	02
	Total		**34**

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	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:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

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

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	**Computer system;** Operating System: Windows 10 or higher **Memory:** minimum of 1 GB RAM, Processor Speed: minimum of Intel Core i5 or equivalent, Hard Drive: 320 GB or larger Internet connection and projector	1 to 17 except 6,9,10,11
2	ECG machine-10 or 12 lead with sensitivity5, 10, 20, auto (I~aVF: 10, V1~V6: 5) mm/mV	6
3	**Phono cardiograph** - Contact type MIR sensor Phono-pre-amplifier: Matched to sensor with gain adjustable up to 5000. Frequency response: 10 Hz to 2 KHz (+ 1db) Filter: Mass-Weber type with cut-offs at 1 KHz with slopes of 20 db, 30db, 40db and 60db per octave. Adjustable by 5-Way rotary switch. Output Level: Audio-visual indication with light flashes and beeps. Output electrical signal available: 2 Volts peak to peak. Output impedance: Less than 100 ohms.	9
4	**Digital Storage Oscilloscope** ; 60MHz/100MHz/200MHz bandwidth, 500MS/s to 1GS/s real-time sample rate, 50GS/s sample rate for repetitive waveforms, High resolution color LCD display	
5	**Spirometer:** Volume: 12 L Range: 0 to +/- 15 L/sec Accuracy: Better than 2% of scale Resistance: @ 10 L/sec < 5 mmH2O Digital resolution: Optical encoder 8ml Temperature: Internal spirometer thermistor	10
6	**Sphygmomanometer:** Bulb - pumps air into the cuff, larger sizes available. Valve - twists clockwise to deflate the cuff. Gauge - watch-like hand, measures in mmHg. Cuff - restricts blood flow, has inflatable bladder, has Velcro. Working Cycle	10-13,17

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamentals of Physiology	1a. Describe the function of the given components of Man - instrument system with sketch. 1b. Describe with sketches the	1.1 **Man-Instrument System:** Block diagram, Elements. 1.2 **Cardiovascular System:** Structure of heart, cardiovascular circulation, electrical conduction system of heart, generation of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	function of the given human physiology system. 1c. Explain the given parameters related to Cardiovascular system 1d. Describe the function of the given part of human Nervous system.	heart sound, importance of cardiac output. 1.3 **Respiratory system:** Physiology of respiratory system, mechanism of breathing, lung volumes and capacities. 1.4 **Nervous system:** Structure and functioning of neuron. Structure of brain. Functions of cerebrum, cerebellum, pons, mid brain, medulla oblongata, thalamus, hypothalamus, Spinal cord. Neuronal Communication diagram and description. 1.5 **Kidney:** Nephron, Structure, functions and operation.
Unit– II Bioelectric Signals and Electrode System	2a. Describe with sketches the use of the given bioelectric potentials of human body. 2b. Select the relevant bioelectric electrodes to measure the given situation with justification. 2c. Explain with sketches the working of the given bioelectric instrument to measure bioelectric potentials of human body. 2d. Select relevant ECG lead system to for the given situation with justification. 2e. Interpret the specification of the given instrument/ electrode. 2f. Describe the procedure to maintain the given bioelectric instrument used to measure bioelectric Signals	2.1 **Bio-Electric Potential:** Resting and Action potentials- Concept, schematic diagrams, waveform. Electrode Theory- Electrode electrolyte interface with schematic diagram 2.2 **Bio-Electrode:** Construction and diagram of various electrodes used for measuring ECG, EEG and EMG. a) Microelectrodes b) Surface electrodes: Suction cup electrode, Disposable electrode, Floating type electrode, Metal Disk electrode c) Needle electrodes. 2.3 **ECG system:** Block diagram, Working. Leads – Unipolar, Bipolar-Einthoven triangle. Electrocardiogram- Waveform, Interpretation. 2.4 **EMG system:** Electromyography- Concept, Block diagram and working. 2.5 **EEG:** Electroencephalogram, block diagram, working, waveforms and description of various stages of sleep
Unit– III Biomedical Parameters Measurement	3a. Describe with sketches the origin of given heart sound. 3b. Describe with sketches the construction of the given biomedical instrument for measuring the given parameter. 3c. Explain with sketches the working of the given biomedical instrument for measuring the given parameter. 3d. Interpret the specification of the given biomedical instrument. 3e. Describe the procedure to	3.1 **Measurement of heart sound:** Phonocardiograph- Block diagram, working. 3.2 **Blood Pressure measurement:** Principle, list the types of direct and indirect method of blood pressure measurement. Sphygmomanometer: Construction, working of sphygmomanometer. Blood pressure measurement using sphygmomanometer. 3.3 **Blood flow Measurement:** Diagram, construction and working - Plethysmograph, electromagnetic, ultrasonic method. 3.4 **Respiration rate Measurement:** Diagram, construction and working of Spirometer. 3.5 **Audiometer:** Construction, working and applications.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	maintain the given biomedical instrument used to measure the given parameters.	
Unit-IV Life Support Instruments and Electrical Safety	4a. Describe with sketches the construction of the given life support instrument. 4b. Explain with sketches the working of the given Life support instrument. 4c. Interpret the specifications of the given Life support instrument. 4d. State patient safety precautions to be taken for given electric shock and leakage current. 4e. Describe the procedure to maintain the given life support instrument.	4.1 **Defibrillator:** Concept of fibrillation, defibrillation. Types of defibrillators. DC defibrillation-diagram, working, output waveforms. Electrodes used - Paddle electrodes. 4.2 **Pacemaker:** Concept of Pacemaker. Types of Pacemaker - internal and external. Working of various pacing modes. Block diagram of Pacemaker and its working. 4.3 **Hemodialysis machine:** Need, function, block diagram, working, 4.4 **Biotelemetry:** Block diagram, working. 4.5 **Micro shock and macro shock:** Effects of leakage current on human body. Types of leakage current. Precaution to minimize electric shock hazards and leakage current
Unit –V Imaging Systems	5a. Describe with sketches the construction of the given imaging system 5b. Explain with sketches the working of the given imaging systems. 5c. Describe the given modes of Ultrasonography. 5d. Interpret the specifications of the given imaging system. 5e. Describe the procedure to maintain the given instrument used to measure imaging systems.	5.1 **X-ray:** Principle of X rays. X ray machine-Block diagram, working, Application, specifications. Image intensifier- schematic diagram and working. 5.2 **CAT:** Principle of CT scan, Block diagram, working, Applications, specifications. 5.3 **Ultrasonography:** Principle, Block diagram, working, applications, specification. Various modes of ultrasonography- A, B and M mode. 5.4 **MRI:** construction, working, application, specification. 5.5 **Tomography (PET):** Single Photon Emission Computer Tomography (SPECT) - construction, working, application, specification.

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Physiology	10	06	12	--	18
II	Bioelectric Signals and Electrodes system	10	04	10	--	14
III	Biomedical Parameters Measurement	10	04	06	02	12
IV	Life Support Instruments and	10	04	06	04	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	Electrical Safety					
V	Imaging Systems	08	02	04	06	12
Total		**48**	**20**	**38**	**12**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a) Prepare power point presentation or animation for understanding the working of physiology of human body organs.
b) Visit to hospital to understand the operation of various imaging equipments.
c) Visit to hospital to understand the operation of various life support equipments.
d) Read the safety precautions of various biomedical equipments.
e) Library / Internet survey of advanced biomedical equipment.
f) Prepare power point presentation or animation for understanding the concept of working of biomedical instrument.
g) Prepare a survey report on biotelemetry.

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:

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) Video programs/YouTube 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 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.
k) Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

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-projects 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.

Suggestive lists of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a) Prepare report on abnormalities found in ECG/EEG/EMG waveforms by collecting different samples.
b) Prepare a survey report on Blood pressure measurement of different age group and prepare comparative chart.
c) Visit a hospital and prepare a survey report on different instrument used in ICU.
d) Visit a hospital and prepare a detail report on electrical safety of different biomedical instrument.
e) Prepare comparative specification chart of different models of life support equipments.
f) Prepare comparative specification chart of different models of equipments to measure bioelectric potential using ECG/EEG/EMG.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Handbook of biomedical instrumentation	Khandpur; R. S.	McGraw Hill New Delhi 2014 **ISBN:** 9789339205430
2	Introduction to biomedical equipment technology	Carr, Joseph J, Brown, J.M	Pearson education, New Delhi 2002 ISBN: 9788177588835
3	Biomedical instrumentation measurements.	Cromwell, Lesli P, Weibell, Fred J., Pfeiffer, Erich A.	PHI Learning, New Delhi 2nd edition 2002, ISBN:, 9780130764485
4	Medical instrumentation application and design	Webster, John G.	John Wiley and Sons, New Delhi 2009, ISBN:978-0-471-67600-3

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) http://bmsp-coep.vlabs.ac.in/PulseMissingDetector/index.html
b) http://bmsp-coep.vlabs.ac.in/#
c) https://www.youtube.com/watch?v=_lgd03h3te8
d) https://www.youtube.com/watch?v=CkGqp5tr-Qk
e) https://www.youtube.com/watch?v=hc1YtXc_84A
f) https://www.youtube.com/watch?v=44B0ms3XPKU
g) https://www.youtube.com/watch?v=HnKMB11ih2o
h) https://www.youtube.com/watch?v=xIZQRjkwV9Q
i) https://www.youtube.com/watch?v=XMizSSOejg0

j) https://www.youtube.com/watch?v=m6SC7hOnAEI
k) https://www.youtube.com/watch?v=Ok9ILIYzmaY
l) https://www.youtube.com/watch?v=e19nlN6JRH4
m) https://www.youtube.com/watch?v=bn4m1VO2OzQ
n) https://www.youtube.com/watch?v=QD1PaKSBUmw
o) https://www.youtube.com/watch?v=S2EEixdkL8A

Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Sixth**

Course Title : **Building Automation**

Course Code : **22649**

1. RATIONALE

Knowledge of building environments is fundamental requirement to the design, operation and maintenance of today's complex buildings. Building management system plays a vital role in automation of Commercial buildings, Government offices, Hospitals, Pharmaceutical industries, Hotel industries, Clubs, Casinos, Air Ports, etc. Instrumentation diploma engineers has major role in building automation hence knowledge of Building Management System is essential for instrumentation students. This course will help the students to understand the various aspects of different automation systems seen in well-structured buildings.

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 instrumentation involved in Building Automation Systems.**

3. COURSE OUTCOMES (COs)

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

a) Select the relevant components for Building management systems (BMS).
b) Maintain the various equipment/components of HVAC.
c) Maintain the different Circuits/ components in BMS Subsystems.
d) Maintain Direct Digital Controllers for controlling parameters in BMS.
e) Use advanced features for effective facility control using BMS software.

4. TEACHING AND EXAMINATION SCHEME

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

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

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

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

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

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

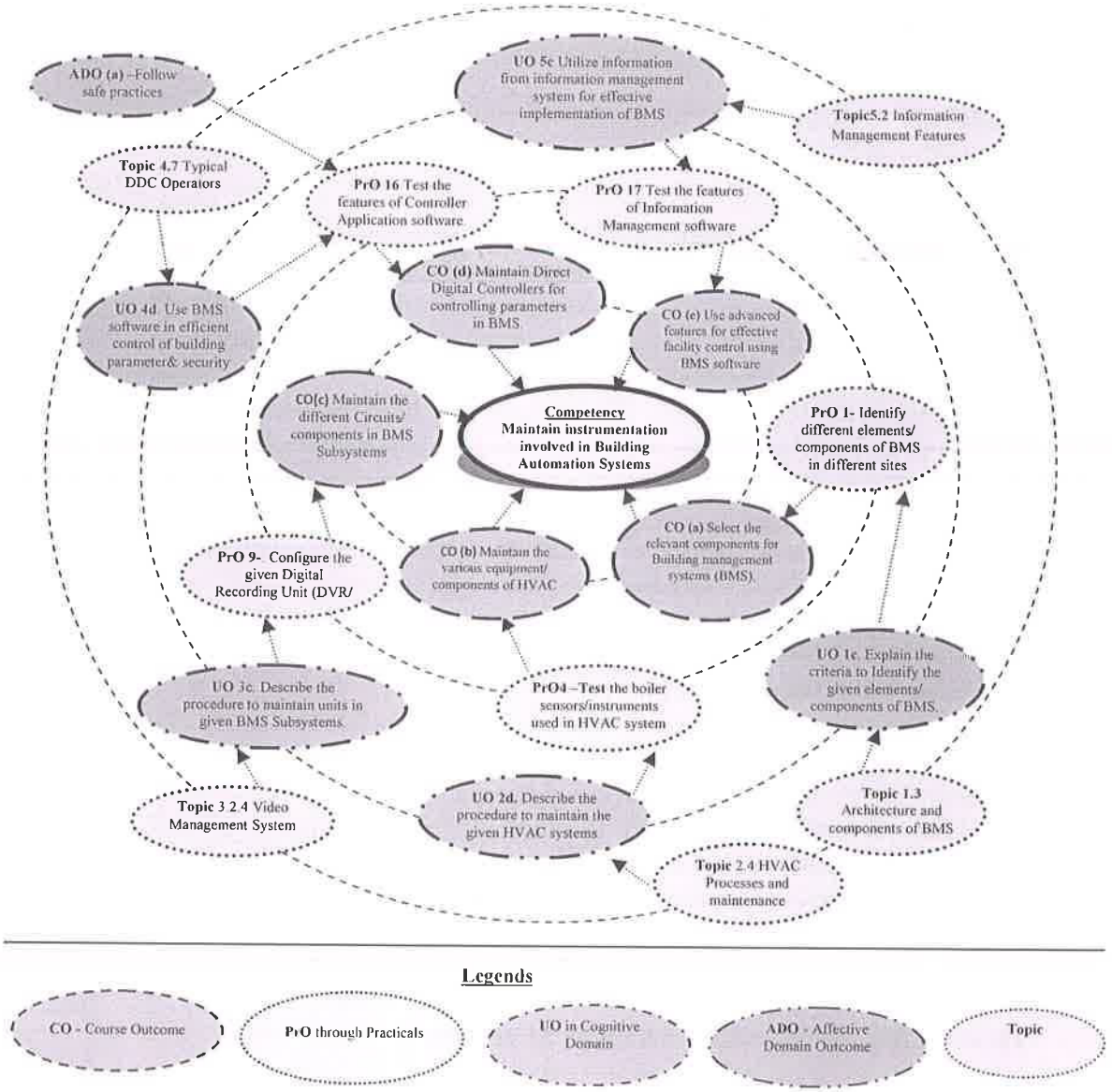

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify different elements/ components of BMS in different sites. Part-I	I	2*
2	Identify different elements/ components of BMS in different sites. Part-II	I	2*
3	Test the chiller sensors/instruments used in HVAC system.	II	2*
4	Test the boiler sensors/instruments used in HVAC system.	II	2*
5	Dismantle, test and assemble the sensors used in AHU.	II	2*
6	Dismantle, test and assemble the sensors used in unitary system.	II	2*
7	Test the given Fire detector for Building safety & security.	III	2*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Test the given Smoke detector for Building safety & security.	III	2*
9	Configure the given CCTV camera (non IP / IP based) using relevant software available with your laboratory.	III	2*
10	Configure the given Digital Recording Unit (DVR/ NVR) available with your laboratory.	III	2*
11	Troubleshoot the faults in the given CCTV system.	III	2*
12	Test the features of the given RFID based access control system.	III	2*
13	Install a single door access control system for the given application.	III	2*
14	Troubleshoot the faults in the given access control system.	III	2
15	Test the features of Controller Operating software.	IV	2*
16	Test the features of Controller Application software.	IV	2
17	Test the features of Information Management software.	V	2
	Total		**34**

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	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:

a) Follow safety practices.
b) Practice good housekeeping.
c) Practice energy conservation.
d) Work as a leader/a team member.
e) Follow ethical Practices.

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

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year

- 'Characterisation Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

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	Fire detector, smoke detector	1,6,7
2	RFID Detector System	1,12,13
3	Proximity sensors	1,3,4,5,6
4	Face and Voice detection system	2
5	Biometric system	2
6	PLC, DCS set up: with atleast16 Input/ 16output module	2
7	SCADA software:	2
8	HVAC set up	1,2,3,4,5
9	RTD, T/C, Thermistors, humidity sensor	1,3,4,5
10	CCTV Cameras: IP based/ non IP/ PTZ 2 MP, IR cameras, 20-30 meter distance	2,9,11
11	CCTV DVR/ NVR: 4/8/16 channel, Up to 2 SATA hard disks can be connectivity, 4TB SATA hard disk, local redundant recording, playback with all features like zoom, forward/ reverse, export video on USB etc.	2,10,11
12	Switch: 4/8/16 10/100/1000 Mbps Gigabit Ports, PPPoE/ simple, IEEE 802.1X port-based	2,11
13	Computers: with i3 6th gen. processor, 500 Gb HDD, 4GB RAM, Windows7	2,15,16, 17
14	IBMS Software	2,15,16, 17

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. Building Management System	1a. Describe the functions of the given BMS components. 1b. Explain with sketches the design considerations of BMS for the given application. 1c. Explain the criteria to Identify the given elements/ components of BMS. 1d. Prepare the Specifications of the BMS for the given requirements.	1.1 Concept of Building Management System (BMS) and its components such as Access control, CCTV, fire/ smoke detection and control, lighting control etc. 1.2 Requirements and design considerations and its effect on functional efficiency of building automation system, 1.3 Architecture and components of BMS. 1.4 Applications
Unit-II. HVAC system	2a. Describe science of HVAC system for the given application. 2b. Explain processes involved in HVAC system by	2.1 HVAC, Basic Processes (Heating, Cooling etc). 2.2 Basic Science: Air Properties, Psychometric Chart, Heat Transfer mechanisms, Examples.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	preparing Psychometric Chart in the given application. 2c. Calculate properties of air using Psychometric Chart for given application 2d. Describe the procedure to maintain the given HVAC systems.	2.3 Human Comfort: Human comfort zones, Effect of Heat, Humidity, and Heat loss. 2.4 Processes and maintenance: Heating Process & Applications (e.g. Boiler, Heater (no constructional details)), Cooling Process & Applications (e.g. Chiller (no constructional details)), Humidifying process and applications (e.g. Air Washers, Vaporizing humidifier), Ventilation Process & Applications (i.e. Central Fan System, AHU, Exhaust Fans), 2.5 Unitary Systems (VAV, FCU etc).
Unit-III. BMS Subsystems	3a. Explain with sketches the concepts of the given BMS Subsystems. 3b. Describe the procedure to test components/ elements and theirs functions in the given BMS Subsystems. 3c. Describe the procedure to maintain the given units in specified BMS Subsystems. 3d. Describe the procedure to Test the sensors/circuits used in given BMS Subsystems 3e. Suggest the relevant CCTV, FAS, ACS components for specified end users.	3.1 **Fire Alarm Systems** a) Basic of FAS systems b) FAS Architecture, Principles of Operation. c) FAS Components: Different fire sensors, smoke detectors, Fire Alarm Control Panel, Annunciator panel, Suppression systems d) Applications **3.2 CCTV Systems** a) Basic of CCTV systems. b) System Architecture of CCTV Systems c) Concepts Camera Connectivity, d) Video Management System: DVR, DVM, NVR e) Applications **3.3 Access Control Systems** a) Basic Concept. b) Component of Access Control Systems c) Access Control System Devices –Its features and Working principles d) Benefits of Access Control Systems
Unit-IV. Direct Digital Controller	4a. Suggest the controller for the given BMS application. 4b. Describe with sketches the procedure to use microprocessors in automation of complex buildings. 4c. Differentiate given controllers at various levels in BMS 4d. Describe with sketches the procedure Use BMS	4.1 Role of BMS Automation software 4.2 Evolution of DDC 4.3 Block diagram of DDC 4.4 Controller configuration 4.5 Types of Controller a) Zone Level b) System Level c) Operation Level d) Management Level 4.6 Controller Software a) Operating Software b) Application software- DDCS, EMS 4.7 Typical DDC Operators

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	software in efficient control of building parameters and security.	
Unit-V. Advance Technology for effective facility Control	5a. Explain with sketches the optimal features of BMS software for the given building. 5b. Explain with sketches Information Management Features in BMS software 5c. Describe the procedure to Utilize information from information management system for effective implementation of BMS. 5d. Prepare the documents for information management system.	5.1 Features for optimal Control: Optimal START / Optimal STOP, Optimal Run time, Load Rolling, Demand limiting, Economizer switchover, Night purge, After hour, Supply air reset (Chilled water or Hot Water), Condenser water reset, chiller Sequencing. 5.2 Information Management Features: a) Summaries b) Password c) Alarm Report d) Time Scheduling e) Trending f) Totalization g) Graphics

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 FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Building Management System	06	04	02	--	06
II	HVAC System	12	04	04	08	16
III	BMS Subsystems	10	04	08	12	24
IV	Direct Digital Controller	10	04	04	04	12
V	Advance Technology for effective facility Control	10	04	04	04	12
Total		**48**	**20**	**22**	**28**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a) Prepare design considerations and its effect on functional efficiency of BMS for the given premises.
b) Prepare the diagrams for duct system used in the HVAC system for the given building.
c) Prepare the specifications for boilers, chillers and humidifiers used for given industry/building.
d) Identify various components of AHU used in various applications.
e) Identify various components unitary systems used in various applications.
f) Prepare the specifications for fire detectors.
g) Prepare the specifications for smoke detectors.
h) Prepare the diagrams of fire Alarm Control Panels, annunciator panels.
i) Prepare the specifications for CCTV system.
j) Prepare the specifications for the given access control system.
k) Prepare specification of controllers used in various BMS systems.
l) Prepare specification of controllers software used in various BMS systems.
m) Prepare a layout of BMS control room for various applications using internet/YouTube.
n) Make a survey and prepare a report on optimal Control features used in various buildings (e.g. malls, hotels, hospitals, cold storage etc).

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:

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) Video programs/YouTube 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 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 big facilities/complex buildings or manufacturing industries.
k) Instruct students to safety concern of handling electronic instruments and also to avoid any damage to the electronic instruments.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a group of students that needs to be assigned to him/her in the beginning of the semester. The project undertaken is 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. The 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) Draw architecture of HVAC system, BMS system.
b) Built/construct a model for boiler used in HVAC.
c) Built/construct a model for chillers used in HVAC.
d) Built/construct a model for humidifier used in HVAC.
e) Built/construct a model for cooling tower used in HVAC.
f) Build a circuit for fire detector
g) Build a circuit for smoke detector
h) Build a circuit for fire and smoke alarm system.
i) Setup a single camera CCTV system.
j) Setup a single door access control system.
k) Design a flowchart for various parameter control strategies for a specific application.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Smart Buildings	Jim Sinopoli	Butterworth-Heinemann imprint of Elsevier, 2nd edition, 2010. ISBN- 9780978614409
2	Building Environment: HVAC Systems	Alan J. Zajac	Johnson Controls, Inc. ISBN- 9780766821002
3	Understanding Building Automation system	Reinhold A. Carlson, Robert A. Di Giandomenico	R.S. Means Company, Inc. (1991) First Edition ISBN- 9780876292112
4	Intelligent Building System	Albert Ting-Pat So, WaiLok Chan	Kluwer Academic, publisher, 3rd ed., 2012. ISBN- 9783319684611
5	Design of Special Hazards and Fire Alarm Systems	Robert Gagnon	Thomson Delmar Learning; New Delhi, 2007 ISBN-9781418039509
6	HVAC Controls and Systems	Levenhagen, John I.Spethmann, Donald H.	McGraw-Hill Publication, New Delhi, ISBN- 9780071786577
7	Process Control-Instrument Engineers Handbook	Bela G. Liptak	Chilton book co. New York, 2010, ISBN- 9781483145020

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a) Energy Management System : www.nptel.ac.in/courses/108106022/LECTURE%201.pdf:
b) Building Management System: www.melbourne.vic.gov.au/SiteCollectionDocuments/bms-the-basics-explained.pdf:
c) HVAC:www.pdfs.semanticscholar.org/presentation/11c9/9a40a4ff55687ada3b9a2a3a9f25b04b9631.pdf:
d) HVAC, BAS basics, DDC, controller softwares : https://customer.honeywell.com/resources/techlit/TechLitDocuments/77-0000s/77-E1100.pdf

e) Building Automation basics, CCTV, Access control, security systems:http://advancedcontrolcorp.com/blog/2015/05/what-is-a-building-automation-system
f) BAS: https://www.printfriendly.com/p/g/FrX73d
g) BMS software: http://faculty.kfupm.edu.sa/ARE/amhammad/ARE-457-course-web/Building-Management-System.pdf
h) BMS software:https://www.environment.gov.au/system/files/energy/files/bms-guide.pdf

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

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

Semester : **Sixth**

Course Title : **Capstone Project – Execution & Report Writing**

Course Code : **22060**

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 programme.**

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.

a) Implement the planned activity individually and/or as team.
b) Select, collect and use required information/knowledge to solve the identified problem.
c) Take appropriate decisions based on collected and analysed information.
d) Ensure quality in product.
e) Incorporate energy and environment conservation principles.
f) Consider the ethical issues related to the project (if there are any).
g) Assess the impact of the project on society (if there is any).
h) Communicate effectively and confidently as a member and leader of team.

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

4. TEACHING AND EXAMINATION SCHEME

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

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

a) The students would like to revise the 'Capstone Project – Plan' based on the feedback received in the fifth semester examination.

b) 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

1. Chapter–1 Introduction (background of the Industry or User based Problem/Task)
2. Chapter–2 Literature Survey (to finalise and define the Problem Statement)
3. Chapter–3 Scope of the project
4. Chapter–4 Methodology
5. Chapter-5 Details of designs, working and processes

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

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

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

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.

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

S. No.	Criteria	Marks
1	Project Proposal	05
2	Punctuality and overall contribution	
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**

8. SPECIAL TEACHING STRETAGIES (If any)

a) 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

b) Teachers should help students in selecting a topic which is relevant and challenging (but within capacity) for students according to their abilities.

c) ***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 getting 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 year20__-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) .....

b) .....

c) .....

d) .....

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) .....

d) .....

3. **Affective Domain Outcomes**

a) .....

b) .....

c) .....

d) .....

PROGRESSIVE ASSESSMENT (PA) Sheet		
S. No.	**Criteria**	**Marks**
1	Project Proposal /Identification	10
2	Punctuality and overall contribution	
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

S. 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, most latest	About 20 relevant sources, most 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	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,

S. No.	Characteristic to be assessed	Poor	Average	Good	Excellent
		omitted, some details are wrong			charts and sketches
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 question.	Replied to considerable number of questions but not very properly	Replied properly to considerable number of question.	Replied to most of the questions properly

Appendix C
Suggestive Project Diary format

Week no:
Activities planned:
Activities Executed:
Reason for delay if any
Corrective measures adopted
Remark and Signature of the Guide