Maharashtra State Board of Technical Education, Mumbai

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

Program Name : Diploma in Mechatronics

Program Code : MK **With Effect From Academic Year: 2019 - 20**

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

Semester : Third **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	Basic Mechanical Engineering	BME	22370	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
2	Analog & Digital Electronics	ADE	22371	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
3	Industrial Measurement	IME	22372	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Electrical Engineering	EEN	22373	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
5	Basic 'C' Programming	BCP	22374	3	-	4	7	3	70	28	30*	00	100	40	50@	20	50	20	100	40	200
6	Mechanical Working Drawing	MWD	22070	1	-	4	5	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
			Total	**18**	**-**	**16**	**34**	**--**	**350**	**--**	**150**	**--**	**500**	**--**	**200**	**--**	**200**	**--**	**400**	**--**	**900**

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

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

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

@ Internal Assessment, # External Assessment, *# Online Examination, ^ Computer Based 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 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 Mechatronics**

Program Code : **MK**

Semester : **Third**

Course Title : **Basic Mechanical Engineering**

Course Code : **22370**

1. RATIONALE

Knowledge of various materials and motion transmission devices (mechanisms and machine) is a pre-requisite for enabling a mechatronics engineer to work in an industry. This course provides the knowledge of engineering material, kinematics and dynamics of different machine elements and various mechanisms used for motion transmission. Knowledge of this course enable a diploma holder to select suitable mechanism for motion transmission.

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 principles of kinematics and dynamics in various mechatronics 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 Metal for given application.
b. Select Non-metal for given application.
c. Identify various links in different mechanisms.
d. Interpret the motion of cams and followers.
e. Select belts, chain and gear drives for given applications.
f. Select suitable flywheel & governor for various 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
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

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

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment; @- Internal 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 center of this map.

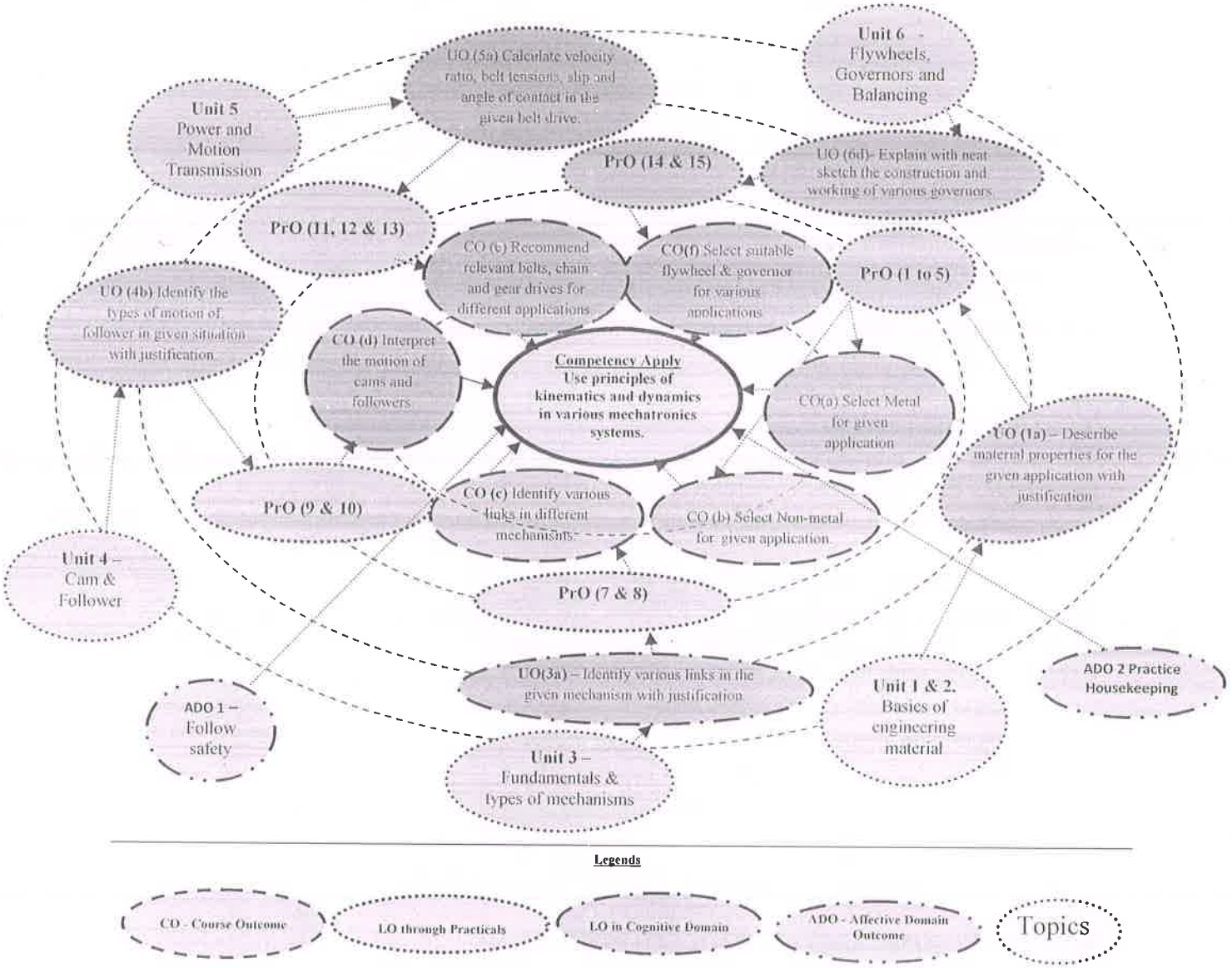

Figure 1 - Course Map

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 Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1	Test hardness of a given sample by using Brinell hardness tester. (Compare Sample of Mild Steel and Alloy steel)	I, II	02*
2	Test hardness of a given sample by using Rockwell hardness tester. (Compare Sample of Mild Steel and Alloy steel)	I, II	02
3	Test toughness of ductile and brittle material by conducting Charpy impact test as per IS 1598.	I, II	02*
4	Determine adhesive strength of a given sample by using peel tester.	I, II	02*
5	Perform flame test for identification of plastics.	I, II	02
6	Find ratio of time of cutting stroke to return stroke for quick return.	II	02*

	motion of Shaper Machine		
7	Estimate important kinematics data of following mechanism: - a) Single Slider crank mechanism b) Scotch yoke mechanism	III	02*
8	Estimate important kinematics data of following mechanism: - a) Ackerman's steering gear mechanism b) Geneva mechanism.	III	02
9	Draw profile of a radial cam with knife edge follower *(Minimum 2 problems on A2 size drawing sheet)*	IV	02*
10	Draw profile of a radial cam with roller follower *(Minimum 2 problems on A2 size drawing sheet)*	IV	02
11	Identify various drives of machines used in workshop.	V	02
12	Determine slip, length of belt, angle of contact in an open belt drive to understand its performance.	V	02*
13	Determine gear train parameters for given gear train.	V	02*
14	Measure radius and height of Spring loaded centrifugal governor for different rotational speed, mass of ball & spring stiffness	VI	02
15	Perform balancing of rotating unbalanced system.	VI	02*
	Total		30

Note

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

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

S.No.	Performance Indicators	Weightage in %
a.	Arrangement of available equipment / test rig or model	10
b.	Setting and operation	10
c.	Safety measures	10
d.	Observations and Recording	20
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	15
g.	Submission of report in time	15
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. Maintain tools and equipment.
e. Follow ethical Practices.

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Digital Brinell Hardness Tester – Hardness Range HBW< 125, Model Number B 3000	1
2	Digital Rockwell Hardness tester – easy to use electronic console, Hi/Lo tolerance settings, Adjustable time at load, Average test group results 2-9, Test result memory capacity -5000 result, Output-average range.	2
3	Peel tester- Maximum Capacity 100N	4
4	**Impact Testing Machine: -** CHARPY Test Apparatus: Pendulum drop angle 140^0; Pendulum effective weight 20-25 kg; Striking velocity of pendulum 5-6 m/sec; Pendulum impact energy 300 J;	3
5	Working model of Single Slider crank mechanism, Scotch yoke mechanism, Ackerman's steering gear mechanism, Geneva mechanism.	7,8
6	Working model of various cam & followers	9,10
7	Working models of different types of belts.	12
8	Working model of gear trains (Simple, compound, reverted, epicyclic)	13
9	Working model of various types of governors.	14
10	Balancing machine: revolving masses & reciprocating masses.	15

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Basics of Engineering material	1a. Classify Engineering Materials 1b. Describe material properties for the given application with justification 1c. Draw Iron-Carbon diagram & its characteristics. 1d. Select steel for relevant application with justification. 1e. Select cast iron for relevant application with justification.	1.1 Classification of engineering materials. 1.2 Materials Properties. • Mechanical • Chemical Properties • Thermal Properties • Electrical / Electromagnetic 1.3 Iron-carbon equilibrium diagram and its characteristic 1.4 **Steel & its alloy:** Broad Classification of steel: a) **Plain carbon steel**: Definitions, Types, Composition, properties and application b) **Alloy Steel:** - Definition, effect of alloying elements on properties of alloy steel c) **Tool steel:** Types, composition

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1f. Select nonferrous Metals and alloy for relevant application with justification.	Properties and application **d) Stainless steel:** Types, composition Properties and application 1.5 **Cast Iron-** Classification, composition, properties and application 1.6 **Non-Ferrous Metals & alloys:** a) **Copper and its alloy (Brasses & Bronzes):** Composition, Properties and applications
Unit II Non-metallic and advanced materials	2a. Describe properties of Polymers and its application. 2b. Describe Characteristics of various types of plastics 2c. Explain properties and application of Ceramics 2d. Select relevant composite material for the given application with justification. 2e. Suggest relevant alternative materials for the given application with justification.	2.1 **Polymeric Materials** a) Polymers-types, characteristics b) Properties and applications of Thermoplastics, Thermosetting Plastics and Rubbers. 2.2 Characteristics and uses of ABS, Acrylics, Nylons, Vinyl's, Epoxides, Melamine's and Bakelite. 2.3 **Ceramics** –Types of ceramics, Properties and applications of glasses and refractories. 2.4 **Composite Materials-** Properties and applications of Laminated and Fiber reinforced materials. 2.5 **Advanced Engineering Materials-** Properties and applications of Nano materials and smart materials.
Unit– III Fundamentals and types of mechanisms	3a. Identify various links in the given mechanism with justification. 3b. Select suitable mechanism for the given application with justification.	3.1 **Kinematics of Machines:** Introduction to Statics, Kinematics, Kinetics, Dynamics; Kinematic links, joints, pairs, chain and its types; Constrained motion and its types, Inversion, Mechanism, Machine and Structure. 3.2 **Inversions of Kinematic chains:** **a) Four Bar Chain** – Locomotive coupler, Beam engine and Pantograph. **b) Single slider crank chain-** Pendulum pump, Rotary I.C. engine mechanism, Oscillating cylinder engine, Whitworth quick return mechanism, Quick return mechanism of shaper; **c) Double slider chain**-Scotch Yoke mechanism, Elliptical trammel, Oldham's coupling.
Unit-IV Cams & Followers	4a. Classify types of cam and follower for given application with justification. 4b. Identify the types of motion	4.1 **Cam & Follower** –Introduction, Applications, Classification of Cam & Followers, Cam terminology. 4.2 Types of follower motions & their displacement diagrams – Uniform velocity,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of follower in given situation with justification. 4c. Draw cam profile for the given motion and for given applications	Simple harmonic motion, Uniform acceleration and retardation. 4.3 Drawing of profile of radial cam based on given motion of reciprocating knife edge and roller follower with and without offset.
Unit –V Power and Motion Transmission Elements	5a. Select suitable belt for the given application with justification. 5b. Calculate velocity ratio, belt tensions, slip and angle of contact in the given belt drive. 5c. Selection of chains for given applications. 5d. Calculate Train value and velocity ratio for the given simple, compound, reverted and epicyclic gear trains using spur and helical gears.	5.1 **Belt Drives-** a. Introduction to Flat belt, V-belt and its applications, materials used for the belt. b. Introduction of timing belt and pulley. Angle of lap, length of belt, Slip and creep. Determination of velocity ratio of tight side and slack side tension, centrifugal tension and initial tension, condition for maximum power transmission. Merits, demerits and selection of belts for given applications. *(Simple numericals)* 5.2 **Chain Drives-** Introduction to chain drives, Types of chains and sprockets, Methods of lubrication, Merits, demerits and selection of chains for given applications. 5.3 **Gear Drives-** Introduction to gear drives, Classification of gears, Laws of gearing, gear terminology, Types of gear trains, Train value and velocity ratio for simple, compound, reverted and epicyclic gear trains using spur and helical gears, Merits. Demerits and selection of gear drives for given applications.
Unit-VI Flywheels, Governors and Balancing	6a. Explain with sketches the turning moment diagram for the given single cylinder 4-Stroke I.C. engine for the given data. 6b. Explain with sketches the method of balancing a rotating mass as per the given conditions. 6c. Explain with neat sketch the construction and working of various governors Estimate the balancing mass and position of plane analytically and graphically in the given situation for the given data.	6.1 **Flywheel-** Introduction to flywheel-need, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C. Engine *(No numerical).* 6.2 Coefficient of fluctuation of energy, coefficient of fluctuation of speed and its significance. 6.3 **Governors-** Introduction, types, functions and applications, Terminology of Governors. 6.4 Comparison of Flywheel and Governor. 6.5 **Balancing** – Need and types of balancing, balancing of single rotating mass, Analytical/Graphical methods for balancing of several masses revolving in same plane.

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Engineering material	12	02	04	06	12
II	Non-metallic and advanced materials	08	02	02	04	08
III	Fundamentals and types of mechanisms	10	04	04	04	12
IV	Cams & Followers	12	02	04	06	12
V	Power and Motion Transmission Elements	14	04	04	08	16
VI	Flywheels, Governors and Balancing	08	02	04	04	10
Total		**64**	**16**	**22**	**32**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare presentation on different types of Power and Motion transmission elements.
b. Collect information from internet related to different materials used for various applications, its compositions and properties.
c. Collect information from internet related to various mechanisms/elements like piston, crank, connecting rod, cam, flywheel, governor, or of mechanisms etc. along with function and area of application.
d. List the various mechanisms used in different mechatronics system.
e. Collect the information of various power transmission devices used in mechatronics systems.
f. Visit the workshop related to mechatronics system and collect the data of items/mechanisms which is used in various mechatronics systems, their material, working & application.

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/animation to explain various mechanisms.
g. Use proper equivalent analogy to explain different concepts.
h. Show models, educational charts, videos & real life examples of various mechanisms.
i. Demonstration of real industrial parts and mechanism used in various mechatronics systems.
j. Industrial visit to any industry where mechatronics systems is available.
k. Guide the students to do the survey of various materials used in different applications.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Collect the samples of various materials used in day to day applications and prepare the chart containing composition, properties & applications.
b. Collect the information from internet related to the different advanced materials for Mechatronic applications.
c. Study of various mechanical properties of materials.
d. Comparative study of different materials.
e. Field survey to collect applications of various types of belts.
f. Prepare working model of various types of belts.
g. Prepare working/ Demo model of different mechanisms by using low cost material.
h. Prepare animations of different mechanisms by using free software available on internet.
i. Field survey of various mechanism used in different mechatronics systems.
j. Field survey to collect applications of various types of flywheel and governors.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Elements of Mechanical Engineering	Manglik V. K.	PHI Learning Pvt. Ltd, New Delhi, ISBN:9788120348691
2	Engineering Materials	Agarwal B.K.	McGraw-Hill Education, New Delhi. ISBN 978-00-745-4505-1

S. No.	Title of Book	Author	Publication
3	Theory of Machines	Khurmi R.S. Gupta J.K.	S. Chand Publications, New Delhi, ISBN: 9788121925242
4	Theory of Machines	Rattan S.S.	McGraw-Hill Education, New Delhi ISBN: 9780070591202
5	Theory of Machines	Bevan Thomas	Pearson Education India, New Delhi, ISBN:9788131729656

14. SOFTWARE/LEARNING WEBSITES

a. www.technologystudent.com/gears1/gears7.htm
b. https://www.youtube.com/watch?v=h2VhzUv61b8
c. http://vimeo.com/32224002
d. https://www.studyvilla.com/electrochem.aspx
e. https://www.youtube.com/watch?v=zNzpOwWzxXw
f. https://www.youtube.com/watch?v=Jq35SP5lQOs
g. https://www.youtube.com/watch?v=dbywZ4PJ3QA


BOARD OF TECHNICAL EDUCATION

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Third**

Course Title : **Analog and Digital Electronics**

Course Code : **22371**

1. RATIONALE

Diploma Mechatronics engineer deals with the various analog and digital electronic components while maintaining various electronic equipments. This course has been designed to develop skills to test electronics circuits. After studying the course student will develop an insight to identify, build and troubleshoot Analog and Digital electronic circuits.

2. COMPETENCY

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

- **Use different electronic components for relevant system.**

3. COURSE OUTCOMES (COs)

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

a. Identify different types of semiconductor diodes.
b. Use of diodes in different electronics applications.
c. Interpret working of transistor in electronic circuits.
d. Use of logic gates and Boolean Logic for building digital circuits.
e. Use of combinational and sequential logic circuits.
f. Use data converters in electronic systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

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

***Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment; @- Internal 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 center of this map.

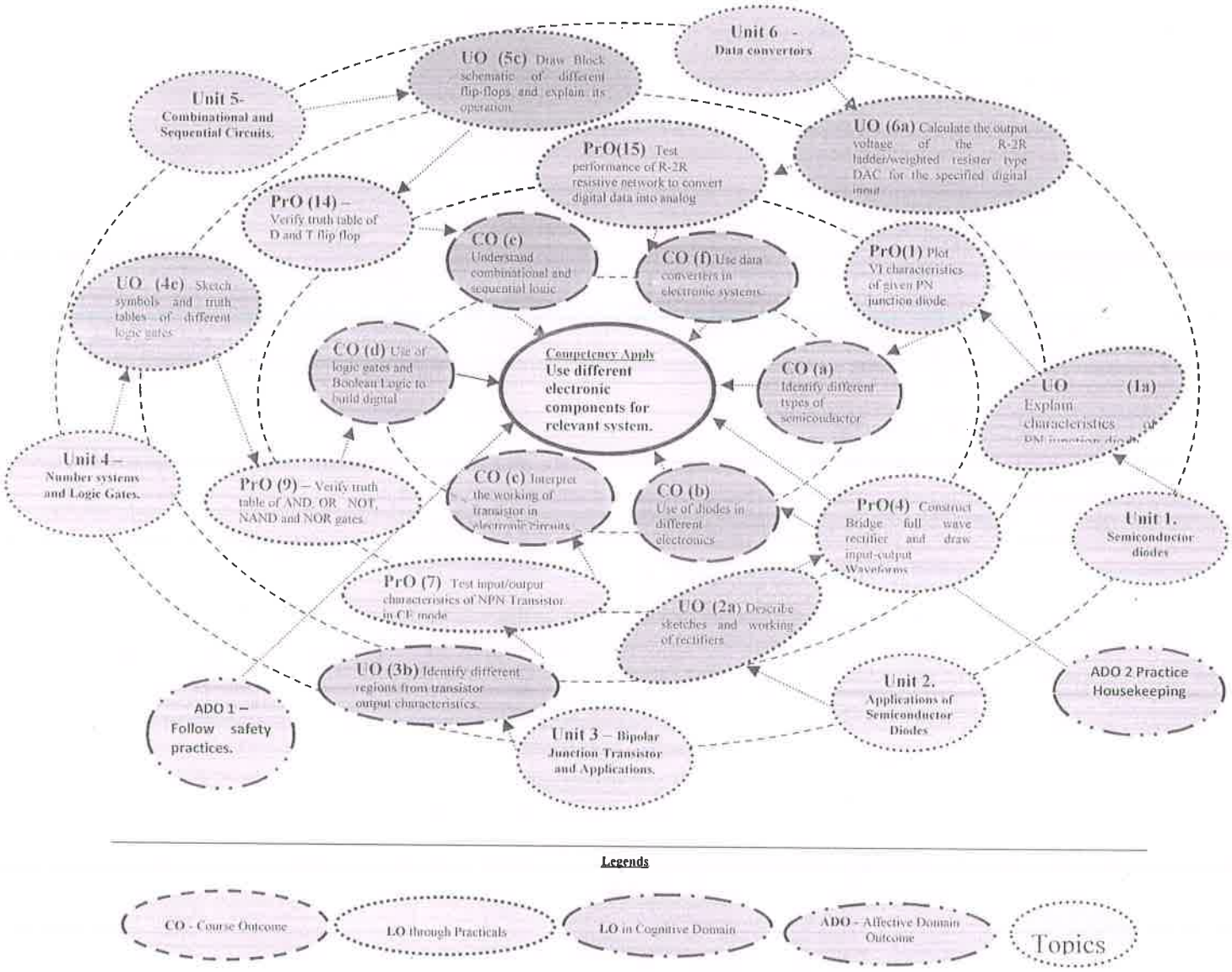

Figure 1 - Course Map

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	Plot VI characteristics of given PN junction diode.	I	2*
2	Plot VI characteristics of given Zener diode.	I	2
3	Construct half wave rectifier for observing input–output Waveforms.	II	2
4	Construct Bridge full wave rectifier for observing input-output Waveforms.	II	2*
5	Test performance of given zener diode as voltage regulator.	II	2*
6	Test performance of regulated power supply using IC 78XX and 79XX.	II	2
7	Test input/output characteristics of NPN Transistor in CE mode.	III	2*
8	Determine gain and Bandwidth of single stage RC coupled	III	2

	amplifier.		
9	Verify truth table of AND, OR. NOT, NAND and NOR gates.	IV	2*
10	Test functionality of EX-OR and EX-NOR gates.	IV	2
11	Verify truth table of Half and Full adder.	V	2
12	Verify truth table of 8:1 Multiplexer using IC 74151	V	2*
13	Verify truth table of 1:8 Demultiplexer using IC.	V	2
14	Verify truth table of D and T flip flop.	V	2*
15	Test performance of R-2R resistive network for converting digital data into analog.	VI	2*
16	Test performance of weighted resister network for converting digital data into analog.	VI	2
	Total		**32**

Note

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

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

S.No.	Performance Indicators	Weightage in %
a.	Arrangement of available equipment	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	20
e.	Interpretation of result and Conclusion	10
f.	Answer to sample questions	10
g.	Submission of report in time	10
	Total	**100**

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

a. Follow safety practices.
b. Practice good housekeeping.
c. Maintain tools and equipment.
d. Follow ethical Practices.

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Cathode ray Ooscilloscope (CRO): 0-20 MHz Dual Trace, Dual Beam with Component Tester	3,4,5,8
2	Function Generator with TTL output: 20MHz	8
3	Ammeter (0-25 mA), Voltmeter (0-5V, 0-10V DC)	1 to 8
4	DC Regulated Fixed Power Supply: 5V Short Circuit protection display for voltage and current.	9 to 14
5	DC Regulated Power Supply: Variable DC Voltage 0-30V, 2A. Short Circuit protection display for voltage and current.	1,2,6 to 16
6	Dual Power Supply: +/- 15V	15 to 16
7	Digital Multimeter: 3 1/2 Digit Display with R, V and I measurement and Diode, Transistor testing facility.	1 to 16
8	Digital and Analog IC tester: To test wide range of ICs such as 74 series, 40/45 series of CMOS ICs.	9 to 16
9	Trainer kits/bread board, Logic IC's (7400, 7402, 7404, 7408, 7432, 7486, 74266, 7474, 7476, 74151, 741, 74155, 7805, 7905) Electronic components (Rectifier Diode, LED, Zener Diode, Transistor, Resistors, Capacitors) for performing Practicals.	1 to 16
10	Trainer kits for digital ICs: Trainer kit shall consist of Digital IC's for logic gates, Flip-Flops, Shift Registers, counter along with toggle switches for inputs and bi-color LED at outputs and built in power supply.	9 to 14

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Semiconductor diodes	1a. Explain characteristics of PN junction diode. 1b. Explain V-I characteristic of zener diode 1c. Compare PN- junction diode with LED. 1d. Draw symbols of different semiconductor diodes.	1.1 Symbol, construction and working principle of PN junction diode. Forward and Reverse bias. VI characteristics of PN- junction diode. 1.2 Symbol, Construction, Working principle and VI characteristics of Zener diode. 1.3 Symbol, Construction and Working principle of light emitting diode (LED). 1.4 Symbol, construction and working principle of photo diode.
Unit– II Applications of Semiconductor Diodes	2a. Describe working of rectifiers. 2b. Compare different parameters of rectifiers. 2c. Describe working principle of filters. 2d. Explain zener diode as voltage regulator. 2e. Draw block diagram of DC regulated power supply.	2.1 Types of Rectifiers: Half wave, Full wave, Bridge Rectifier. Working principle, circuit diagram, Input and Output voltage waveform. 2.2 Performance parameters of rectifier: PIV, Ripple factor and Efficiency. 2.3 Need for filters, circuit diagram and working of L, C, and II filter.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		2.4 Zener diode working as voltage regulator. 2.5 Working principle, Block diagram of Regulated Power Supply, IC 78XX and IC 79XX, Complete DC power supply circuit.
Unit-III Bipolar Junction Transistor and Applications.	3a. Classify Unipolar and bipolar devices. 3b. Describe working of transistor. 3c. Explain output characteristics of transistor 3d. Determine the current gain of transistor. 3e. Explain working of transistor as switch 3f. Explain transistor as an amplifier.	3.1 Unipolar and bipolar devices. 3.2 Types, Symbol of BJT, construction and working principle of NPN transistor. 3.3 Configurations of transistor CE, CB and CC 3.4 Transistor parameters: alpha beta, input and output resistance, relation between alpha and beta. 3.5 Input and output characteristics of CE configuration, saturation active and cut off regions in output characteristics 3.6 Transistor as a switch 3.7 Single stage RC coupled amplifier, Circuit diagram function of each components.
Unit –IV Number systems and Logic Gates.	4a. Convert the given number into specified number system. 4b. Perform binary addition and multiplication. 4c. Perform subtraction using ones and twos compliment. 4d. Perform addition of decimal numbers using BCD code. 4e. Sketch symbols and truth tables of different logic gates. 4f. State different Boolean Laws.	4.1 Number system: base or radix of number system, binary, octal, decimal and hexadecimal number system 4.2 Binary addition and multiplication. 4.3 Subtraction using 1's compliment and 2's compliment. 4.4 Representation of decimal numbers in Binary coded decimal (BCD) form, Rules for BCD addition, BCD addition, ASCII. 4.5 Logic gates: Symbol, logic expression and Truth table of basic gates (AND, OR, NOT), universal gates (NAND and NOR) and Derived gates (EX-OR, EX-NOR). 4.6 Boolean algebra: Laws of Boolean algebra, De-Morgan's theorems.
Unit-V Combinational and Sequential Circuits.	5a. Implement Adder/Subtractor using logic gates. 5b. Explain working of Multiplexers and Demultiplexers using truth table. 5c. Draw RS Latch using NAND and NOR gate. 5d. Explain working of different	5.1 Arithmetic circuits: Half and Full Adder, Half and Full Subtractor. 5.2 Multiplexers and Demultiplexers: block diagram working, truth table and applications of Multiplexers and Demultiplexers. 5.3 Basic memory cell: RS Latch using NAND and NOR gate. 5.4 Block schematic and Truth Table of

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	flip-flops. 5e. Explain working of counter. 5f. Explain working of shift register.	SR, JK, T, and D Flip Flop. 5.5 Counters: Synchronous and Asynchronous 3 bit. 5.6 Shift resisters: Right and left Shift registers.
Unit-VI Data convertors	6a. Classify Data convertors. 6b. Explain working principle of ADC/DAC. 6c. Draw pin diagram of ICs 0808/0809 6d. Write specifications of ICs 0808/0809.	6.1 Data converters: Types, Working of weighted resister and R2R ladder circuit. 6.2 DAC IC 0808 and its Specification. 6.3 Type of ADC: Block diagram of ADC, Working of single slope ADC, Dual slope ADC, SAR ADC. 6.4 ADC IC 0809 and its 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	Semiconductor diodes	06	02	02	04	08
II	Applications of Semiconductor Diodes	14	02	04	08	14
III	Bipolar Junction Transistor and Applications.	12	02	04	06	12
IV	Number systems and Logic Gates.	14	04	04	06	14
V	Combinational and Sequential Circuits.	12	02	04	06	12
VI	Data convertors	06	02	04	04	10
	Total	64	**14**	**22**	**34**	**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. Collect data sheets of Semiconductor diode, Zener diode, BJT, LED, Photodiodes and Logic ICs.
b. Undertake Market survey for prices of electronic components and Equipments.
c. Prepare layout and artwork of power supply using IC 78XX and 79XX).
d. Conduct market survey for collecting specifications of regulated power supply.

e. Compare specifications of different electronic components.
f. Use internet for searching Video, Animations, PPTs and e-books for course content.
g. Use of internet to access Virtual Labs for experiments.

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 various components, operation and working of electronic components and circuits.
g. Before starting practical, teacher should explain the required prerequisite.
h. Instructions to students regarding care and maintenance of measuring equipments.
i. Show video films to explain functioning of various expreiments and applications.
j. Teacher should ask the students to go through Datasheets and Technical manuals.
k. Arrange expert lecture in the emerging areas of analog and digital electronics.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. **Diode**: Build a circuit on general purpose PCB for clipping a positive half cycle at 1.5V of a waveform with input signal 5 Vpp.
b. **LED and Photodiode:** Build ON/OFF circuit for LED using photodiode.
c. **Rectifier:** Build half wave or Full wave bridge rectifier for specific output voltage.
d. **BJT:** Build a circuit to switch ON and OFF the LED by using BJT as switch.
e. **Voltage Regulator:** Build a DC Regulated power Supply. (e.g. 5V, 9V, 12V etc...)
f. Build a digital circuit for implementing given Logic expression. (e.g. Y= A+B*C, Y= A'B+AB')
g. Build a digital circuit for implementing 4-bit adder.
h. Build a digital circuit for implementing debounce switch.

i. Build a digital circuit for implementing LED Flasher.
j. Build a digital circuit for implementing LED BAR display.
k. Build a digital circuit for implementing decade counter.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	A text book of Applied Electronics	Sedha, R. S.	S. Chand, New Delhi, 2013 ISBN: 8121927838
2	Principles of Electronics	Mehta, V. K. Mehta, Rohit	S. Chand, New Delhi, 2014 ISBN: 9788121924504
3	Fundamentals of Electronics Devices and Circuits	Bell, Devid	Oxford University Press, International edition, USA, 2015. ISBN: 9780195425239
4	Modern Digital Electronics	Jain, R. P.	McGraw-Hill Publishing, New Delhi. 2011 ISBN:9780070669116
5	Digital Electronics Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2016 ISBN: 9788126514663
6	Digital Principles and Applications.	Leach, D. P.: Malvino A. P.: Saha, G.	McGraw-Hill Publishing, New Delhi.2014, ISBN: 9789339203405

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=m1wRzTq0m5M
b. https://www.youtube.com/watch?v=QVGPj4YSYmk
c. https://www.youtube.com/watch?v=YGwllYpX1Wk
d. https://www.youtube.com/watch?v=fsJjA2-gWKY
e. https://www.youtube.com/watch?v=x1wOMwYgcDM
f. https://www.youtube.com/watch?v=Da39JHhNWqk
g. https://www.youtube.com/watch?v=QAHsqK8La1c
h. https://www.youtube.com/watch?v=3X1FZjJeKTo
i. https://www.youtube.com/watch?v=HDQaoDQj-Wc
j. https://www.youtube.com/watch?v=FotH5fYPhwo
k. https://www.youtube.com/watch?v=Wr2qDZnKFTg
l. https://www.youtube.com/watch?v=_760TVXb0wg
m. https://www.youtube.com/watch?v=4b8VW0X6nj4
n. https://www.youtube.com/watch?v=zjnildUJgh8
o. https://www.youtube.com/watch?v=O9EWk_0tsAs
p. https://www.youtube.com/watch?v=0mvFRADNYJU
q. https://www.youtube.com/watch?v=-L0FwqDR8Yo
r. https://www.youtube.com/watch?v=EjYkYCQ5RDo
s. https://www.youtube.com/watch?v=bG2xqgF2lzM
t. https://www.youtube.com/watch?v=6nq5jcQas-I
u. https://www.tutorialspoint.com/basic_electronics/index.htm
v. https://www.tutorialspoint.com/digital_circuits/index.htm
w. https://www.electronics-tutorials.ws/
x. http://cbseacademic.nic.in/web_material/Curriculum/Vocational/2018/Basic_Electronics_XI.pdf
y. https://www.iitg.ac.in/cseweb/vlab/Digital-System-Lab/experiments.php
z. http://vlabs.iitkgp.ernet.in/be/

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Third**

Course Title : **Industrial Measurement**

Course Code : **22372**

1. RATIONALE

Every Mechatronics Engineer has to deal with various types of instruments in the Industry. Industrial measurement deals with the measuring of different variables that influence production and equipments during the development of product. This course describes the working principle of various types of measuring 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:

- **Use mechanical, analog and digital measuring instruments for industrial processes.**

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. Apply different characteristics of measuring instruments.
b. Select relevant transducers for measuring displacement, force, torque and strain.
c. Select relevant transducers for measuring pressure and temperature.
d. Use transducers for measuring flow and level.
e. Select relevant transducers for measuring sound, speed and humidity.
f. Select various signal conditioning techniques and data acquisition system.

4. TEACHING AND EXAMINATION SCHEME

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

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

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

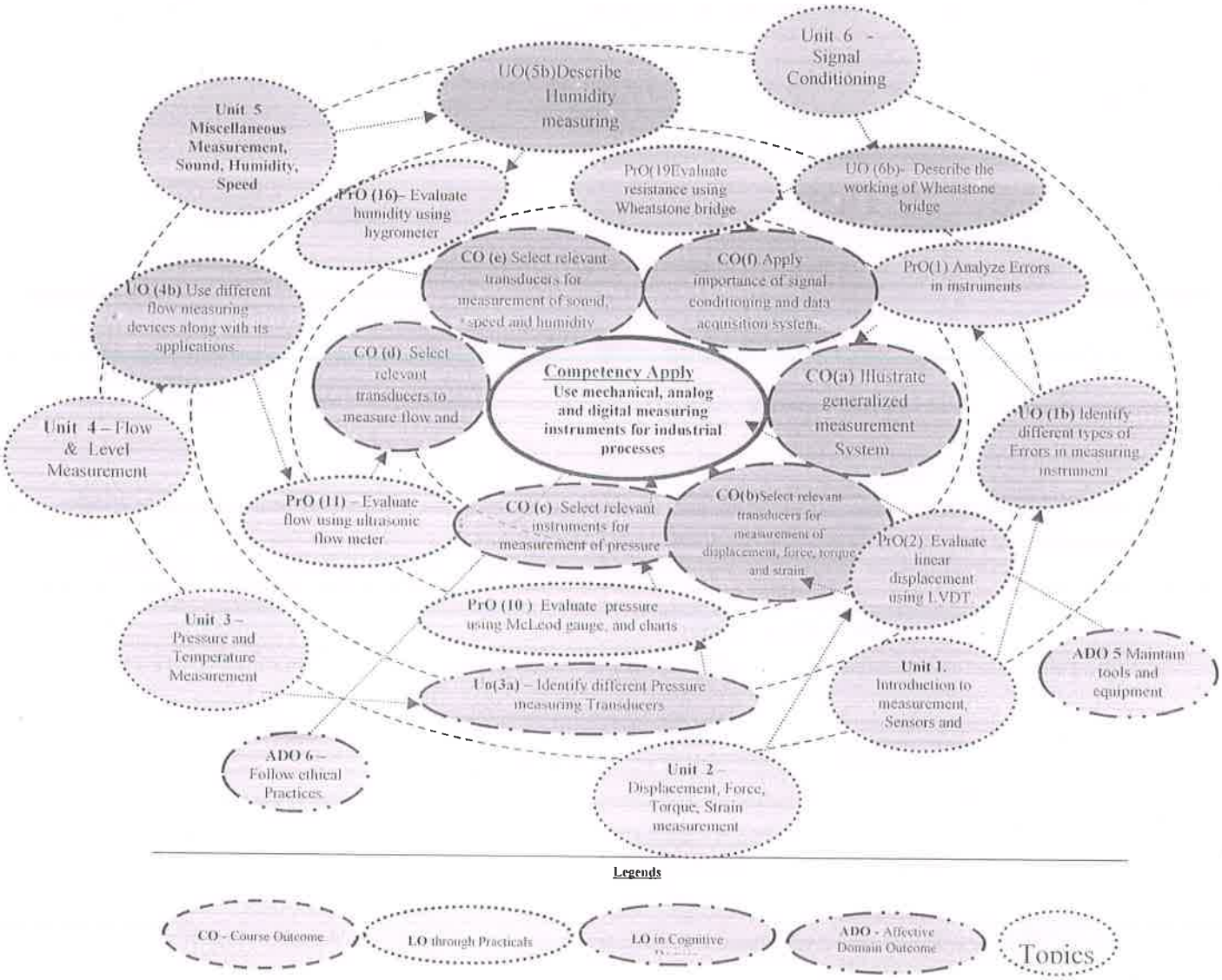

Figure 1 - Course Map

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 Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
1	Measure Errors in the given instruments	I	02*
2	Measure linear displacement using LVDT.	II	02*
3	Measure strain using strain gauge	II	02
4	Measure weight using Strain gauge Load Cell	II	02
5	Measure temperature using RTD	III	02
6	Measure temperature using Thermocouple	III	02*
7	Measure temperature using Thermistor.	III	02
8	Measure temperature using glass thermometer.	III	02
9	Measure pressure using bourdon tube pressure gauge	III	02
10	Measure pressure using McLeod gauge	III	02*
11	Measure flow using ultrasonic flow meter.	IV	02
12	Measure flow using electromagnetic flow meter.	IV	02

13	Measure Level by using Capacitive Transducers.	IV	02*
14	Measure Flow by using Rotameter	IV	02*
15	Measure humidity using hygrometer.	V	02
16	Measure sound level by sound meter.	V	02
17	Measure speed using stroboscope	V	02*
18	Measure resistance using Wheatstone bridge	VI	02*
	Total		**36**

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 needs to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

S. No.	Performance Indicators	Weightage in %
a.	Arrangement of available instruments or model	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
	Total	**100**

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

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Maintain tools and equipment.
e. Follow ethical Practices.

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	LVDT displacement measuring kit : measurement range 0-50 mm, micrometer screw gauge assembly for displacement.	2

S. No.	Equipment Name with Broad Specifications	PrO. No.
2	Strain gauge trainer: strain/force measurement- sensor-4 arm bridge with stain gauge mounted cantilever 2 kg, with digital display	3
3	Load cell: force measurement range 5-50 N, strain gauge capacity-2 kg	4
4	RTD (Resistance temperature detector)	5
5	Thermocouple: range -10 to 200^0C	6
6	Thermistor: range -10 to 100^0C	7
7	Glass thermometer: range 0^0 to 100^0C, glass tube	8
8	Bourdon tube pressure gauge: C type,	9
9	McLeod gauge: with vacuum pump	10
10	Ultrasonic flow meter: 100ppm of 100 microns in size particulate or bubbles required. Battery operated large character display, measures fluid velocities from (0.10 to 9.00 MPS), 100:1 turns down ratio, pipe sizes from 6.3 mm	11
11	Electromagnetic flow meter	12
12	Capacitive transducer for level measurement: Capacitive probe, range 0 - 100 mm, glass cabinet with scale 0-100 mm, digital display.	13
13	Rotameter trainer: standard glass Rotameter, process tank with motor pump display	14
14	Hygrometer/ sling psychomotor: RH between 10 and 100%, accuracy +/- 5%, DBT & WBT range 25 to 120^0F	15
15	Sound level meter: Measuring range 30-130 dB, portable and easy to use	16
16	Stroboscope: range up to 5000 rpm display, LED digital	17
17	Wheatstone bridge to measure resistance	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Introduction to measurement, Sensors and Transducers.	1a) List different characteristics of measuring instrument 1b) Define static characteristics of measuring instruments 1c) Define dynamic characteristics of measuring instruments 1d) Classify different types of Errors in measuring instrument. 1e) List desirable characteristics of transducers 1f) Classify transducers. 1g) Explain working principles of sensors	1.1 **Introduction to measurement system-** Definition of measurement, Standard of measurement, Types of measurement, generalized measuring system, significance of measurement. Introduction to calibration. 1.2 **Static characteristics**: -Accuracy, Precision, Range, Span, Error, Linearity, Hysteresis, Reproducibility, Repeatability, Dead zone, Span, Range, Threshold. 1.3 **Dynamic Characteristics:** -Speed of response, lag, Fidelity, Dynamic error. 1.4 **Measurement of Error**: -Classification of error, Types of errors, Environmental error, Transmission error, observational error, operational error. 1.5 **Transducers** - Introduction, Basic requirements of transducers and Characteristics of transducers. 1.6 **Classification** based on transduction phenomenon. (a) Active and Passive transducers (b) Primary and Secondary transducers (c) Analog and Digital transducers. Selection Criteria of transducers 1.7 **Sensors** (Proximity and Optical) Working principle and applications
Unit- II Displacement, Force, Torque, Strain measurement	2a) Explain working principle of displacement transducers. 2b) Explain working principle of force and strain measuring transducers. 2c) Explain working principle of strain gauges. 2d) Explain working principle of Torque measuring devices and Dynamometers. 2e) List applications of Hall effect sensors	2.1 Working principle and construction of resistive Transducer, Inductive transducer, LVDT, RVDT, potentiometer, capacitive transducers. 2.2 **Force Measurement-** Characteristics of force measurement, Working principle and construction of piezoelectric transducers, Strain gauge load cell. 2.3 Strain Gauge Transducers: Working principle of (Unbonded & Bonded), 2.4 **Torque Measurement:** -Mechanical and Electrical torsion meter 2.5 **Dynamometers:** - Construction & working of transmission dynamometer, Absorption dynamometer, Eddy current dynamometer. 2.6 Hall Effect sensor, applications of Hall Effect transducer.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-III Pressure and Temperature Measurement	3a) Explain working principle of different Pressure measuring Transducers. 3b) Explain working principle of different types of Temperature measuring devices	3.1 **High Pressure Measurement-** Working principle and construction of Bourdon tube, bellows, diaphragm, piezoelectric transducer, photoelectric transducer. **Low pressure Measurement-** Working principle and construction of McLeod gauge, pirani gauge. 3.2 **Temperature measurement-** Working principle and construction of Thermocouple, RTD, Thermistor. **Pyrometer-** Working principle and construction of Optical and Radiation pyrometer, Applications of Temperature and Pressure measurement.
Unit –IV Flow & Level Measurement	4a) List different types of flow. 4b) Explain working of flow measuring devices with neat sketch 4c) Explain working le of different types of Level measuring devices with neat sketch	4.1 Types of flow, Units of flow, 4.2 **Flow measuring transducers-** Working principle and construction of Orifice meter, venturimeter. Rotameter. Hot wire anemometer, Electo-magnetic flow meter, Ultrasonic flow meter, Turbine flow meter. 4.3 **Level Measurement-** working principle and construction a) Direct measurement- Sight glass method, float operated level measurement. b) Indirect measurement- Level measurement by capacitive probe
Unit-V Miscellaneous Measurement , Sound, Humidity, Speed	5a) Explain working principle of different sound measuring devices. 5b) Explain working of Humidity measuring device with neat sketch 5c) Explain working of speed measuring devices with neat sketch.	5.1 **Sound Measurement** – Microphone & its type and applications. 5.2 **Humidity Measurement-** Hair hygrometer. sling psychomotor (construction & working) 5.3 **Speed Measurement-** Working principle and construction of Mechanical tachometer. Electrical tachometer, Stroboscope and Eddy current generation tachometer.
Unit-VI Signal Conditioning	6a) Define signal conditioning 6b) Explain working of Wheatstone bridge 6c) List different applications of linear and non-linear signal conditioning. 6d) Explain with block diagram construction of data acquisition system	6.1 **Signal conditioning:** Definition, importance and functions. 6.2 Working of D.C Wheatstone Bridge. 6.3 **Linear signal conditioning:** -Adder, subtractor, Instrumentation amplifier. 6.4 **Non-Linear Signal conditioning** a) Amplitude Modulation. b) Demodulation. c) Filtering. 6.5 **Data Acquisition System:** Introduction, block diagram.

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 measurement, Sensors and Transducers.	06	02	02	04	**08**
II	Displacement, Force, Torque, Strain measurement	08	02	04	06	**12**
III	Pressure and Temperature Measurement	10	02	06	08	**16**
IV	Flow & Level Measurement	08	02	04	06	**12**
V	Miscellaneous Measurement, Sound, Humidity, Speed	08	02	02	06	**10**
VI	Signal Conditioning	08	02	04	06	**12**
	Total	**48**	**12**	**22**	**36**	**70**

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

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 Presentation on given topic related to measuring instrument.
b. Prepare/Download the specifications of available measuring instruments in industrial measurement laboratory.
c. Collect Catalogues or brochures of different types of measuring instruments by taking a market survey.
d. Visit to any industry for observing following -
   i. Use of measuring instruments.
   ii. Calibration of instruments.
   iii. Maintenance of instruments.
e. Collect information regarding calibration of measuring instruments from NABL website.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the

development of the COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use Animations to explain various components, operation and maintenance of measuring instruments.
g. Correlate subtopics with Industrial measurement instruments and equipments.
h. Before starting practical, teacher should demonstrate the working of measuring instruments.
i. Instructions to students regarding care and maintenance of measuring equipments.
j. Show video/animation films to explain functioning of various sensors and transducers
k. Teacher should ask the students to go through instruction and Technical manuals

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Collect information about different contact and non-contact type measuring instruments.
b. Collect the information of sensors available in market along with brochures and catalogues.
c. Prepare charts of different measuring transducers
d. Collect the information of temperature measuring devices along with specifications.
e. Collect information of types of sensors used in boiler, power plant etc.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electrical and Electronic measurement and Instrumentation	A.K. Sawney	Dhanpat Rai Publication ISBN 978-81-7700-100-6
2	Mechanical and Industrial Measurement	R. K. Jain	Khanna Publication ISBN 81-7409-191-2
3	Mechanical measurement and Instrumentation	R. K. Rajput	S. K. Kataria & Sons ISBN 81-88458-83-X
4	Principle of Industrial Instrumentation	D. Patranabis	Mc Graw Hill ISBN 13:978-0-07-069971-7
5	Mechanical Measurement	S. P. Venketashan	Ane Books India ISBN 81-8052-140-9

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=anCnrtjNLQM LVDT
b. https://www.youtube.com/watch?v=2z0k2Sti7oU potentiometer
c. https://www.youtube.com/watch?v=_IUmyFn0kGs Thermocouple
d. https://www.youtube.com/watch?v=R5rs78Sp28s Thermistor
e. https://www.youtube.com/watch?v=w8ml0Exihhc Proximiy sensor
f. https://www.youtube.com/watch?v=Zs8Il7fzc6w RTD
g. https://www.youtube.com/watch?v=90jKxRso27Y sling psychrometer
h. https://www.youtube.com/watch?v=GXDJvva1g9A Orifice meter, Venturimeter
i. https://www.youtube.com/watch?v=KPrSPqfVJhA stroboscope
j. https://www.youtube.com/watch?v=Bx2RnrfLkQg ultrasonic flow meter
k. https://www.youtube.com/watch?v=tukBEEgQ3nI Errors
l. https://www.youtube.com/watch?v=YfQSf2NBGqc flow measurement
m. https://www.youtube.com/watch?v=6YxDbEA4BrQ McLeod gauge
n. https://www.youtube.com/watch?v=0du-QU1Q0T4 capacitive level measurement
o. https://www.youtube.com/watch?v=_WUqizELOjg eddy current dynamometer
p. https://www.youtube.com/watch?v=EwwYd1wt3ho bellow gauge pressure measure
q. https://www.youtube.com/watch?v=7kk3cT0eTWo diaphragm gauge
r. https://www.youtube.com/watch?v=TgyMZA9fHFE piezoelectric transducer


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
MUMBAI

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Third**

Course Title : **Electrical Engineering**

Course Code : **22373**

1. RATIONALE

Electrical power is the main resource for any type of industry. According to industrial scenario the students must know the basic knowledge of electrical engineering as they have to work with various electrical fields like Basic fundamentals, magnetic circuits, poly-phase circuits, different types of electrical machines, & Safety.

2. COMPETENCY

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

- **Select proper electrical drives for automotive and industrial applications.**

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 single phase & three phase supply for industrial equipment & machine.
b. Use principles of magnetic circuits in electrical devices.
c. Select transformer & DC motor for specific requirements.
d. Select AC machines for given application.
e. Select electrical measuring instrument.
f. Use relevant protective devices.

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, # External 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 center of this map.

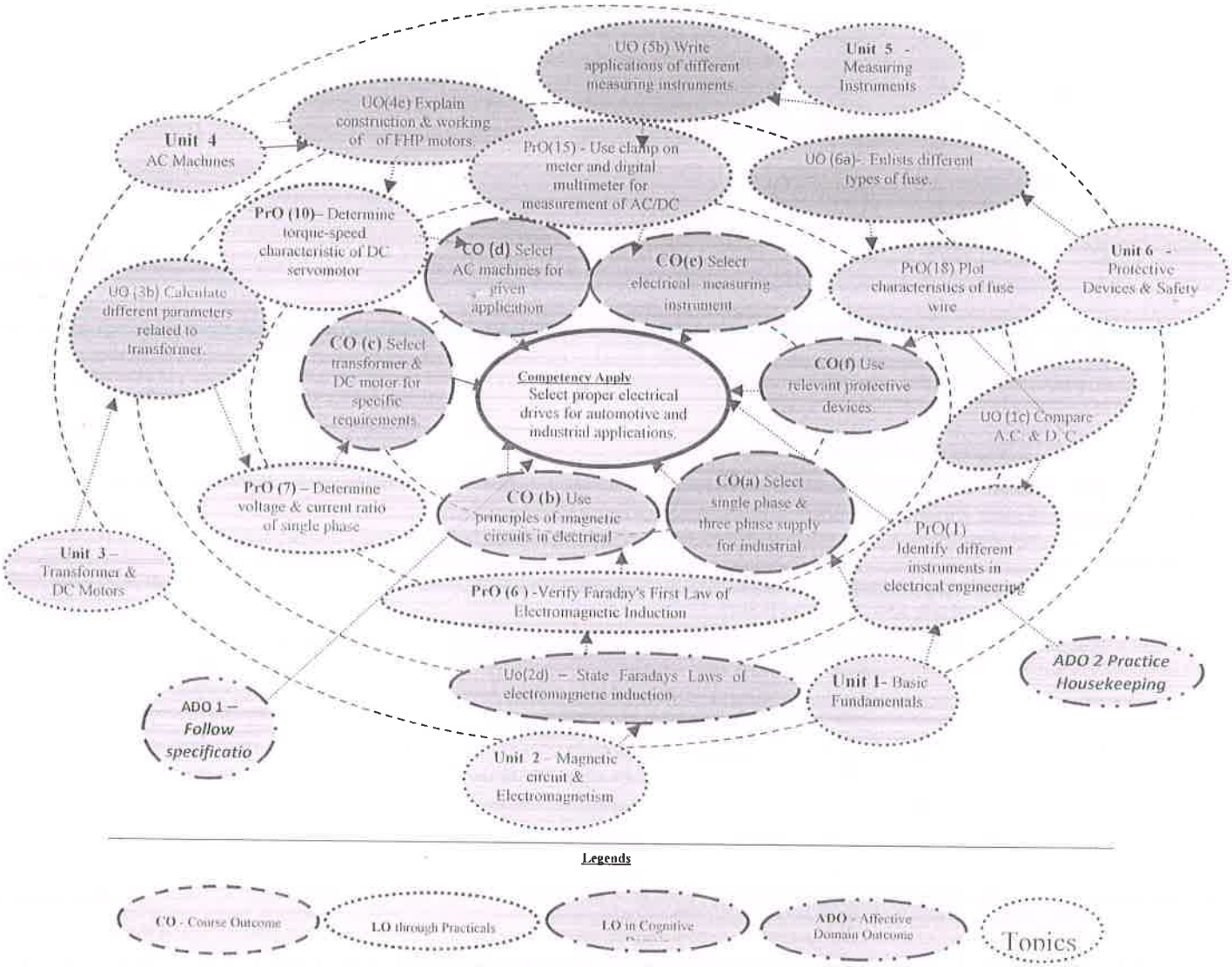

Figure 1 - Course Map

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:

Sr. No.	Practical Outcomes (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
1	Identify different instruments in electrical engineering laboratory.	I, V	02*
2	Measure equivalent resistance of series & parallel connection.	I	02
3	Determine frequency, time period, peak values, RMS values of a sinusoidal AC waveform by using C. R. O.	I	02
4	Determine line & Phase values of voltage and current of balanced star and delta load connections.	I	02*
5	Plot B-H curve to determine permeability of magnetic material.	II	02*
6	Verify Faraday's First Law of Electromagnetic Induction for a. Statically induced e.m.f. b. Dynamically induced e.m.f.	II	02

7	Determine voltage & current ratio of single phase transformer.	III	02*
8	Control speed of D.C series motor by armature resistance control method.	III	02*
9	Operate DC motor using 3 point starter or 4 point starter.	III	02
10	Determine torque-speed characteristic of DC servomotor.	IV	02*
11	Reverse direction of rotation of single phase universal motor.	IV	02
12	Connect three phase motor in both directions using DOL or star-delta or auto transformer starter.	IV	02
13	Measure speed of three phase Induction motor by rotor resistance variation and variable frequency supply to stator.	IV	02*
14	Identify different component of single phase capacitor start capacitor run motor .	IV	02
15	Use clamp on meter and digital multimeter for measurement of AC/DC voltage and AC/DC current.	V	02*
16	Measure angular velocity of motor using optical tachometer.	V	02
17	Measure insulation resistance of different types of cables using Megger.	VI	02
18	Plot characteristic of fuse wire.	VI	02*
	Total		**36**

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 needs 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:

Sr.No.	Performance Indicators	Weightage in %
a.	Selection of suitable apparatus / instrument	20
b.	Preparation of experimental set up	10
c.	Safety measures	20
d.	Observations and recording	10
e.	Interpretation of result and conclusion	20
f.	Answer of sample questions	10
g.	Submission of report in time	10
	Total	**100**

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

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

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	DC & AC Ammeter, 0-10/20 A (5 Qty)	2,4,5,6,7,8, 9,15
2	DC & AC Voltmeter, 0-150/300 V (5 Qty)	2,4,5,6,7,9, 15
3	Single phase transformer: 1 KVA, 1 Phase, 230/115 V, Air closed, Enclosed type. (2 Qty)	5,7
4	Single phase auto-transformer- Input: 0 to 230 V, 10 A, Output: 0 to 270 V (2 Qty)	2,5,6,7,18
5	Loading rheostat – 7.5 KW, 230 V (5 Qty), 3 Phase, 4 wire Balanced Load, (Each branch having equal load) (1 Qty), Load – wire wound fixed resisters.	2,8,15
6	CRO – 20 MHz, Dual channel.(1 Qty)	3
7	Digital Multimeter (2 Qty)	4.5.6.7.8.9, 15.
8	Lamp bank: 230 V, 0 to 20 A. (1 Qty)	4.7.8
9	Three phase Auto transformer – 15 KVA, Input: 0 to 415V, 3 Phase, 50Hz. output: 0 to 415 V, 30A per line, Air cooled (1 Qty)	4.12.13
10	DC Series & Shunt Motor (up to 230V, 5 HP) (1 Qty)	8.9
11	Servo Motor Kit (1 Qty)	10
12	DOL, star-delta, Auto transformer starter (1 Qty each)	9,12
13	1 Phase Induction Motor, ½ HP, 230 V, 50 Hz, AC supply. (1 Qty)	14
14	3 Phase Induction Motor, 3HP/5HP, 415 V, 50 H Z, 1140 RPM (1 Qty)	12.13
15	Universal Motor ¼ HP, (1 Qty)	11
16	Variable Frequency Drive kit (200 – 240VAC ± 10%) (1 Qty)	13.16
17	Tachometer – Non contact type, (0-10000rpm) (1 Qty)	16
18	Clamp-on-meter (0-50A) (1 Qty)	15
19	Megger (0-1000Ω) (1 Qty)	17
20	Fuse Wires	18

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Basic Fundamentals	1a. Define work, power & energy 1b. State ohms law. 1c. Compare A.C. & D. C. Quantity. 1d. Define different terms related to AC quantities. 1e. Draw circuit diagram for pure resistive, pure inductive & pure capacitive AC circuit. 1f. Calculate current and voltages in the given series & parallel AC circuit. 1g. Calculate different line & phase quantities of star and delta connection.	1.1 Introduction to EMF, current, potential difference, work, power, energy & its units. 1.2 Ohms Law, Effect of Electric current. 1.3 Classify A.C. & D. C. Quantity. 1.4 Definitions; Cycle, frequency, phase, period, maximum value, average value, r.m.s. value, Types of power & Power factor. 1.5 Circuit diagram of pure resistance, pure inductance & pure capacitance in A. C. Circuits. 1.6 Series & Parallel circuit of resistance. 1.7 Star and Delta circuit, Line and Phase relationship.
Unit– II Magnetic Circuit & Electromagnetism	2a. Define technical terms related to magnetic circuit. 2b. Compare electric & magnetic circuit. 2c. Draw B-H curve for given magnetic material. 2d. State Faraday's Laws of Electromagnetic Induction 2e. Compare Statically & Dynamically Induced emf.	2.1 Definition of Magnetic lines of force, Magnetic Flux, Flux density, Magneto-Motive-Forces (MMF), Magnetic Field Strength, Reluctance. 2.2 Comparison of Electric and Magnetic circuit. 2.3 Magnetization Curve (B - H Curve), Hysteresis Loop. 2.4 Faraday's Laws of Electromagnetic Induction, Fleming's Right hand Rule, Lenz's Law. 2.5 Statically & Dynamically Induced emf.
Unit-III Transformer & DC Motors	3a. Explain construction & working of given type of transformer. 3b. Calculate different parameters related transformer. 3c. Compare Auto transformer & Two winding transformer. 3d. Explain construction & working of given type of DC motor. 3e. List different types of DC motor & applications..	3.1 Transformer construction and principle of operation. 3.2 EMF equation and transformation ratio of transformer 3.3 Auto transformer & Two winding transformer. 3.4 DC motor construction & principle of operation. 3.5 Types of DC motor & its applications.
Unit –IV AC Machines	4a. Explain construction & working of three Phase induction motor. 4b. Explain Variable frequency drive. 4c. Write necessity of starter. 4d. List different types of starters with application.	4.1 Three phase induction motor – construction, operation & application. 4.2 Introduction to Variable frequency drives(VFD) 4.3 Need of Starters. 4.4 Different types of starter its

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4e. Explain construction & working of different types of FHP motors. 4f. Write the classification of drive. 4g. List types of Enclosure.	applications. 4.5 Other Motors (FHP): Universal motor, Servo Motor, Stepper Motor construction working and applications. 4.6 Classification of drives, Factors for selection of motor for different drives. 4.7 Types of Enclosure.
Unit-V Measuring Instruments	5a. Explain construction & working of PMMC or MI type of meter. 5b. Write applications of different measuring instruments. 5c. Explain construction & working tachometer.	5.1 Construction, working and use of AC and DC ammeter, voltmeter (PMMC and MI meters only). 5.2 Electro-dynamic wattmeter, energy meter, digital multimeter, Clip on meter, megger, (Applications only) 5.3 Construction, operation and use of Analog & Digital Tachometer.
Unit-VI Protective Devices & Safety	6a. Enlists different types of fuses. 6b. Write application of MCB & MCCB. 6c. Write color coding related to electrical conductor. 6d. Write necessity of earthing. 6e. Explain different electrical safety tools	6.1 Types of Fuses and its Operation. 6.2 Operation & application of MCB, MCCB and ELCB. 6.3 Colour coding of conductors in AC and DC, Single phase & three phase supply. 6.4 Earthing: Necessity of earthing, factors affecting earthing. 6.5 Introduction to different electrical safety tools.

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	Basic Fundamentals	10	02	04	08	**14**
II	Magnetic Circuit & Electromagnetism	06	02	04	04	**10**
III	Transformer & DC Motors	08	02	04	06	**12**
IV	AC Machines	14	04	06	06	**16**
V	Measuring Instruments	04	02	02	04	**08**
VI	Protective Devices & Safety	06	02	02	06	**10**
	Total	**48**	**14**	**22**	**34**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Visit site & interpret the name plate ratings & identify the parts of a transformer.
b. Make star & delta connections of different types of load.
c. Visit site and interpret the name plate rating and identify the parts of electrical machines.
d. Market survey regarding commonly used electrical equipment's other than curriculum.
e. Prepare power point presentation or animation for showing working of DC or AC motors.
f. Present seminar on any one of the above or relevant topic.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. **Basic Fundamental:** Prepare star & delta, balance or unbalance load.
b. **Magnetic Circuit & Electromagnetism:** Collect B-H curves & Hysteresis loop for various types of magnetic or non-magnetic material from Internet. Based on permeability and shapes of curves, each student will decide suitability of each material for different application.

c. **Transformer & DC Motor:** Collect information of nearby pole mounted substation and Identify - manufacturer, rating, different parts and their function and protective devices.
d. **AC Machines:** Collect information of - technical specification, features offered by different manufacturers and price range of different AC motors.
e. **Measuring Instruments:** Identify different component by dismantle of PMMC or MI instrument.
f. **Protective Devices:** Identify different protective and safety devices used with their specification in institute workshop.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1	Electrical technology (Vol. I & II)	B. L. Theraja	S. Chand & Co. New Delhi ISBN:9788121924405
2	Basic Electrical Engineering	Mittle & Mittal	McGraw Hill Education, (India), ISBN: 97800700885725
3	Fundamental of Electrical Engineering	Saxena, S. B. Lal	Cambridge University press, new Delhi. ISBN : 9781107464353
4	Electrical machines	Kothari D. P. & Nagrath I. J	McGraw Hill. New Delhi ISBN : 9780074516324
5	Special purpose electrical machines	S. K. Sen	Khanna Publication, New Delhi ISBN : 9788174091529
6	Electrical & Electronics measurement and instrumentation	A. K. Sawhney	Dhanpai Rai and Sons, New Delhi ISBN: 9780000279744

14. SOFTWARE/LEARNING WEBSITE

a. https://www.youtube.com
b. https://electrical4u.com
c. https://electricaltechnology.org
d. https://nptel.ac.in
e. https://freevideolectures.com
f. https://housestuffworks.com
g. www.onlinelibrary.wiley.com
h. www.animations.physics.unsw.edu.au//jw/AC.html
i. www.alpharubicon.com/altenergy/
j. www.ieee.org/soc/es/

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Third**

Course Title : **Basic 'C' Programming**

Course Code : **22374**

1. RATIONALE

In modern world of technology Diploma Engineer have to write programs for solving a given problem. 'C' programming is the most preferred approach for software development. This course is designed to make student understand the basic architecture behind the 'C' programming as well to make the student to take a step on a journey of becoming a good computer programmer. This course enables students to develop programs using basic concepts of 'C' such as keywords, identifiers, operators, decision making statements, arrays, functions, preprocessors etc. Most of the mechanical engineering equipment uses embedded 'C' program s to perform some operations. This course provides the basic knowledge of the 'C' and creates a base to develop foundation skills of programming language.

2. COMPETENCY

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

- **Develop C program for solving given problems.**

3. COURSE OUTCOMES (COs)

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

a. Develop 'C' program using operators and arithmetic expressions.
b. Develop 'C' program using control structures.
c. Implement array and strings in a 'C' program
d. Apply functions and structures for solving a given problem.
e. Implement pointers in a 'C' program.
f. Develop 'C' program using preprocessors.

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	-	4	7	3	70	28	30*	00	100	40	50@	20	50	20	100	40

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

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

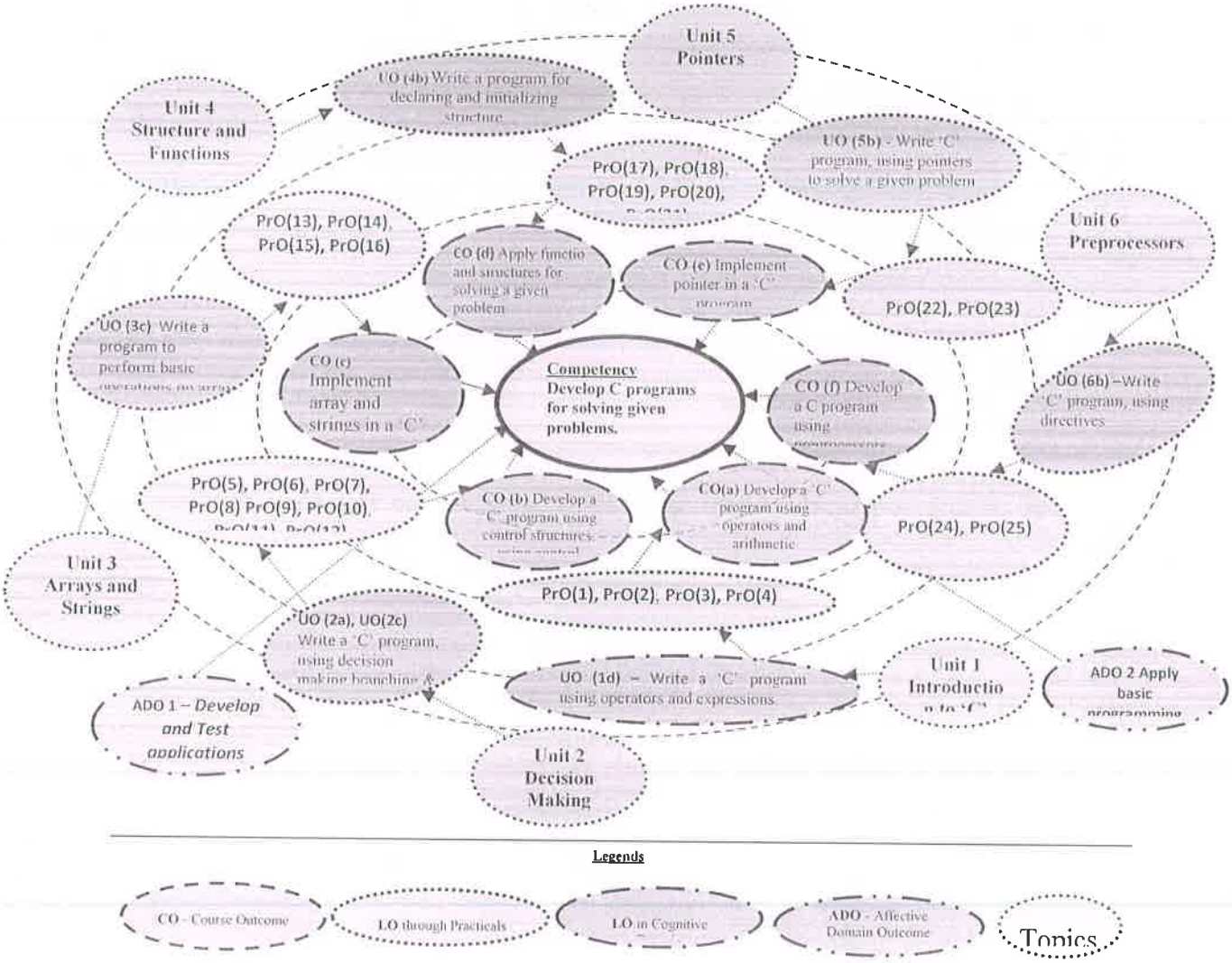

Figure 1 - Course Map

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 Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
1	Write 'C' program using constants, variables and arithmetic expressions. (Two Programs)	I	02*
2	Write 'C' program using increment and decrement operator. (Two Programs)	I	02
3	Write 'C' program for data type conversion.		02
4	Write 'C' program for calculating area , perimeter of rectangle and circumference of circle.		02*

5	**Decision making: branching** Write 'C' program for determining whether a given number is odd or even. Write 'C' program for checking whether a given number is positive or negative.	II	04
6	**Decision making: branching** Write 'C' program for displaying greater number among the three numbers. Write 'C' program for checking whether a character is vowel or consonant.	II	04*
7	**Use of switch statement:** Write 'C' program for displaying days of week by taking input number from 1 to 7.	II	02*
8	**Use of switch statement:** Write 'C' program for displaying grade of student by accepting percentage marks.	II	02
9	**Decision making : looping** Find sum of digits of given five digit integer number.	II	02*
10	**Decision making : looping** Generate multiplication table of a given number.	II	02*
11	**Decision making : looping** Find Fibonacci series for a given number	II	02
12	**Decision making : looping** Write 'C' program for generating following output **1** **2 3** **4 5 6** **7 8 9 10** * * * * * * * * *	II	02
13	**Array :** Write 'C' program for displaying smaller and greater number in an array Write 'C' program for displaying sum of array elements.	III	04*
14	**Array :** Write 'C' program for performing addition of 3X3 matrix. Write 'C' program for finding transpose a given matrix	III	04
15	**String :** Write 'C' program for displaying a reverse of input string. Write 'C' program for checking whether a given string is palindrome or not.	III	04*
16	**String :** Write 'C' program for counting vowels present in a given string	III	02
17	**Structure :** Write 'C' program for creating a structure viz. name,*rollno*, address and mobile number.	IV	02
18	**Structure :** Write 'C' program for creating a structure Employee to hold details viz. name, designation, id and salary, of 3 employees for comparing..	IV	02*

19	**Use of Library functions :** Write 'C' program for using all String handling functions	IV	02
20	**User defined functions :** Write 'C' program for adding two numbers using add () function. Write 'C' program using function for checking a given number prime or not.	IV	04*
21	**User defined functions : (recursive function)** Write 'C' program using recursive function for displaying factorial of a number. Write 'C' program using recursive function for displaying Fibonacci series.	IV	04
22	**Pointer:** Write 'C' program using pointers for printing values of variables and their addresses.	V	02*
23	**Pointer:** Write 'C' program using pointers for performing basic arithmetic operations using pointer.	V	02
24	**Preprocessors:** Write 'C' program for finding arithmetic mean of two numbers using macro definitions.	VI	02*
25	**Preprocessors:** Write 'C' program for finding absolute value of a number using macro definitions.	VI	02
	Total		**64**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical needs 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:*

Sr. No.	Performance Indicators	Weightage in %
a.	Correctness of algorithm and logic	40
b.	Debugging ability	20
c.	Quality of input and output displayed (messaging and formatting)	10
d.	Answer to sample questions	20
e.	Submit 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. Maintain tools and equipment.
e. Follow ethical Practices.

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

Sr. No.	Equipment Name with Broad Specifications	PrO No.
1	Computer System (Any computer system with basic configuration)	All
2	'C' Compiler	

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Introduction to 'C'	1a Define algorithm 1b Draw symbols of flowchart 1c List different operators 1d Write a 'C' program using operators and expressions 1e Write input output statements for given problem statement.	1.1 History of 'C', Algorithm, Flowchart, Symbols of Flowchart 1.2 Character Sets, Constants, Variables and Keywords, Types of C Constants, Rules for Constructing Integer, Real and Character Constants, Types of C Variables, Rules for Constructing Variable Names, C Keywords, Data Types, 1.3 The First C Program, Compilation and Execution. 1.4 Operators and Expressions: Types of Operators, Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operators, Special Operator, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Expressions, Type Conversion in Expressions.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		Operator Precedence and Associativity. 1.5 Managing Input and Output Operations: Reading a character, writing a character, formatted input, formatted output.
Unit– II Decision Making	2a. Write 'C' program using decision making (Branching) control structures for the given problem statement 2b. Explain significance of break statement 2c. Write 'C' program using decision making (Looping) control structures for the given problem statement. 2d. Explain significance of continue statement	2.1 Branching: Introduction, 2.1.1 *if* statements: simple if statement, if – else statement, nested if statement, ladder if statement 2.1.2 *switch* Statements, break statement, go – to statement. 2.2 Looping: Introduction, while loop, do - while loop, for loop, nesting of loops, continue statement.
Unit-III Arrays and Strings	3a. Define an array and strings 3b. Write a program for initialization of an array and string 3c. Write a program for performing operations on array and strings 3d. Name different standard library functions of string 3e. Write a program for performing operations on strings using standard library functions.	3.1 Array: Array definition, Array declaration and Initialization, Types of array- 1 dimensional, 2 dimensional and multidimensional, Operations on array. 3.2 String – String Definition, String declaration and initialization, Standard library functions of String, String Operations with library functions and without library functions.
Unit –IV Structure and Functions	4a. Define structure and function 4b. Write a program for declaring and initializing structure 4c. Write a program using various types of functions 4d. Write 'C' program using recursion for solving a given problem statement	4.1 Defining a Structure, Declare Structure Variables, Accessing Structure Members, Structure Initialization. 4.2 Concept and need of function, Function Declaration, Function Calls, Category of function, recursive function.
Unit-V Pointers	5a. Define pointer 5b. Write 'C' program using pointers for solving a given problem statement.	5.1 Pointers: Concept of a pointer, declaration, and initialization, pointer operators, Pointer arithmetic.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-VI Preprocessors	6a. List features of 'C' preprocessors 6b. Write 'C' program using directives	6.1 Pre-processor: Features of C Pre-processor, Macro expansion – macros with arguments, Macros versus Functions, 6.2 File inclusion, directives - *#if* and *#elif, #undef directive, #pragma.*

***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 'C'	08	02	04	04	10
II	Decision Making	10	02	04	10	16
III	Arrays and Strings	10	02	04	10	16
IV	Structure and Functions	12	02	04	10	16
V	Pointers	04	--	02	04	06
VI	Preprocessors	04	02	04	--	06
	Total	**48**	**10**	**22**	**38**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Prepare journals based on practical performed.
b. Explore and analyze topics to improve the level of creativity and analytical skill by taking Quiz tests/assignments.
c. Create a PowerPoint presentation on the topic relevant to the course to improve communication skills.
d. Visit different web sites relevant to topics. Listen video lectures and submit a report.

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. Before starting practical, teacher should demonstrate the working of editor used for developing and execution of Write 'C' program.
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.
i. Encourage students to enroll on MOOCS for basic 'C' Programming courses

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Develop library management application.
b. Develop store management application.
c. Develop employee management system and generate salary sheet.
d. Develop student result management system and generate student mark sheet.
e. Any other micro project suggested by subject faculty on similar line. (Use structure and other features of 'C' to develop above listed applications.)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Let us C	Yashwant Kanetkar	BPB Publication, New Delhi, ISBN: 978-8183331630
2	The C Programming Language	Brain W Kernighan, Ritchie Dennis.	PHI Learning Private Limited, New Delhi. ISBN: 978-8120305960
3	Programming in ANSI C	Balgurusamy E	McGraw Hill Education, New Delhi ISBN : 978-1259004612
4	The Complete Reference: C	Herbert Schildt	McGraw Hill Education, New Delhi ISBN-13: 978-0072121247

14. SOFTWARE/LEARNING WEBSITES

a. http://www.w3schools.com
b. http://www.spoken-tutorial.org
c. http://www.codeacademy.com
d. http://www.nptel.ac.in
e. http://www.tutorialspoint.com


BOARD OF TECHNICAL

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Third**

Course Title : **Mechanical Working Drawing**

Course Code : 22070

1. RATIONALE

A Mechatronics diploma holder, irrespective of his field of operation in an industry is expected to possess a thorough understanding of machine drawing, which include clear special visualization of object and the proficiency in reading and interpreting a wide variety of production drawings. The course aims at developing the ability to get knowledge of conventional representation, limits, fits and tolerances, geometrical tolerances, surface roughness representation. Assembly and detail drawing of parts are also included in the course, which helps in reading and drawing various production drawings. These drawings comprise of all the information required to produce the component. This course envisages reinforcing and enhancing the knowledge and skill acquired in the earlier two courses viz. Engineering Graphics & Engineering Drawing.

2. COMPETENCY

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

- **Interpret working drawing**

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 various drawing codes, conventions and symbols as per IS SP-46.
b. Identify various Fits and Tolerances.
c. Indicate the various roughness symbol and geometrical tolerances.
d. Draw production drawings used to produce products.
e. Draw assembly and detailed drawings of products.

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	
1	-	4	5	--	--	--	--	--	--	--	50#	20	50~	20	100	40	

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

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

***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, 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 center of this map.

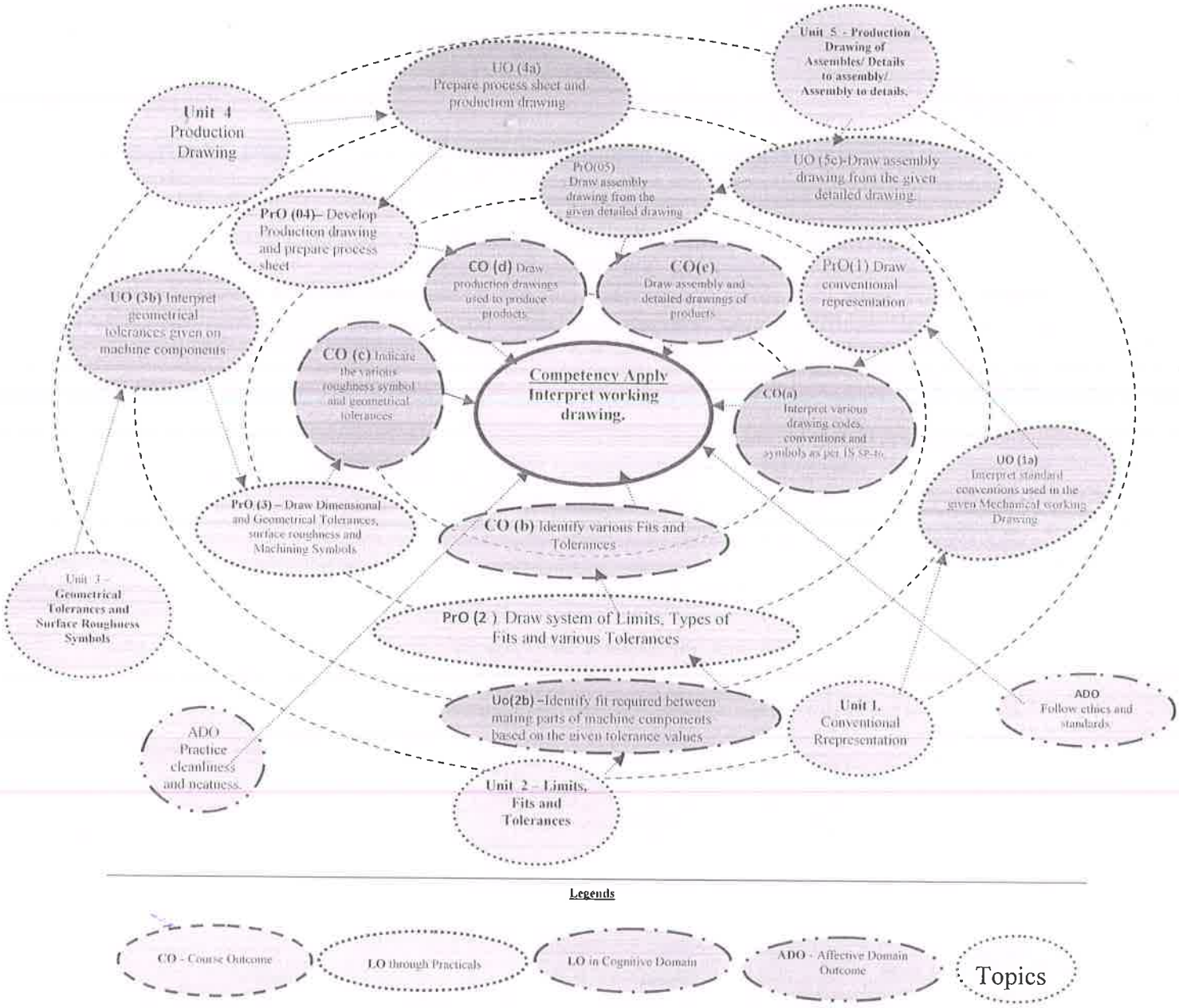

Figure 1 - Course Map

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:

Sr No	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
Sheet No.:1			
1	Draw various Conventional Representations as per SP – 46 (1988) **(Part I)** (Conventional breaks and common features)	I	02
2	Draw various Conventional Representations as per SP – 46 (1988) **(Part II)** (Machine components and Welding symbols)	I	02*
3	Draw various Conventional Representations as per SP – 46 (1988) **(Part III)** (Pipe joints and sheet metal joints)	I	02
Sheet No.:2			
4	Draw system of Limits, Types of Fits and various Tolerances **(Part I)**	II	02
5	Draw system of Limits, Types of Fits and various Tolerances **(Part II)**	II	02*
6	Draw system of Limits, Types of Fits and various Tolerances **(Part III)**	II	02
Sheet No.:3			
7	Draw Dimensional and Geometrical Tolerances, surface roughness and Machining Symbols on given figures and tables. **(Part I)**	III	02
8	Draw Dimensional and Geometrical Tolerances, surface roughness and Machining Symbols on given figures and tables. **(Part II)**	III	02*
9	Draw Dimensional and Geometrical Tolerances, surface roughness and Machining Symbols on given figures and tables. **(Part III)**	III	02
Sheet No.:4			
10	Develop Production drawing and prepare process sheet of slip bushes showing dimensional and geometrical tolerance, surface finish etc. **(Part I)**	IV	02*
11	Develop Production drawing and prepare process sheet of Gears showing dimensional and geometrical tolerance, surface finish etc. **(Part II)**	IV	02
12	Develop Production drawing and prepare process sheet of flange showing dimensional and geometrical tolerance, surface finish etc. **(Part III)**	IV	02
13	Develop Production drawing and prepare process sheet of Shaft showing dimensional and geometrical tolerance, surface finish etc. **(Part IV)**	IV	02
14	Develop Production drawing and prepare process sheet of Connector showing dimensional and geometrical tolerance, surface finish etc. **(Part V)**	IV	02
15	Develop Production drawing and prepare process sheet of Control panel cabinet showing dimensional and geometrical tolerance, surface finish etc. **(Part VI)**	IV	02*
Sheet No.:5			
16	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. **(Part I)** (Footstep Bearing)	V	02
17	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances	V	02*

	and surface finish symbols. (**Part II**) (Pedestal Bearing)		
18	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part III**) (Single pillar type tool Post)	V	02
19	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part IV**) (Square tool post)	V	02
20	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part V**) (Screw Jack)	V	02
21	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part VI**) (Lathe tail stock)	V	02
22	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part VII**) (Pipe vice)	V	02
23	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part VIII**) (Drill Jig)	V	02
24	Draw assembly drawing from the given detailed drawing showing conventional representations, Dimensional and Geometrical tolerances and surface finish symbols. (**Part IX**) (Universal Coupling)	V	02*
Sheet No.:6			
25	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part I**) (Oldham Coupling)	V	02
26	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part II**) (Universal Coupling)	V	02
27	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part III**) (Cotter Joint, Knuckle joint.)	V	02
28	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part IV**) (Screw Jack)	V	02*
29	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part V**) (Foot step Bearing)	V	02
30	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part VI**) (Drill Jig)	V	02
31	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part VII**) (Pedestal Bearing)	V	02
32	Draw detailed drawings from given assembly drawing showing conventional representation, Dimensional and Geometrical tolerances and surface finish symbols. (**Part VIII**) (Single pillar Lathe tool post)	V	02
	Total		**64**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical needs 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.	Interpretation of given problem	20
2.	Draw sheet using different drafting instrument	35
3.	Follow line work for neat and accurate drafting	10
4.	Dimensioning the given drawing and writing text	10
5.	Answers to sheet related questions	10
6.	Submit the assigned sheet on time	05
7.	Follow cleanliness and housekeeping in Drawing Hall	05
8.	Attendance and punctuality	05
	TOTAL	**100**

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

a. Use drawing instruments safely.
b. Practice cleanliness and neatness.
c. Follow ethics and standards.

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

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will escort in uniformity in conduct of practical's, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. Unit. No.
1.	Drawing Table with Drawing Board of Full Imperial/ A1 size.	All
2.	Paper Models of objects for rectangular sheet metal control panel cabinet.	15
3.	Models of machine components for conventional representation.	01 to 09
4.	Actual assemblies mentioned in unit V.	16 to 32
5.	Set of various production drawings being used by industries.	All
6.	Specimen library of various machine components	All
7.	Set of drawings sheets mentioned in section 6.0 could be developed by experienced teachers and made available on the MSBTE portal to be used as reference/standards.	All

S. No.	Equipment Name with Broad Specifications	PrO. Unit. No.
8.	Drawing equipment's and instruments for class room teaching-large size: a. T-square or drafter (Drafting Machine) b. Set squares (45^0 and 30^0- 60^0) c. Protractor Drawing instrument box (containing set of compasses and dividers).	All
9.	Interactive board with LCD overhead projector.	All

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Conventional Rrepresentation	1a. Interpret standard conventions used in the given Mechanical working Drawing. 1b. Interpret welding symbols in the given working drawing. 1c. Draw conventional representation for Machine Components 1d. Draw various sheet metal working joints.	1.1 Conventional breaks in pipe, rod and shaft. 1.2 Conventional representation of common features like slotted head, radial rib, knurling, serrated shaft, splined shaft, ratchet and pinion, holes on circular pitch, internal and external thread. 1.3 Conventional representation of standard parts like ball and roller bearing, gears, springs. 1.4 Pipe joints and valves. 1.5 Sheet metal working joints like Folding/Tab joints, Pulling Rivet, Self-clinching, Screw joint, Pressing Joint. 1.6 General welding symbols, length and size of weld, surface contour and finish of weld, all round and site weld, symbolic representation in Engineering practices and its interpretation.
Unit– II Limits, Fits and Tolerances	2a. Calculate tolerances on the given machine components. 2b. Identify fit required between mating parts of machine components based on the given tolerance values.	2.1 Definitions, introductions to ISO system of Tolerance. 2.2 Dimensional tolerances: -Terminology, selection and representation of dimensional tolerance- number and grade method. Unilateral and bilateral tolerance, Hole and shaft base systems. 2.3 Types of fits- Clearance, transition and Interference, Selection of fit for engineering applications. 2.4 Calculation of limit sizes and identification of type of fit from the given sizes like Ø50 H7/s6, Ø30 H7/d9 etc.
Unit– III Geometrical Tolerances and Surface	3a. Interpret surface roughness characteristics from the values the given on component drawing. 3b. Interpret geometrical	3.1 Geometrical Tolerances: Types of geometrical tolerances, terminology for deviation, representation of geometrical tolerance on drawing. 3.2 Machining symbol and surface texture:

Roughness Symbols	tolerances given on machine components.	Indication of machining symbol showing direction of lay, sampling length, roughness grades, machining allowances, manufacturing methods. Representation of surface roughness on drawing.
Unit– IV Production Drawing	4a. Prepare process sheet and production drawing. 4b. Interpret the production drawing of various components.	4.1 Processes sheets 4.2 Reading of Production drawing 4.3 Preparation of production drawing & process sheet of component such as slip bushes, gears, flange, shaft, connector, control panel cabinet.
Unit– V Production Drawing of Assembles/ Details to assembly/ Assembly to details.	5a. Describe the procedure of Assembly and dismantling of assembly. 5b. Select the components sequentially. 5c. Draw assembly drawing from the given detailed drawing. 5d. Draw detailed drawing from the given assembly drawing.	5.1 Introduction, types of assembly drawing and dismantling of assembly. Bill of Material. 5.2 Assembly and Detail of following components: a) Bearing: Foot Step & Pedestal Bearing. b) Lathe: Single (pillar type) and Square tool Post. c) Bench vice & Pipe Vice. d) Screw Jack. e) Lathe machine: tail stock, Drill Jig f) Couplings: Oldham & Universal couplings. g) Shaft Joints: Cotter Joint, Knuckle joint.

***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 PRACTICAL QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Conventional Rrepresentation	3	2	2	4	8
II	Limits, Fits and Tolerances	3	2	2	4	8
III	Geometrical Tolerances and Surface Roughness Symbols	3	2	2	6	10
IV	Production Drawing	3	--	4	6	10
V	Production Drawing of Assembles/ Details to assembly/ Assembly to details.	4	--	4	10	14
Total		**16**	**06**	**14**	**30**	**50**

***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. Student should maintain a separate A3 size sketch book which will be the part of term work and submit it along with drawing sheets. Following assignment should be drawn in the sketch book
   i. Minimum 5 Assignments each on Unit No I, II and III.
   ii. Minimum 2 problems each on Unit No IV to V.
   Note- Problems on sheet and in the sketch. book should be different.
b. Students should collect production drawings from nearby workshops/industries and try to visualize the part from the given views.
c. Prepare paper models of Rectangular control panel cabinet.
d. Visit any sheet metal workshop and prepare a report related to type of components, dimensions, material, area of application, raw material required, name of operations performed.
e. Identify the various fits from machine components available in workshop and laboratories.
f. Assembly and dismantling of screw jack.

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 during practice.
i. Arrange visit to nearby industries and workshops for understanding various production drawings.
j. Show video, animation films, solid modeling software to explain assembly and details.
k. Prepare wall charts for dimensional and geometrical tolerances.

12. SUGGESTED MICRO-PROJECTS

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

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

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

a. Prepare a chart on various types of welding symbols used for fabrication work.
b. Prepare a chart representing conventional representation of various piping joints used in sugar factory, chemical industries etc.
c. Prepare assembly drawing and working drawing of machine vice/ lathe tailstock/ tool post etc. available in institute workshop.
d. Prepare paper models of rectangular control panel cabinet.
e. Prepare a control panel cabinet from a sheet metal
f. Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Machine Drawing	Bhatt N.D., Panchal V.M.	Charotar Publishing house Pvt. Ltd., Anand, Gujarat, 2013, ISBN 9789380358635
2	Engineering Drawing practice for schools and colleges IS : SP- 46	Bureau of Indian standard	BIS Delhi, Third reprint, October 1998 ISBN 8170610912
3	Production Drawing	Narayanan L.K., Kannaich P., VenkatReddy K.	New Age International Publication, New Delhi, 2009 ISBN: 9788122435016
4	A text book of Machine Drawing	Gill P.S.	S.K.Kataria and Sons. New Delhi,2007, ISBN: 9789350144169
5	Machine Drawing	N. Sidheshwar, P Kannaiah, VVS Sastry	McGraw Hill, New Delhi, 2009 ISBN : 9780074603376
6	Machine Drawing	Narayanan L.K., Kannaich P., VenkatReddy K.	New Age International Publication, New Delhi, 2008 ISBN: 978-81-224-1917-7
7	SP 46 :2003 Handbook	--	BUREAU OF INDIAN STANDARDS, ICS 01.100.01; 03.180 ISBN 81-7061 -019-2

14. SOFTWARE/LEARNING WEBSITES

a. sketch up 7 software for solid modelling
b. http://www.weldingtechnology.org
c. http://www.newagepublishers.com
d. https://www.youtube.com/watch?v=So-xvb1_PBA
e. https://www.youtube.com/watch?v=AP_T7hf5Wv0
f. https://www.youtube.com/watch?v=omhoWIs2d-M
g. https://www.youtube.com/watch?v=5E8SCm0K0_4

h. https://www.powershow.com/view4/575424-YTQ5Y/Assembly_drawings_powerpoint_ppt_presentation
i. https://www.slideshare.net/bholapatel/assembly-drawing-53146699
j. https://www.bing.com/videos/search?q=assembly+of+screw+jack+drawing&view=detail&mid=817034FA42E00E6A4869817034FA42E00E6A4869&FORM=VIRE
k. https://www.youtube.com/watch?v=5vgYeGpNuUk