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 : Fourth | **Scheme - I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Environmental Studies	EST	22447	3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100
2	Microcontroller Programming	MCP	22471	3	-	4	7	3	70	28	30*	00	100	40	50@	20	50	20	100	40	200
3	Control Systems	CSS	22472	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Elements of Mechanical Engineering	EME	22473	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Industrial Fluid Power	IFP	22474	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Computer Aided Mechatronics Drafting	CMD	22072	-	-	4	4	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
7	CNC Machine Tool Technology	CMT	22073	1	-	4	5	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
			Total	**16**	**-**	**18**	**34**	--	**350**	--	**150**	--	**500**	--	**225**	--	**225**	--	**450**	--	**950**

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

Theory and practical periods of 60 minutes each. Total Marks : **950**

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 Production Engineering/Production Technology/ Mechanical Engineering/Civil Engineering/Electrical Engineering/Diploma in Mechatronics**

Program Code : **PG/PT/ME/CE/CR/CS/EE/EP/EU/MK**

Semester : **Fourth**

Course Title : **Environmental Studies**

Course Code : **22447**

1. RATIONALE

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

2. COMPETENCY

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

- **Diagnose and manage environment related issues**

3. COURSE OUTCOMES (COs)

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

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

4. TEACHING AND EXAMINATION SCHEME

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

(#) Online Theory Examination.

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

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

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

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

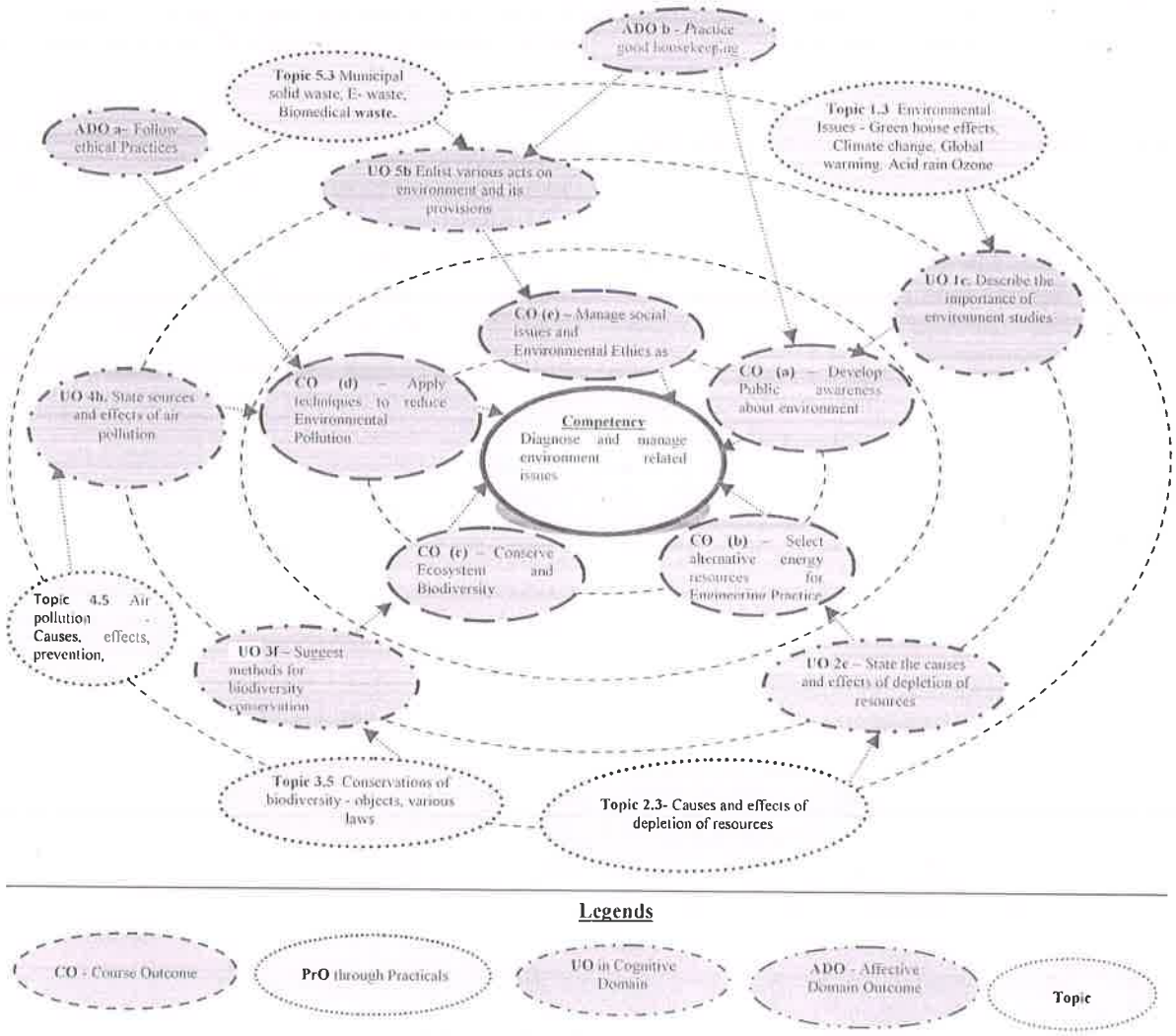

Figure 1 - Course Map

6. SUGGESTED EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	NIL		
	Total		

Note

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

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

S. No.	Performance Indicators	Weightage in %
1	NIL	
Total		

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

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

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

8. UNDERPINNING THEORY COMPONENTS

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

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Environment	1a. Discuss the scope of Environment. 1b. Describe various types of environment 1c. Describe the importance of environment studies.	1.1 Definitions, need of environmental studies. 1.2 Segments of environment- Atmosphere. Hydrosphere Lithosphere. Biosphere 1.3 Environmental Issues Green house

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Discuss about the need of public awareness about environment. 1e. Describe various environmental issues.	effects, Climate change, Global warming, Acid rain Ozone layer depletion, Nuclear accidents. 1.4 Concept of 4R (Reduce, Reuse, Recycle and Recover), 1.5 Public awareness about environment.
Unit– II Energy Resources	2a. List various natural resources. 2b. Describe Renewable, Nonrenewable and Cyclic resources. 2c. State the causes and effects of depletion of resources. 2d. State advantages and disadvantages of forms of energy. 2e. Select appropriate solutions of efficient use of energy. 2f. State the impacts of overuse of natural resources.	2.1 Natural Resources - Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources. 2.2 Renewable, Non-renewable and Cyclic Resources. 2.3 Causes and effects of depletion of resources. 2.4 Energy forms (Conventional and non-conventional). 2.5 Present global energy use and future demands. 2.6 Energy conservation. 2.7 Over use of natural resources and its impacts on environment.
Unit- III Ecosystem and Biodiversity	3a. State the aspects and division of ecosystem. 3b. State the general characteristics and function of ecosystem. 3c. List levels of biodiversity. 3d. Enlist the endangered species. 3e. Describe value of biodiversity. 3f. Suggest methods for biodiversity conservation.	3.1 Ecosystem - Definition , Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem. 3.2 Biodiversity - Definitions, Levels, Value and loss of biodiversity. 3.3 Biodiversity assessment initiatives in India. 3.4 Threats and Hotspots of biodiversity. 3.5 Conservations of biodiversity - objects, various laws.
Unit– IV Environmental Pollution	4a. Define pollution. 4b. State the sources of pollution. 4c. State the effects of land pollution on environment and lives. 4d. State various units and their functions of water treatment plant. 4e. State the needs of water conservation. 4f. State the impacts of sewage. 4g. State various units and their functions of sewage treatment plant. 4h. State sources and effects of air pollution.	4.1 Definition of pollution, types- Natural & Artificial (Man- made). 4.2 Soil / Land Pollution – Causes and effects on environment and lives , preventive measures. 4.3 Water Pollution - Sources of water (surface and sub surface), sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards, flow diagram of water treatment plant, Water conservation. 4.4 Wastewater - Generation(domestic and industrial), Impacts, flow diagram of sewage treatment plant, CPCB norms of sewage discharge.

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

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Environment	06	4	6	-	10
II	Energy Resources	10	4	8	4	16
III	Ecosystem and Biodiversity	08	4	4	4	12
IV	Environmental Pollution	16	8	8	4	20
V	Social Issues and Environmental Education	08	4	4	4	12
	Total	**48**	**24**	**30**	**16**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

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

a. Plant and adopt a tree in your nearby locality/Polytechnic campus and prepare report about its growth and survival after six months with photos.
b. Organize seminar on air pollutants of relevant MIDC area/vehicle
c. Organize poster exhibition about global warming and ozone depletion.
d. Visit a nearest water purification/effluent treatment plant.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

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

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

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

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

13. SUGGESTED LEARNING RESOURCES

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

14. SOFTWARE/LEARNING WEBSITES

a. www.eco-prayer.org
b. www.teriin.org
c. www.cpcb.nic.in
d. www.indiaenvironmentportal.org.in
e. www.whatis.techtarget.com
f. www.sustainabledevelopment.un.org
g. www.conserve-energy-future.com

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Fourth**

Course Title : **Microcontroller Programming**

Course Code : **22471**

1. RATIONALE

Microcontroller has become an integral part in various products in day to day life. This course is intended for developing the skills of interfacing and programing of different I/O devices with microcontroller. Diploma engineers will be able to develop microcontroller based applications for domestic and industrial products.

2. COMPETENCY

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

- **Apply the knowledge of microcontroller for 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. Interpret functions of various pins of 8051 microcontroller.
b. Develop simple 8051 programs using C language.
c. Use timers, interrupts and serial ports for 8051 C programs.
d. Develop C programs for basic input/output devices.
e. Develop applications using different sensors and motors.
f. Select different advanced microprocessors.

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 center of this map.

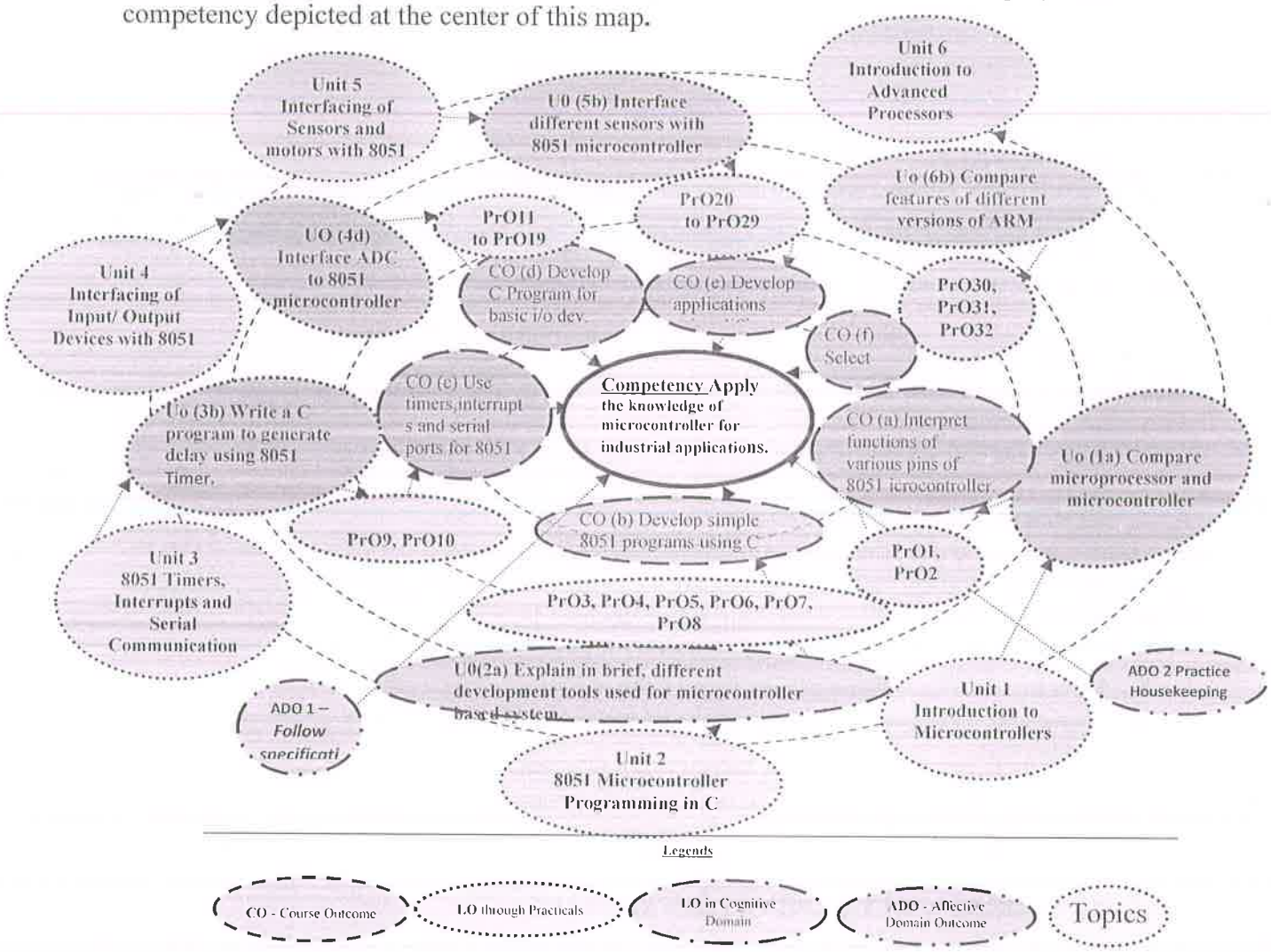

Figure 1 - Course Map

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	Identify various blocks of 8051 microcontroller development board.	I	2*
2	Use Integrated Development Environment tool for developing C programs for 8051 microcontroller.	I	2*
3	Develop C program for 8051 microcontroller for input/output operation over port pins.	II	2*
4	Demonstrate the usage of preprocessor directives in 8051 C programs.	II	2
5	Develop C program for toggling the port pins after certain interval using a delay function.	II	2

6	Develop C program for block transfer of 8-bit data from source to destination internal data memory locations.	II	2*
7	Perform various arithmetic operations on 8051 Port data.	II	2*
8	Perform various logical operations on 8051 Port data.	II	2
9	Use 8051 timer for generating the square wave of specified frequency on a port pin.	III	2*
10	Develop C program for transmitting the message "Hello World" on serial port.	III	2*
11	Develop C program for LED blinking.	IV	2*
12	Develop C program for turning ON/OFF the LED by a switch.	IV	2*
13	Develop C program for controlling a lamp interfaced with 8051 microcontroller through a relay.	IV	2*
14	Construct single digit up- counter (0-9) using LED 7-segment display.	IV	2*
15	Develop C program for 8051 microcontroller for sounding the buzzer on occurrence of an external interrupt.	IV	2*
16	Develop C program for displaying a message "Welcome" on the 16 x 2 LCD.	IV	2*
17	Develop C program for generation of sawtooth waveform using DAC.	IV	2
18	Develop C program for generation of triangular waveform using DAC.	IV	2*
19	Develop C program for 8051 microcontroller for converting the analog signal into digital form using an ADC.	IV	2*
20	Develop C program for displaying the temperature sensed by LM35.	V	2
21	Develop C program for speed control of DC motor.	V	2*
22	Develop C program for direction control of DC motor.	V	2
23	Develop C program for direction control of stepper motor.	V	2*
24	Develop C program for speed control of stepper motor.	V	2
25	Develop C program for rotating the servo motor by certain angle.	V	2*
26	Simulate the interfacing of servo motor with 8051 microcontroller.	V	2*
27	Develop C program for the IR sensor interfaced with 8051.	V	2*
28	Develop C program for PIR Motion sensor interfaced with 8051.	V	2*
29	Develop C program for ultrasonic sensor interfaced with 8051	V	2*
30	Identify various blocks of ARM7 development board.	VI	2
31	Use the Integrated Development Environment tool for programming ARM7.	VI	2*
32	Simulate the LED blinking program using ARM7 controller.	VI	2*
	Total		**64**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum **24** or more practical 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.	Experimental setup with proper interfacing	20
b.	Program development	25
c.	Program debugging and downloading	15
d.	Observations and Verification of output	20
e.	Answers to sample questions	10
f.	Timely Submission	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 practical's, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrOs No.
1	8051 Microcontroller Development Board- single board system with 8K RAM, ROM/Flash memory with battery backup, 16x2 LCD display, RS-232/USB interfacing facility with built in power supply.	1 to 29
2	PC with IDE software for 8051.	1 to 29
3	CRO- Bandwidth AC 10Hz ~20MHz, DC ~20MHz.	9,17,18
4	Digital multimeter – 3 ½ digit display.	19
5	Switch and LED module.	11,12
6	Relay trainer board suitable to interface with 8051 trainer kit.	13
7	LED 7-Segment display Module.	14
8	5V DC Buzzer.	15
9	DAC0808 trainer board.	17,18
10	ADC0808 trainer board.	19, 20
11	LM35, IR sensor, PIR Motion sensor, Ultrasonic sensor.	20,27,28, 29
12	DC motor, Stepper motor, Servo motor.	21 to 25
13	ARM7 development board.	30
14	Simulation software for 8051 I/O Interfacing.	26

S. No.	Equipment Name with Broad Specifications	PrOs No.
15	Program development and Simulation software for ARM7.	31,32

8. UNDERPINNING THEORY COMPONENTS

The following topics/sub topics 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 Microcontrollers	1a. Compare microprocessor and microcontroller 1b. Distinguish between Von-Neumann and Harvard architecture 1c. Explain 8051 architecture with features and memory organization. 1d. Explain power saving options of microcontroller 1e. Describe structure of P0, P1, P2 and P3.	1.1 Microprocessor and Microcontroller-Basic introduction, Block diagram and Comparison. 1.2 Harvard and Von-Neumann architecture 1.3 8051 Microcontroller Architecture, Features, Pin configuration and internal memory organization. 1.4 8051 as a Boolean processor, power saving options-idle and power down mode. 1.5 8051 I/O Port structure.
Unit II 8051 Microcontroller Programming in C	2a. Explain in brief, different development tools used for microcontroller based system. 2b. Differentiate between assembly language and Embedded C programming. 2c. Develop C programs for given microcontroller using decision control and loops. 2d. Develop embedded C programs for basic input output operations over port pins. 2e. Use various operators in C program for 8051.	2.1 Development Tools-Editor, Assembler, Compiler, Cross-compiler, Debugger, Emulator, Programmer. 2.2 Comparison between embedded C programing and assembly language programming. 2.3 Embedded C data types, decision control and looping, preprocessor directives. 2.4 Embedded C programs on-data transfer with ports and memory. 2.5 Embedded C programs using arithmetic and logical operators.
Unit– III 8051 Timers, Interrupts and Serial Communication	3a. Explain with sketch, different modes of 8051 Timer/Counter. 3b. Write a C program to generate delay using 8051 Timer. 3c. Explain the functions of various bits of IE and IP SFRs. 3d. Explain different modes of serial communication. 3e. Develop C program for 8051 microcontroller for serial communication. 3f. Interface 8051 microcontroller with serial port using RS232 protocol.	3.1 Timers/Counters: SFRs- TMOD, TCON, Timer/ Counter Modes. 3.2 C programs for Timer/Counter. 3.3 Interrupts: Polling and Interrupts, IE and IP SFR, Simple C program on interrupts 3.4 Serial Communication: SFRs- SCON, SBUF, Modes of serial communication. 3.5 8051 C programs on serial communication. 3.6 Serial communication standard RS232, DB9 pin functions, interfacing of 8051 microcontroller with MAX 232.
Unit-IV Interfacing of	4a. Explain with suitable sketch the interfacing of basic	4.1 Interfacing of LED, Switch, Relay, and buzzer with 8051 and its programming

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Input/ Output Devices with 8051	input/output devices with 8051 microcontroller. 4b. Develop 8051 C programs for basic I/O devices. 4c. Develop C programs for LED 7-segment and LCD. 4d. Interface ADC to 8051 microcontroller to convert analog signal into digital using C program. 4e. Interface DAC to 8051 microcontroller for generating different waveforms using C program.	in C. 4.2 Interfacing of LED 7-segment display and 16 x 2 LCD with 8051 and its programming in C. 4.3 Interfacing of ADC0808 with 8051 and its programming in C. 4.4 Interfacing of DAC0808 with 8051 and its programming in C to generate square, triangular and saw tooth waveforms.
Unit –V Interfacing of Sensors and motors with 8051	5a. Interface temperature sensor with 8051 microcontroller. 5b. Interface different sensors with 8051 microcontroller along with its simple C program. 5c. Interface different motors with 8051 to operate them using C programs.	5.1 Interfacing and programming of LM35 with 8051 microcontroller. 5.2 Interfacing and Programming of Sensors: IR sensor, PIR motion sensor and ultrasonic sensor. 5.3 Interfacing and Programming of Motors: DC motor, Stepper motor & servo motor.
Unit-VI Introduction to Advanced Processors	6a. List features of ARM7TDMI processor 6b. Compare features of different versions of ARM processors.	6.1 ARM7TDMI- Introduction, Features and applications. 6.2 Different versions of ARM and their features only.

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

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Microcontrollers	08	02	02	04	08
II	8051 Microcontroller Programming	06	02	04	08	14
III	8051 Timers, Interrupts and Serial Communication	08	02	04	04	10
IV	Interfacing of Input/ Output Devices with 8051	12	02	04	10	16
V	Interfacing of Sensors and motors with 8051	10	02	04	08	14
VI	Introduction to Advanced Processors	04	02	04	02	08
	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. Download the datasheet of 8051 microcontroller and ARM7TDMI microcontroller and study it.
b. Prepare a presentation on role of microcontroller in mechatronics industry.
c. Collect information from internet, magazines and journals about microcontroller based applications in the field of mechatronics.
d. Conduct an internet survey on different microcontroller development boards and programmers, add-on modules available in market.
e. Prepare a quiz on 8051 microcontroller with answer key.
f. Undertake the survey of different microcontrollers used in industries.
g. Conduct a survey of open source microcontroller boards available in market.

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 concepts.
g. Encourage students to use mobile apps related to the course.
h. Encourage students to refer educational websites related to course to further enhance the concepts learnt.
i. Guide students to undertake innovative micro projects.
j. Continuously monitor the students' performance and provide constructive feedback.

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 chart on comparative study of different microcontrollers currently used in market.
b. Build machine light controller circuit.
c. Build circuit to blink LEDs in different patterns.
d. Build quiz buzzer system.
e. Build system for controlling speed of stepper motor.
f. Build system using LCD to display name of your institute in rolling fashion.
g. Build 8051 based product counter.
h. Build obstacle detector using microcontroller.
i. Build countdown timer using LED 7-segment display.
j. Build automatic door opening/closing system.
k. Build 8051 based system for speed control of DC motor.
l. Build 8051 based temperature display system using LM35.
m. Build distance measurement circuit using ultrasonic sensor.
n. Build 8051 based obstacle detector using IR sensor.
o. Build motion sensor circuit using open source microcontroller based board and PIR sensor.
p. Prepare report on features of advanced microprocessors.
q. Prepare report on 8051 based line follower ROBOT

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller and Embedded Systems using Assembly and C	Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay	Pearson Education, New Delhi Second Edition 2007,ISBN: 9788131710265
2	Microcontrollers Theory and Applications	Ajay V. Deshmukh	McGraw-Hill Education.New Delhi,2011, ISBN: 978-0070585959
3	The 8051 Microcontroller	Kenneth J.Ayala	Cengage Learning, 3rd Edition, New Delhi,2007**ISBN:** 978-8131502006,
4	Microcontrollers: Principles and Applications	Ajit Pal	PHI Learning Pvt. Ltd., 2012, ISBN 978-8120343924
5	The Definitive Guide To The ARM CORTEX-M0	Josheph Yiu	ELSEVIER Publication, 2011 ISBN 978-0-12-385477-3

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=iXSXIJn_Xwc
b. https://www.tutorialspoint.com/microprocessor/microcontrollers_overview.htm
c. https://www.elprocus.com/category/microcontrollers/8051/
d. https://www.electronicshub.org/8051-microcontroller-introduction/
e. https://www.youtube.com/watch?v=gAAUAZiQlhQ

f. https://www.youtube.com/watch?v=5hVjGQX7ez8
g. https://www.keil.com/demo/eval/c51.htm
h. https://www.edsim51.com/index.html
i. https://www.engineersgarage.com/
j. https://youtu.be/BxxLqTtEI9s
k. https://youtu.be/M0VljVAfMVE
l. https://youtu.be/V9AzfvkWPW0
m. https://youtu.be/3hltHQXAQm8
n. https://youtu.be/5V3N1SYgVhQ
o. https://youtu.be/2AVOxLPKjeA
p. https://openlabpro.com/learn/8051-microcontroller-tutorials/
q. https://www.electronicshub.org/arm-introduction/
r. https://developer.arm.com/docs/ddi0210/latest/introduction/architecture
s. ARM architecture reference manual : - www.arm.com


KARNATAKA STATE BOARD OF TECHNICAL

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Fourth**

Course Title : **Control Systems**

Course Code : **22472**

1. RATIONALE

A control system is a discipline which uses the principles of control engineering to drive things in a desired direction, either from external input or sensed conditions. This course will facilitate students to use different control systems with wide range of applications from simple automatic controller to advanced control system. Diploma engineers should be able to control the various parameters at desired value in industry. This course helps the students to understand and apply the concepts, principles and procedure of controlling various parameters in different Mechatronics based industry. Students will also able to apply the knowledge of given control systems for basic fault finding in industry.

2. COMPETENCY

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

- **Maintain electronic control systems in 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. Identify types of given Control System.
b. Analyze different given Control System for different standard test input signal.
c. Test stability of given Control System.
d. Maintain different Control action used for Industrial application.
e. Maintain different Control System component in Industrial application.

4. TEACHING AND EXAMINATION SCHEME

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

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

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

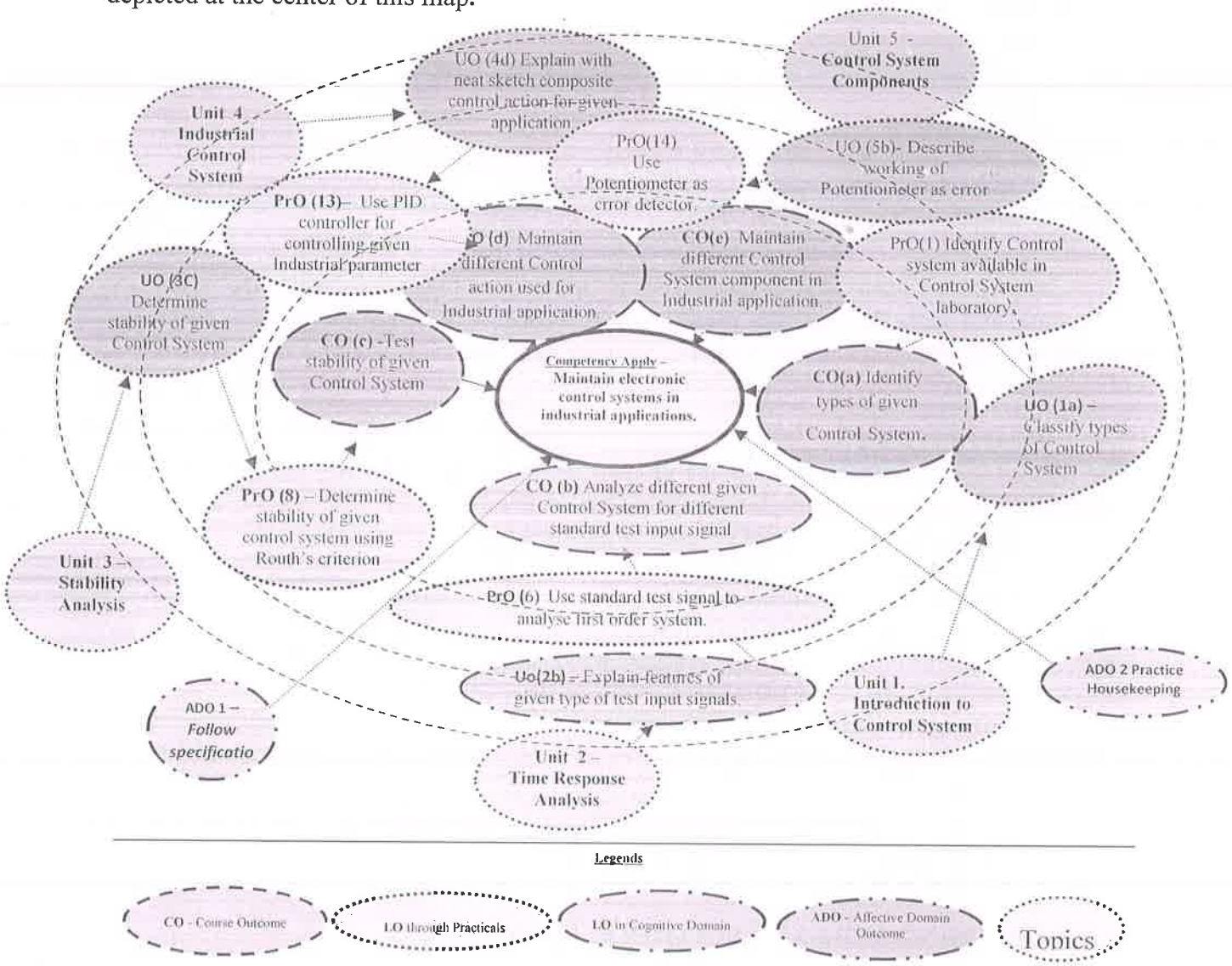

Figure 1 - Course Map

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	Identify Control system available in Control System laboratory.	I	02*
2	Interpret open loop system using traffic light system	I	02
3	Interpret close loop system using temperature control system	I	02
4	Analyze RC first order electrical circuit for step input.	II	02
5	Analyze RLC second order electrical circuit for step input.	II	02
6	Use standard test signal to analyse first order system.	II	02*
7	Use standard test signal to analyse second order system.	II	02
8	Determine stability of given control system using Routh's criterion	III	02*

9	Determine value 'k' for deciding conditional stability of given control system using Routh's criterion.	III	02
10	Use P controller for controlling given Industrial parameter such as temperature, level etc.	IV	02*
11	Use PI controller for controlling given Industrial parameter such as temperature, level etc.	IV	02
12	Use PD controller for controlling given Industrial parameter such as temperature, level etc.	IV	02
13	Use PID controller for controlling given Industrial parameter such as temperature, level etc.	IV	02*
14	Use Potentiometer as error detector.	V	02*
15	Use Synchro as error detector.	V	02*
16	Use DC position control system.	V	02
17	Use AC position control system.	V	02
18	Use Stepper Motor as Servo System component for position Control System.	V	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 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 practicals, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Traffic light control system setup with red, yellow and green lights	1,2
2	Temperature control system setup with heater, temperature sensor and relay	1,3
3	Standard test signal generator kit: Step, Ramp and parabolic signals.	2,3
4	First order trainer kit	2.6
5	Second order trainer kit	2,3,6,7
6	ON-OFF controller: Heater, Temperature sensor, Relay.	1,4,5
7	Proportional , PI, PD, PID controllers and the control system setup	10,11,12,13
8	Potentiometer as an error detector trainer kit.	14
9	Synchro transmitter, control transformer and power supply.	15
10	DC position control system trainer kit.	16
11	AC position control system trainer kit.	17
12	Stepper motor trainer kit.	18

8. UNDERPINNING THEORY COMPONENTS

The following topics/sub topics 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 Control System	1a. Classify types of Control System 1b. Differentiate between Open loop and Closed loop Control System 1c. Determine Transfer Function of given Control System 1d. Determine overall Transfer Function of complex block diagram using block diagram reduction rules.	1.1 **Control System**: Definition, block diagram, examples. 1.2 **Types of Control System** a) Open loop System : Block diagram, working , examples b) Closed loop System : Block diagram, working , examples c) Classification : Liner / Nonlinear System, Linear Time Variant, Linear Time invariant 1.3 **Transfer Function** : Definition, Transfer Function applied to Linear differential equation and electrical system such as RC and RLC circuits, properties of Transfer Function such as characteristics equation, order of system, number of poles and zeros. 1.4 **Block diagram reduction technique**: Need, reduction rules and numerical examples

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit II Time Response Analysis	2a. Identify poles ad zeros of given Control System. 2b. Explain features of given type of test input signals. 2c. Determine transient of given Control System using Unit Step input. 2d. Explain different Time domain specifications.	2.1 **Time domain analysis** :Transient and steady state response, concept of pole, zero, examples 2.2 **Standard Test inputs :** Step, Ramp, Parabolic and Impulse input, mathematical equation, response and their Transfer function 2.3 **First order system:** Analysis for Unit step input and their response. 2.4 **Second order system:** Analysis for Unit step input (no derivation) and their response, effect of damping. 2.5 **Time response Specification:** Peak time, rise time, settling time, delay time, peak overshoot & their numerical.
Unit– III Stability Analysis	3a. Explain condition for stability of given Control System. 3b. Draw pole zero plot of given Control System. 3c. Determine stability of given Control System using Routh's criterion. 3d. Determination of constant 'k' for deciding stability of linear feedback system.	3.1 **Stability:** Definition, Analysis of stable, unstable, critically stable, conditionally stable. 3.2 **Relative Stability:** Location of poles and zeros in S-plane for stable, unstable and relative stable. 3.3 **Routh's stability criterion:** Routh's array, statement, different cases and conditions with numerical problems. 3.4 **Application of Routh's criterion:** Determination of 'k' for conditional stability of linear feedback system.
Unit-IV Industrial Control System	4a. Identify elements of Process Control System. 4b. Explain with neat sketch ON-OFF control action for given application. 4c. Explain with neat sketch continuous control action for given application. 4d. Explain with neat sketch composite control action for given application. 4e. Differentiate between P, PI, PD, PID control action. 4f. Draw neat sketch of Electronic Op-Amp based PID control action.	4.1 **Process Control System:** Block diagram, working. 4.2 **Control action mode :** a) Discontinuous Mode: ON-OFF control action, output equation, operation, neutral zone. b) Continuous mode: Proportional (proportional band), Integral, Derivative control actions output equations operation and their responses. 4.3 **Composite control action** : a) PI control action, b) PD control action c) PID control action, output equation, operation, response. 4.4 **Electronic Op-Amp based controllers**: PI, PD, PID circuit diagram and equations.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Control System Components	5a. Identify elements of Servo System. 5b. Describe working of Potentiometer as error detector. 5c. Describe working of Synchro as error detector. 5d. Describe of rotary encoder for given application. 5e. Differentiate between AC and DC servomotor 5f. Differentiate between DC servomotor and stepper motor 5g. Describe working of variable reluctance stepper motor. 5h. Differentiate between AC and DC position Control System.	5.1 **Servo System** : Definition, block diagram, working 5.2 **Servo Component :** a) **Potentiometer:** construction, working, potentiometer as error detector. b) **Synchro:** construction, working, Synchro as error detector. c) **Rotary encoder:** Types, working, application. 5.3 **Servo Motor :** a) **DC servomotor**: Salient features, construction, working, application b) **AC servomotor**: Salient features, construction, working, application c) **Stepper Motor**: Salient features, construction, working, types: PM & variable reluctance, application 5.4 **Position control system:** a) AC Position control: Block diagram and working b) DC Position control: Block diagram and working.

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

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Control System	10	02	06	06	14
II	Time Response Analysis	08	02	04	06	12
III	Stability Analysis	08	02	04	06	12
IV	Industrial Control System	10	02	06	06	14
V	Control System Components	12	04	06	08	18
Total		**48**	**12**	**26**	**32**	**70**

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

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 report on market survey for availability different servo component.

b. Prepare report on market survey for availability of different controllers.
c. Visit nearby mechatronics based industries and prepare a report on control system used.
d. Visit nearby engineering institute and prepare report on different used in control system used in their laboratory.
e. Prepare a chart on comparison of control actions.
f. Prepare chart on effect of damping on the response of different types of control systems.
g. Prepare a chart on effect of location of poles on stability of different types of control system.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use flash/animation to explain various control actions.
g. Use proper equivalent analogy to explain different concepts.
h. Show models, educational charts, videos & real life examples of various control actions and servo component.
i. Demonstration of real industrial servo control elements and control actions 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 control system components 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. Build/test an automatic feedback temperature control system.

b. Build/test an automatic feedback water level control system.
c. Build/test RC circuit and check its output response.
d. Build/test RLC circuit and check its output response.
e. Build/test ON-OFF controller for the given type of control loop.
f. Build/test Op-Amp based P controller for the given type of control loop.
g. Build/test Op-Amp based PI controller for the given type of control loop.
h. Build/test Op-Amp based PD controller for the given type of control loop.
i. Build/test Op-Amp based PID controller for the given type of control loop.
j. Build/test Op-Amp based Potentiometer as an error detector for the given control system.
k. Troubleshoot faulty equipment/kit available in control system lab.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Control System Engineering	Nagrath I. J, M. Gopal.	New age International, New Delhi, Sixth edition, ISBN: 9788122420081
2	Modern Control Engineering	Ogata K.	Pearson India, Noida, Fifth edition ISBN : 9332550162
3	Process Control Instrumentation Technology	Johnson C. D.	PHI Learning, New Delhi, 2015 ISBN: 978-9332549456
4	Control System Engineering	Nise Norman S	Willey India, Delhi, Sixth Edition ISBN: 978-8126519477
5	Control Systems	Anand Kumar	PHI Learning, New Delhi,2014 ISBN:9788120349391
6	Control Systems	Varmah K. R.	McGraw Hill, New Delhi,2010 ISBN: 9780070678750

14. SOFTWARE/LEARNING WEBSITES

a. https://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/
b. https://www.electrical4u.com/transfer-function/
c. https://www.electrical4u.com/types-of-controllers-proportional-integral-derivative-controllers/
d. https://www.youtube.com/watch?v=nq3CyAWsS6A - servomotor
e. https://www.youtube.com/watch?v=1nKJNxtNUOc –stepper motor
f. https://www.youtube.com/watch?v=X-A5oL76ys8 -potentiometer
g. https://www.youtube.com/watch?v=SMuBjZH__hc - syncro as error detector practical
h. https://www.youtube.com/watch?v=V1mlWDNeOlU potentiometer as error detector practical
i. https://www.youtube.com/watch?v=3i1NO6tI-y0 – pid controller practical
j. https://www.youtube.com/watch?v=KS-xRcKih7E – stability
k. https://www.youtube.com/watch?v=ziu1OTwUrbw –time response analysis

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Fourth**

Course Title : **Elements of Mechanical Engineering**

Course Code : **22473**

1. RATIONALE

A diploma holder in Mechatronics discipline is expected to select simple machine components used in automation industries. This course helps students understand usual design procedures, standard design codes & selection procedures of standard components. This course also aims at developing analytical abilities to give solutions to engineering design problems.

2. COMPETENCY

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

- **Select suitable machine components.**

3. COURSE OUTCOMES (COs)

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

a. Select suitable materials for designing of machine elements.
b. Estimate simple stresses in machine elements.
c. Apply concept of load & stresses in design procedure.
d. Design simple machine elements.
e. Select standard mechanical elements using manufacturer's catalogue.

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.

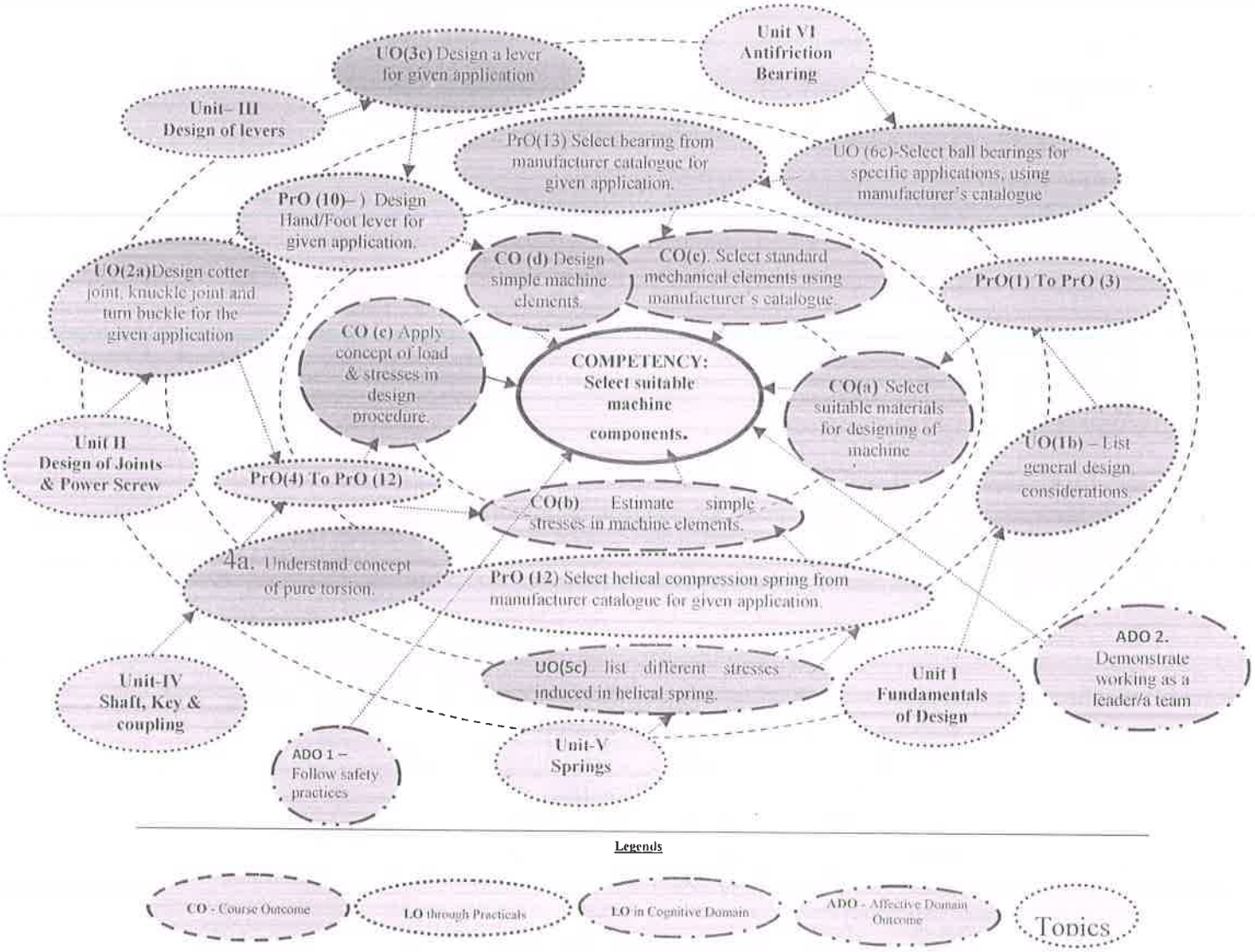

Figure 1 - Course Map

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** (PrOs) (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
1	List materials used in mechanical elements in your laboratories/workshop (Shaft, Key, Spring, Gear, Bearing, Nut & Bolt, lever)	I	02*
2	Justify the material selection using design data book for elements in Practical 1	I	02
3	List various modes of failure for the machine elements used in various laboratories/ workshops, under different loading conditions.	I	02
4	Design knuckle joint for given loading condition **(Part- I)**	II	02*
5	Draw assembly and details of knuckle joint. **(Part-II)**	II	02
6	Design cotter joint for given loading condition **(Part- I)**	II	02
7	Draw assembly and details of cotter joint. **(Part-II)**	II	02
8	Determine different stresses induced in power screw.	II	02*
9	Design Hand/Foot lever for given application.	II	02*

10	Design bell crank lever for given application.	III	02
11	List different shafts used in various industrial applications.	IV	02*
12	Determine torsional strength of a transmission shaft for given loading condition.	IV	02*
13	Select helical compression spring from manufacturer catalogue for given application.	V	02*
14	Select bearing from manufacturer catalogue for given application.	VI	02*
	Total		**28**

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A 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.	Data interpretation & Calculation	30
b.	Interpretation of result and Conclusion	20
c.	Answer to sample questions	10
d.	Neatness in Drawing	10
e.	Submission of report in time,	30
	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. 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	Model / wall charts of Cotter Joint, Knuckle Joint and Turn Buckle	4, 5, 6, 7
2	Model / wall chart of Hand/foot lever.	8
3	Model / wall chart of bell crank lever.	9

S. No.	Equipment Name with Broad Specifications	PrO. No.
4	Working models of transmission shaft	10
5	Test Rig for torsional strength of transmission shafts	11
6	Working model/ wall charts of spring & Manufacturer catalogues of spring.	12
7	Working model/wall chart of bearing & Manufacturer catalogues of bearing.	13

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 Fundamentals of Design	1a. State need of machine element design 1b. List general design considerations. 1c. List different types of stresses. 1d. Apply basic concepts of load, stress & strain in design procedure. 1e. Understand different theories of failure.	1.1 Design philosophy and general procedures of machine design, Basic procedure of design of machine elements. 1.2 General considerations in Design. 1.3 Modern Design considerations: Ergonomics and aesthetics. 1.4 Types of loads, concepts of stress, types of stresses (Direct, Shear, Bending, Torsional, Crushing and Bearing Pressure), concept of strain, and types of strain. **(Simple Numerical)** 1.5 Factor of safety & its significance. 1.6 Theories of elastic failure • Maximum Principal stress theory. • Maximum shear stress theory • Maximum distortion energy theory. **(No Numerical)**
Unit II Design of Joints & Power Screw	2a. Design cotter joint, knuckle joint and turn buckle for the given application. 2b. List different thread profiles used in power screws. 2c. Identify different types of welded joints & riveted joints.	2.1 **Design of Joints** • Design of cotter joints. • Design of Knuckle joints. • Design of turn buckle. 2.2 **Design of Power Screw** • Basic concept of power screw, Thread profiles used in power screw, relative merits and demerits. • Torque required to raise & lower load by square threaded screws **(No Derivation).** • Stresses in Power Screws. 2.3 **Welded joints** • Introduction • Types of welded joints. • Merits and demerits. 2.4 **Riveted Joints** • Introduction • Types of Riveted joints • Merits & demerits.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– III Design of levers	3a. Understand concept of pure bending. 3b. List different types of levers in mechatronics systems 3c. Design a lever for given application	3.1 Theory of simple bending, Assumptions in the theory of bending, Equation of bending (Flexural formula) **(No Derivation)**, neutral axis, section modulus.**(No Numerical)** 3.2 **Levers:** - Introduction, Application of Levers in Engineering Practice. 3.3 Design of a Lever • Hand/Foot Levers. • Bell Crank Lever
Unit-IV Shaft, Key & coupling	4a. Understand concept of pure torsion. 4b. List different types of shafts for different application. 4c. Select suitable key for given application. 4d. Select suitable coupling for given application.	4.1 Concept of Pure Torsion, Assumptions in theory of pure Torsion, Torsion equation for solid and hollow circular shafts **(No Derivation)**. Power transmitted by a shaft. 4.2 **Shaft:-** • Introduction. • Material Used for Shafts. • Types of Shafts. • Standard Sizes of Transmission Shafts. • Torsional strength of Solid and hollow shaft. • Comparison of solid and hollow shaft. • Replacement of Shaft. 4.3 **Key:** - Introduction, Types of Keys (Sunk Keys, Saddle Keys, Tangent Keys & Round Keys), Splines. Strength of a sunk key. 4.4 **Shaft Couplings**: - Requirements of a Good Shaft Coupling, Types of Shaft Couplings. Introduction of Sleeve or Muff Coupling. Flange Coupling & Flexible Coupling. **(No Numerical)**
Unit –V Springs	5a. Classify springs on the basis of different criteria. 5b. Define spring terminology. 5c. List different stresses induced in helical spring. 5d. Select helical compression spring for given application by using Manufacturer's catalogue.	5.1 Classification and Applications of springs. 5.2 Spring terminology. 5.3 Stresses in helical compression springs. 5.4 Selection of helical compression spring using manufacturer's catalogue.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-VI Antifriction Bearings	6a. Classify bearing. 6b. Define different terms used in ball bearing. 6c. Select ball bearings for specific applications, using manufacturer's catalogue. 6d. Select linear bearings for specific applications, using manufacturers catalogue	6.1 Classification of Bearings – Sliding contact & rolling contact. 6.2 Terminology of Ball bearings – life load relationship, basic static load rating and basic dynamic load rating, limiting speed. 6.3 Selection of ball bearings using manufacturer's catalogue 6.4 Introduction to linear bearings

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

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Design	08	04	04	06	14
II	Design of Joints & Power Screw	12	04	04	08	16
III	Design of levers	06	02	02	04	08
IV	Shaft, Key & coupling	08	02	04	06	12
V	Springs	08	02	04	06	12
VI	Antifriction Bearings	06	02	02	04	08
	Total	**48**	**16**	**20**	**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. Prepare journal based on practical. Journal consists of drawing, observations, required equipment's, date of performance with teacher signature.
b. Undertake micro projects.
c. Compile information from internet related to different materials used for various applications, its compositions and properties.
d. Make chart indicating different screw thread profile, different types of bearing and its specifications, standard sizes of shafts, types of keys, spring terminology and different types of couplings.
e. Collect different types of springs and its applications.
f. Collect different types of bearings and its applications.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use flash/animation to explain various elements used in mechatronics systems.
g. Use proper equivalent analogy to explain different concepts.
h. Show models, educational charts, videos & real life examples of various elements.
i. Demonstration of real industrial parts and elements used in various mechatronics systems.
j. Guide the students to do the survey of various materials used in different elements.

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. Select any one components, find load, stresses acting on them and also prepare chart.
b. Prepare working/ Demo type of bearings used mechatronics of different elements by using low cost material.
c. Select any one bearings used in mechatronics/mechanical systems and prepare report comprising of material, designation function and selection.
d. Prepare list of different levers used in mechatronics/mechanical systems.
e. Prepare list of different springs used in mechatronics/mechanical systems.
f. Prepare list of different joints used in mechatronics/mechanical systems.
g. Prepare animations of different elements by using free software available on internet.
h. Survey of various elements used in different mechatronics systems by doing field Visits.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Design of Machine Elements	Bhandari V. B.	McGraw-hill education India Pvt. Ltd. New Delhi, 2017, ISBN:13:978-9339221126
2	Machine Design	Khurmi R. S. & Gupta J. K.	S. Chand Publications, New Delhi,2005 ISBN: 13-9788121925372
3	Machine Design	Jindal U. C.	Pearson Education India, New Delhi, 2010, ISBN:13-9788131716595
4	Machine Design	Pandya & Shah	Charotar Publishing house pvt. Ltd. Anand, Gujrat, 2015. ISBN:13-9789385039102.
5	Mechanical Engineering Design	Shigley	McGraw-hill education India Pvt. Ltd. New Delhi, 2017, ISBN:13:978-9339221638
6	Design Data Book	PSG	PSG College of Technology Coimbatore,2012, ISBN:10-8192735508
7	Machine Tool Design Handbook	CMTI	Tata McGraw-Hill Education Pvt. Ltd New Delhi, 2004 ISBN-13: 9780074515648

14. SOFTWARE/LEARNING WEBSITES

a. https://youtu.be/HZtYasMDtts
b.www.technologystudent.com/gears1/gears7.htm
c. https://www.youtube.com/watch?v=h2VhzUv61b8
d. https://youtu.be/IohFT1hyg9c
e. https://youtu.be/TOAanx0QPKs

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Fourth**

Course Title : **CNC Machine Tool Technology**

Course Code : 22072

1. RATIONALE

New innovations in the machines as compare to conventional machines. Mechatronics technocrats knows and can run CNC Machines with the identification of specifications are used in CNC Machines. Mechatronics diploma engineers should be able to aware about CNC programming, setting, operating & minor maintenance of machines and various controls.

2. COMPETENCY

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

- **Maintain and control CNC Machines.**

3. COURSE OUTCOMES (COs)

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

a. Identify different components of Conventional NC & CNC Machines.
b. Identify CNC machines based on technical specification.
c. Interpret concepts of control system feedback device and tooling.
d. Prepare CNC part programming.
e. Maintain CNC Machines and related accessories

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.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *- Practical;* ***C*** *– Credit,* ***ESE*** *- End Semester Examination;* ***PA*** *- Progressive Assessment; # - External Assessment, ~ -For the courses having ONLY Practical Examination, the PA marks Practical Part with 60 % weightage and Micro-Project part with 40 % weightage.*

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.

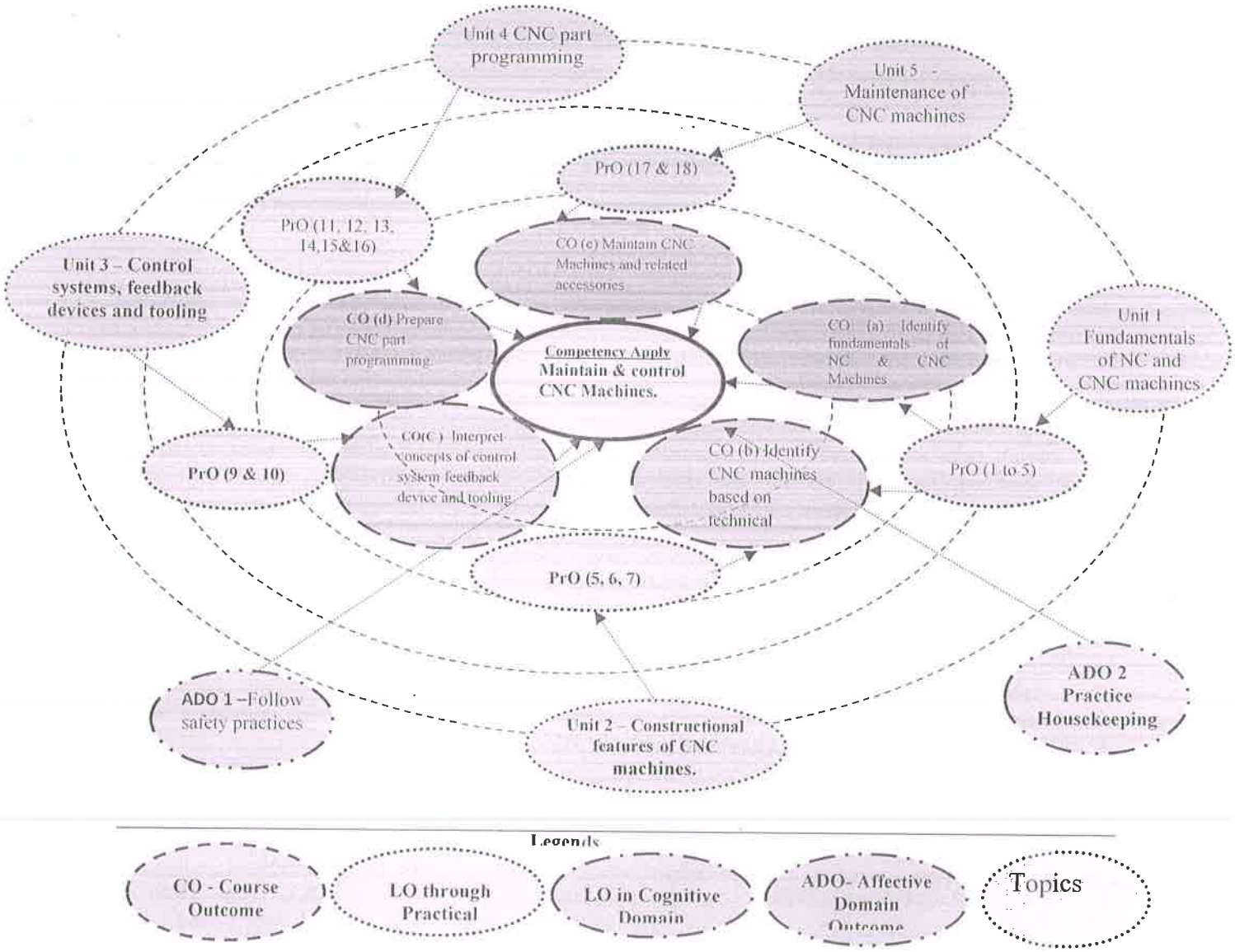

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. Required
1.	Identify different components of conventional Lathe machine.	I	02*
2.	Prepare simple job on conventional lathe machine. (PART-I)	I	02*
3.	Prepare simple job on conventional lathe machine. (PART-II)	I	02
4.	Identify different components of conventional milling machine.	I	02*
5.	Prepare simple job on conventional milling machine. (PART-I)	I	02*
6.	Prepare simple job on conventional milling machine. (PART-II)	I	02

7.	Identify different components in CNC Turning machine	I	02*
8.	Identify different components in CNC Milling machine.	I	02
9.	Verify performance of Stepper driver using Digital multimeter.	II	02*
10.	Measure earth resistance by using Digital earth tester.	II	02*
11.	Identify various sensors/Transducer used in CNC machines.	II	02*
12.	Construct Universal gates for given CNC Machines	III	02*
13.	Test performance of feedback control loop of CNC Machine	III	02*
14.	Test performance of pneumatic /Hydraulic system of CNC machine	III	02*
15.	Identify various controllers used in CNC machines.	IV	02*
16.	List various G & M codes used in the part programming.	IV	02*
17.	Prepare simple part programme for CNC Turning machine	IV	02*
18.	Execute simple part programme on CNC Turning machine.	IV	02*
19.	Prepare simple part programme for CNC Milling machine.	IV	02*
20.	Execute simple part programme on CNC Milling machine.	IV	02*
21.	Prepare daily, weekly and monthly Maintenance check list for CNC Lathe machine.	V	02*
22.	Prepare daily, weekly and monthly Maintenance check list for CNC Milling machine.	V	02
23.	Identify any one electronic system fault occur in given CNC Lathe machine and their causes.	V	02*
24.	Identify any one electronic system fault occur in given CNC Milling machine and their causes.	V	02*
25.	Identify any one electrical system fault occur in given CNC Lathe machine and their causes.	V	02*
26.	Identify any one electrical system fault occur in given CNC Milling machine and their causes.	V	02*
27.	Prepare chart on different troubleshoot in mechanical control system of given CNC Lathe machine	V	02*
28.	Prepare chart on different troubleshoot in mechanical control system of given CNC Milling machine.	V	02*
29.	Execute overall maintenance of CNC Lathe machine.	V	02*
30.	Execute overall maintenance of CNC Milling machine.	V	02*
31.	Identify various Safety precautions taken during CNC operation	V	02*
32.	Prepare chart for Preventive Maintenance for six months.	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 practical marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

S.No.	Performance Indicators	Weightage in %
a.	Safety precautions and good housekeeping.	10
b.	Preparation of job drawing, selection of material, tool & cutting parameters.	20
c.	Programming of a given job.	20
d.	Job setting and machining operations	20
e.	Test minor troubleshoot	10
f.	Answer to questions on operations.	10
g	Submission of job workshop diary 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 practical, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	CNC Turning 250 with standard accessories and multi controller changing facility with simulated control panel and related software. Training or productive type minimum dia.25MM, length 120MM.	7,9,10,11,12,13,14, 15,16,17,18,21,23, 25,27,29
2	CNC Milling 250 with standard accessories and multi controller changing facility with simulated control panel and related software. Training or productive type X-axis travel -225mm, Y-axis travel 150mm, and Z-axis travel115mm with ATC.	8,19,20,22,24,26, 28,
3	Center Lathe Machine-admit between center 500 mm with required set of holding devices, cutting tools, accessories and tool holders.	1, 2, 3
4	Universal milling machine, face milling cutter, side and face milling cutter, end mill cutter, minimum 500 mm longitudinal transverse with required indexing head, set of work holding devices, cutting tools, accessories and tool holders.	4, 5, 6
5	Digital multimeter 5A/230V	23,24,25,26
6	Digital Earth tester 5A/400V	10

S. No.	Equipment Name with Broad Specifications	PrO. No.
7	Appropriate Trainer kit for construct gates	12
8	Feedback control trainer set up.	13

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 Components of Conventional, NC and CNC machines	**N.A.**	1.1 Introduction of Turning and Milling machine. 1.2 Various components used in NC and CNC machine and their functions. 1.3 Classification of CNC machines 1.4 Advantages and disadvantages of CNC machine over conventional machines
Unit II Constructional features of CNC machines.	**N.A.**	2.1 Different drive system a) Servo motor b) Stepper motor 2.2 Recirculating Ball screw and box nut, Tool magazines, ATC, APC, chip conveyer 2.3 Cartesian co-ordinate system, Right hand rule 2.4 Sensors: - Position sensors, velocity sensors, pressure and torque sensors
Unit– III Control systems, feedback devices and tooling	**N.A.**	3.1 According to Machining control system a) straight cut control b) Contouring control c) Point to point control 3.2 According to control loop system a) Open loop control system b) Close loop control system 3.3 According to Programming and tool positioning a) Absolute system b) Incremental system 3.4 Pneumatic system and Hydraulic control systems and its different components 3.5 Adaptive control system with block diagram 3.6 Function of feedback device in close loop control system a) benefits of feedback device b) Types of feedback device
Unit-IV CNC part programming	**N.A.**	4.1 Introduction of part programme 4.2 Types of part programme a) Fixed block format b) Tab sequential format c) Word address format

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		4.3 Different controls of CNC machines. 4.4 Meaning and functions of G and M codes used for part programme 4.5 Simple programmes on CNC turning and CNC milling by using different cycles
Unit –V Maintenance of CNC machines	**N.A.**	5.1 Types of maintenance a) Preventive maintenance b) Corrective maintenance c) TPM (Total Productive Maintenance) 5.2 Mechanical system, Electronic system, Drive system, Tool clamping system, lubrication system, Coolant system, Hydraulic system, Pneumatic systems 5.3 Standard procedure and carry maintenance practice for CNC machines. 5.4 Daily maintenance check list formats for CNC machines 5.5 Various Causes and remedial actions for failure in electronics and mechanical systems in CNC system 5.6 Different safety precaution taken during operating CNC machine

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

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

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

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. List various types of NC and CNC machines.
b. Collect information VMC, HMC and Wire cut CNC machines.
c. Tabulate various cutting tool materials used in CNC machine.
d. List various sensors used in CNC machine.
e. Collect information of different controls used in CNC machine.
f. List various CNC programming software used in industry

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 components of CNC machine.
g. Use proper equivalent analogy to explain different concepts.
h. Show videos &real-life examples of various CNC machines.
i. Industrial visit to any industry where CNC machines is available.
j. Guide the students to do the survey of various CNC manufacturing industries in India.

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. Draw block diagram for CNC turning machine tool and discuss each component.
b. Draw block diagram for CNC milling machine tool and discuss each component.
c. Comparative study of AC servomotors and DC servomotor.
d. Prepare report on feedback measuring devices.
e. Produce simple part in CNC turning by using G90 Cycle.
f. Produce complex part in CNC turning by using G71 Cycle
g. Produce simple part in CNC milling by using sub programme.
h. List the cutting tool you have used during operation also state its specification.
i. Study and prepare report on FANUC, HAAS and SIEMENS control.
j. Visit and prepare report local CNC job shops.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Mechatronics	HMT Limited	McGraw-Hill Education, New Delhi, ISBN 0-07-463643-X
2	CNC machines	M. Adithan B.S.Pabla	New age international publication ISBN 9788122434262
3	Design of Machine Tools	S.K Basu D.K Pal	Oxford and IBH Publishing New Delhi ISBN 978-81-204-1721-2
4	Introduction to NC\CNC Machine	Vishal S.	S.K. Kataria and Sons New Delhi ISBN 978-8188458110
5	CAD/CAM	Sareen Kuldeep	S Chand, New Delhi ISBN9788121928748

14. SOFTWARE/LEARNING WEBSITES

a. http://www.youtube.com/watch=M3EX2PKMIRI
b. http://www.youtube.com/watch=N7N0FMHWWPQ
c. http://www.youtube.com/watch=p11QGPMKQOW
d. https://cadem.com/lms/
e. https://cadem.com/cncetc/
f. http://www.mtabindia.com
g. http://www.swansoftcncsimulator.com

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Fourth**

Course Title : **Industrial Fluid Power**

Course Code : **22474**

1. RATIONALE

It is important to select relevant hydraulic and pneumatic components considering automation and technological developments in various industries. Diploma Engineers has to use hydraulic and pneumatic simple automated systems in different segments of industries. Selection of appropriate hydraulic/pneumatic components needs the knowledge of construction, working and their practical applications. This course will give the basic knowledge and skills to select and use different types of fluid power components in relevant industrial applications.

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 hydraulic and pneumatic components for given application.**

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 the fundamentals of fluid mechanics.
b. Select various components of hydraulic systems.
c. Build/prepare different hydraulic circuits for given simple automation applications.
d. Select various components of pneumatic systems.
e. Build/prepare different pneumatic circuits for given simple automation applications.
f. Construct Electro-hydraulic and Electro-pneumatic circuits for simple automation.

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 center of this map.

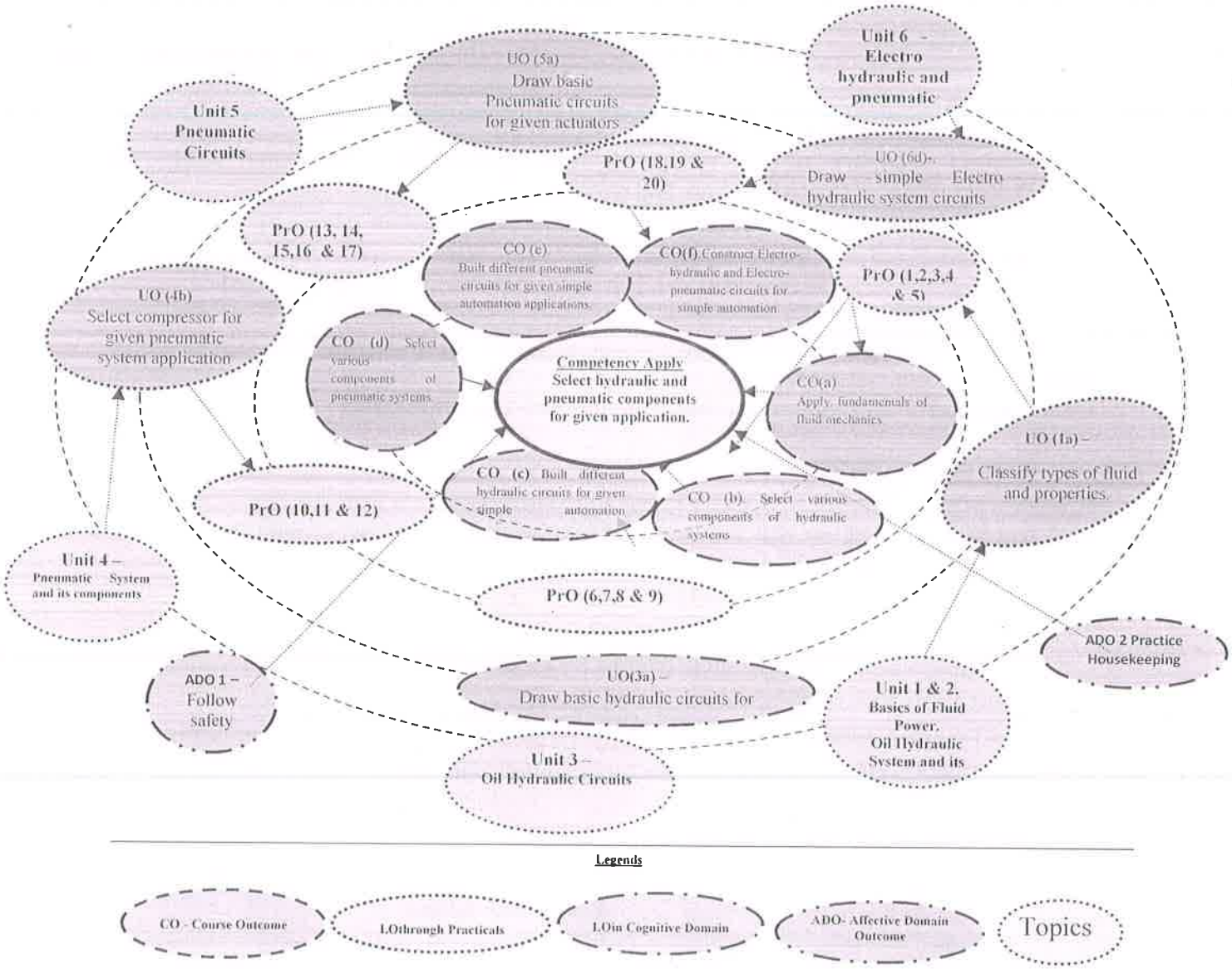

Figure 1 - Course Map

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	Verify Pascal's law using suitable setup.	I	02*
2	Verify Bernoulli's Theorem.	I	02*
3	Identify various components of hydraulic power pack and other components of oil hydraulic system.	II	02*

4	Verify functional parameters of pump and actuators of oil hydraulic system	II	02
5	various valves and accessories mounted on hydraulic trainer	II	02
6	Actuate hydraulic circuit for single acting cylinder, double acting cylinder & hydraulic motor.	III	02*
7	Actuate Meter-in, Meter out speed control hydraulic circuit.	III	02*
8	Actuate suitable sequencing hydraulic circuit for given application	III	02*
9	Discover/Rectify faults in the given oil hydraulic system	III	02
10	Identify components of pneumatic system.	IV	02*
11	Verify functional parameters of Compressor and actuators mounted on Pneumatic trainer	IV	02
12	Identify various valves and accessories mounted on Pneumatic trainer	IV	02
13	Actuate pneumatic circuit for single acting cylinder, double acting cylinder & air motor.	V	02*
14	Actuate speed control pneumatic circuits.	V	02*
15	Actuate indirect (pilot) control pneumatic circuit.	V	02
16	Actuate sequencing pneumatic circuit for given application	V	02*
17	Actuate pneumatic circuit for logic functions (AND/OR/TIME DELAY)	V	02*
18	Discover/Rectify faults in the given pneumatic system	V	02
19	Construct electro-hydraulic circuit using proportional control valve.	VI	02
20	Construct electro-pneumatic circuit using proportional control valve.	VI	02*
21	Develop automation circuit for given practical application.	III, IV, V, VI	02
	Total		**42**

Note:

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the Cos and competency. A 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.	Preparation of practical set up	10
b.	Selection and Connections of required components	15
c.	Setting and operation	10
d.	Safety measures	15
e.	Observations and recording	20
f.	Interpretation of result and conclusion	15
g.	Answer to sample questions	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	Pressure Gauge Apparatus.	1
2	Bernoulli's Theorem Apparatus.	2
3	Hydraulic power pack	3, 4, 5, 6
4	Hydraulic trainer with transparent /actual working components.	4, 5, 6, 7
5	Pneumatic trainer with transparent/ actual working components.	8, 9, 10, 11, 12, 13
6	Working / actual models of pumps, cylinders, valves, other components	4, 5, 6, 7, 8, 9, 10, 11, 12, 13
7	Single /Multistage Reciprocating Compressor (pressure 0-10 bar)	8, 9, 10, 11, 12, 13
8	Limit switches, solenoid operated valves, proximity switches, proportional control valves	14, 15, 16

8. UNDERPINNING THEORY COMPONENTS

The following topics/sub topics 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 Fluid Power	1a. Classify types of fluid. 1b. State properties of fluid 1c. Classify fluid flows. 1d. Verify Pascal's law , law of continuity and Bernoulli's equation 1e. Classify fluid power systems. 1f. Compare various fluid power systems with other systems.	1.1 Classification of fluids, properties of fluids. 1.2 Types of fluid flow steady, unsteady, laminar, turbulent, one, two and three dimensional flow, uniform and non-uniform flow. 1.3 Pascal's law, continuity equation. Bernoulli's Theorem. 1.4 Basic elements of fluid power system. 1.5 Comparison of various system- Hydraulic, Pneumatic, Electric, Mechanical.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit II Oil Hydraulic System and its components	2a. Identify components of oil hydraulic system 2b. Explain construction and working of pump/s 2c. Describe construction and working of control valves 2d. Explain construction and working of actuators 2e. State function, symbols of accessories of oil hydraulic system	2.1 General layout of oil hydraulic system. 2.2 Pumps: function, construction and working of Gear, Vane, and Piston pump. 2.3 Control valves: function, types, construction and working of pressure control valve, Direction control valve and Flow control valves. 2.4 Actuators: function, types, construction and working of linear and rotary. 2.5 Function and symbols of oil filters, intensifier and accumulator.
Unit-III Oil Hydraulic Circuits	3a. Draw basic hydraulic circuits for given actuators 3b. Draw speed control hydraulic circuits for given applications 3c. Draw sequencing hydraulic circuits for given applications 3d. Draw Pilot control Hydraulic circuits for given applications. 3e. Identify common faults in oil hydraulic system	3.1 Basic circuits to actuate Single Acting Cylinder, Double Acting Cylinder, Hydraulic motors. 3.2 Speed control circuits: Meter-in, Meter - out, bleed off. 3.3 Sequencing circuits for simple operations. 3.4 Pilot control /impulse circuits. 3.5 Maintenance of oil hydraulic system-common faults ,causes and remedies
Unit– IV Pneumatic System and its components	4a. Identify components of Pneumatic system. 4b. Explain construction and working of compressor 4c. State the function of FRL unit. 4d. Describe construction and working of control valves 4e. Explain construction and working of pneumatic actuators	4.1 General layout of Pneumatic system. 4.2 Compressor: Construction, working of rotary and reciprocating compressor. 4.3 Function and construction of FRL unit. 4.4 Valves: construction and working of pilot control valves, Shuttle valve, Twin pressure valves, time delay valve. 4.5 Actuators: function, types, construction and working of linear and rotary.
Unit –V Pneumatic Circuits	5a.Draw basic Pneumatic circuits for given actuators 5b.Draw speed control Pneumatic circuits for given applications 5c. Draw Pilot control Pneumatic circuits for given applications 5d. Draw sequencing Pneumatic circuits for given applications 5e. Draw automation circuits using special control valves 5f. Identify common faults in oil hydraulic system.	5.1 Basic circuits to actuate Single Acting Cylinder, Double Acting Cylinder, Air motors. 5.2 Speed control circuits: Single Acting Cylinder, Double Acting Cylinder, Air motors. 5.3 Pilot control /impulse circuits. 5.4 Sequencing circuits for simple operations. 5.5 Automation circuits using logic gates valves, time delay valve. 5.6 Maintenance of pneumatic system-common faults, causes and remedies

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-VI Electro hydraulic and pneumatic systems	6a. Identify components of Electro hydraulic system. 6b. Identify components of Electro pneumatic system. 6c. State function of Proportional control valve. 6d. Draw simple Electro hydraulic system circuits 6e. Draw simple Electro hydraulic system circuits	6.1 Components of Electro hydraulic system. 6.2 Components of Electro Pneumatic system. 6.3 Proportional control valves used in hydraulics/pneumatics. 6.4 Simple circuits for Electro hydraulic system. For example, Control of a double acting cylinder with 4/2 solenoid operated spring return valve. 6.5 Simple circuits for Electro pneumatic system. For example, Control of a single acting cylinder with 3/2 solenoid operated spring return valve.

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

9. SUGGESTED SPECIFICATION TABLE FORQUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Fluid Power	08	02	02	04	08
II	Oil hydraulic System and its components	14	02	04	08	14
III	Oil hydraulic circuits	10	02	04	06	12
IV	Pneumatic system and its components	12	04	06	04	14
V	Pneumatic circuits	12	02	04	08	14
VI	Electro hydraulic and pneumatic systems	08	02	02	04	08
	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. Prepare journal based on practical performed in Industrial fluid power laboratory. Journal consists of drawing, observations, required measuring tools, equipment's, and date of performance with teacher signature.
b. Power Point Presentation on hydraulic and Pneumatic brakes by group of two/three students. (Duration:10 minutes)
c. Power Point Presentation on accessories used in hydraulics and pneumatics by group of two/three students. (Duration:10 minutes)

d. Prepare report of market survey of suppliers for fluid powered Earth moving equipment's like JCB, Mahindra Earth master by group of four students.
e. Prepare chart on full imperial drawing sheet for ISO Symbols used in hydraulic & pneumatic system by group of two students.
f. Prepare chart on full imperial drawing sheet for classification of pumps and actuators by group of two students.
g. Prepare Seminar/presentation on types of oil filters by group of two/three students. (Duration:10 minutes)
h. Prepare display chart on types of seals and gaskets (actual/ used samples) used in hydraulics.
i. Prepare visit report of any automobile service station to observe use of pneumatic hand tools.
j. Prepare visit report of construction sites to observe use of earth moving equipment /other hydraulic /pneumatic equipment's for automation.

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 instrument.
g. Instructions to students regarding care and maintenance of measuring equipment's.
h. Show video/animation films to explain functioning of various measuring Instruments.
i. Teacher should ask the students to go through instruction and Technical manuals of instruments.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project 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 specification of hydraulic pumps using internet by visiting website of suppliers
b. Collect the information from internet related to the different actuators for mechatronic applications.
c. Prepare report of Market Survey of various grades of hydraulic oil.
d. Prepare seminar on Comparative study of hydraulic and pneumatic systems.
e. Collect information of applications of hydraulic system in universal testing machine with the help of Laboratory visit
f. Prepare working model of hydraulic robotics arm.
g. Prepare report of Field visit to toll plaza for automatic movement of tool barrier
h. Prepare animations of different circuits using free software available on internet.
i. Prepare report of Field survey of FRL units used in pneumatic systems.
j. Prepare seminar on visit to service station to collect applications of various hand tools

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Oil Hydraulic system- Principles and maintenance	Majumdar S.R	Tata McGraw Hill, ISBN: 9780074637487
2	Pneumatics Systems Principles and Maintenance	Majumdar S.R	Tata McGraw Hill,ISBN-978-0-07-460231-7
3	Fluid Power with applications	Anthony Esposito	Pearson Education, Inc 2000, ISBN 81-7758-580-0
4	Hydraulics and Pneumatics	Harry Stewart	Taraporewala Publication, ISBN:978-0672234125
5	Pneumatic Controls	Joji B.	Wiley India Pub. ISBN:978-8126515424
6	Hydraulics & Pneumatics A Technicians & Engineers Guide	Andrew Parr	Butterworth-Heinemann Publisher. *ISBN*: 9780080966755
7	Industrial Hydraulics Manual	-----	Vickers Systems International (Company Manual)
8	Product Catalogue of FESTO	-----	Company catalogue
9	Hydraulic and Fluid Mechanics	Modi, P. N. Seth, S.M.	Standard Book House, Delhi, 2017 ISBN-13: 978-818940126
10	Fluid Power	Esposito, Anthony	PEARSON Education, Noida, Delhi. ISBN-13: 978 8177585803
11	Hydraulics and Pneumatics.	Sundaram, S.K.	S. Chand, Pune, 2006. ISBN-13: 978-8121926355

14. SOFTWARE/LEARNING WEBSITES

a. **Hydraulic Pumps**: https://en.wikipedia.org/wiki/Hydraulic_pump
b. **Hydraulic Pumps**:www.hydraulicspneumatics.com/.../Hydraulic PumpsM/.../TechZone-Hydraulic Pumps.
c. **Animation of Hydraulic pumps**: https://www.youtube.com/watch?v=Qy1iV6EzNHg
d. **Animation of Hydraulic pumps**: https://www.youtube.com/watch?v=pWuxYnqYDnk
e. **Eaton Pump assembly**: https://www.youtube.com/watch?v=sEVTIRYHoGg
f. **Video lectures of IIT Faculty** :http://nptel.ac.in/courses/112105047/

g. **Lecture series and notes by IIT faculty** :http://nptel.ac.in/courses/112106175/
h. **Pneumatic control valves animation**: https://www.youtube.com/watch?v=XAItnsUcES0
i. **Control valve symbol generation**: https://www.youtube.com/watch?v=yIot4shcOkE
j. **Animation of D.C.Valve**: https://www.youtube.com/watch?v=jsMJbJQkGTs
k. **Animation of 4/2,4/3 D.C Valves:** https://www.youtube.com/watch?v=CQPwvWXbV3w
l. **Animation of Hydraulic cylinder**: https://www.youtube.com/watch?v=bovfDsAYSbc
m. **Telescopic cylinder animation**: https://www.youtube.com/watch?v=icaqvfAtccY
n. **Pneumatic cylinder :**https://www.youtube.com/watch?v=MmYpzgh6Gok
o. **Speed control hydraulic circuit :** https://www.youtube.com/watch?v=4eCuPVxezzY

Program Name : **Diploma in Mechatronics**

Program Code : **MK**

Semester : **Fourth**

Course Title : **Computer Aided Mechatronics Drafting**

Course Code : **22072**

1. RATIONALE

Computer Aided Drafting is the need of today's developing world as the task become simpler by the use of CAD software for frequent changes as per customer requirement. Moreover, engineering design, consulting engineering firms and manufacturing companies require conversion of engineering documents in computer graphics. The aim of this course is to provide the student with hands-on skill in drafting and editing of an industrial production drawing using CAD software, which helps in reading and drawing various production drawings related to mechatronics application.

2. COMPETENCY

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

- **Prepare drawing using CAD software.**

3. COURSE OUTCOMES (COs)

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

a. Use file management skill in CAD software.
b. Draw simple 2D figures using CAD software.
c. Modify simple 2D figures using CAD software.
d. Use CAD software for Geometric Dimensioning & Tolerancing.
e. Draw working drawings related to mechatronics application.
f. Plot existing drawing.

4. TEACHING AND EXAMINATION SCHEME

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

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

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.

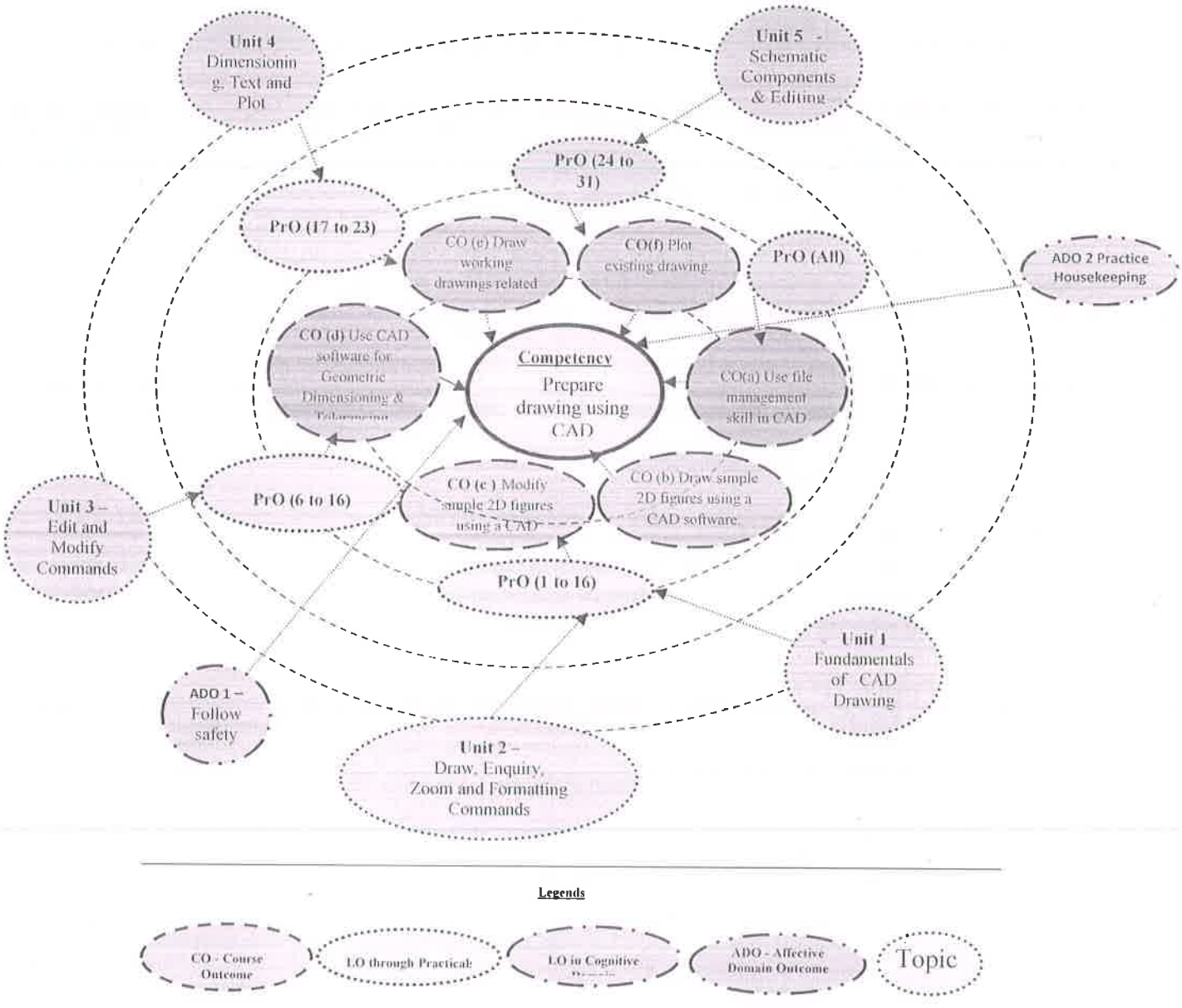

Figure 1 - Course Map

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.	Draw simple 2-D entities using Line commands.	II	02*
2.	Draw simple 2-D entities using Line, Circle and Arc commands.	II	02*
3.	Draw simple 2-D entities using Line, Circle, Arc, Polygon and Ellipse commands.	II	02*
4.	Draw simple 2-D entities using Draw and Text commands.	II	02*
5.	Prepare template with title block and institute logo.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6.	Modify 2-D entities using Erase, Trim, Extend, Scale, Stretch and Lengthen commands.	II, III	02*
7.	Modify 2-D entities using Copy, Move, Mirror, Array and Rotate commands.	II, III	02*
8.	Modify 2-D entities using Offset, Fillet, Chamfer, Break, Divide and Explode commands.	II, III	02*
9.	Use software for drawing and estimating Area, Perimeter, and Centroid for the given 2D entities like Circle, Pentagon, Trapezium, hexagon and 2D entity with arcs and spline curves using 'Enquiry' and 'List' commands.	II, III	02
10.	Draw Hexagonal nut and Bolt (similar objects can be taken up).	II, III	02*
11.	Draw Spherical and Flat headed Rivet (similar objects can be taken up).	II, III	02
12.	Draw orthographic view of given object (Part-I)	II, III	02*
13.	Draw orthographic view of given object (Part-II)	II, III	02
14.	Draw orthographic view of given object (Part-III)	II, III	02
15.	Prepare blocks of Hexagonal nut and bolt and insert them in same and other files (similar objects can be taken up).	II, III	02*
16.	Draw sectional view of a School Compass box (similar objects can be taken up).	II, III	02
17.	Dimension all above components mentioned under serial No.10-16.	IV	02*
18.	Draw part drawing from assembly of Flange coupling showing conventional representation.	IV	02*
19.	Draw part drawing from given assembly of CNC carriage showing conventional representation.	IV	02*
20.	Draw assembly drawing from given detailed drawing of Flange coupling (Part-I)	IV	02*
21.	Show conventional representation, dimensional, geometrical tolerances, surface finish symbols and bill of material in assembly drawing of Flange coupling (Part-II)	IV	02*
22.	Draw assembly drawing from given detailed drawing of CNC carriage (Part-I)	IV	02
23.	Show conventional representation, dimensional, geometrical tolerances, surface finish symbols and bill of material in assembly drawing of CNC carriage (Part-II)	IV	02
24.	Draw simple circuit diagram using circuit building commands.	V	02*
25.	Draw simple Electro-pneumatic circuit using insert pneumatic and P&ID components command.	V	02*
26.	Draw simple Electro-hydraulic circuit using insert hydraulic and P&ID components command.	V	02*
27.	Modify simple circuit using Edit components command.	V	02*
28.	Draw wiring diagram use in test rig in your laboratory.	V	02*
29.	Draw circuit diagram of SMPS use in computer.	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
30.	Draw circuit diagram of amplifier.	V	02*
31.	Draw Electro-hydraulic circuit diagram of lift used in multi-storey building. (Similar objects can be taken up).	V	02*
32.	Plot all above drawings on paper using template with title block and institute logo.	IV	02*
	Total		**64**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 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	Developing/ using Institute Template	20
2	Selecting relevant set up parameters	10
3	Creating given drawing using relevant Commands.	10
4	Dimensioning the given drawing and writing text using blocks and layers effectively.	20
5	Answer to sample questions	20
6	Submission of digital drawing file/plot in time	20
	Total	**100**

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

a. Follow safe practices to operate CAD workstations.
b. Practice energy conservation.
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 usher in uniformity in conduct of practical's. as well as aid to procure equipment by authorities concerned.

S. No.	Equipment/Instruments/Other resources name with Broad Specifications	PrO. No.
1.	Networked Licensed latest version of Computer Aided Drafting software	All

S. No.	Equipment/Instruments/Other resources name with Broad Specifications	PrO. No.
2.	CAD workstation with latest configurations for each student.	All
3.	Plotter/Printer with latest versions.	All
4.	LCD projector and Screen/ Interactive board	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 Fundamentals of CAD Drawing Setup	N.A.	1.1 Fundamentals of Computer Aided Drafting (CAD) and its applications, Various Software for Computer Aided Drafting. 1.2 Co-ordinate System- Cartesian and Polar Absolute, Relative mode, UCS, WCS. 1.3 CAD initial setting commands- Snap, grid, Ortho, Osnap, Limits, Units, Ltscale, Object tracking. 1.4 Object Selection methods- picking, window, and crossing, fence, last and previous. 1.5 Opening, saving and closing a new and existing drawing/template
Unit– II Draw, Enquiry, Zoom and Formatting Commands	N.A.	2.1 Zoom Commands – all, previous, out, in, extent, Realtime, dynamic, window, pan. 2.2 Formatting commands - Layers, block, linetype, lineweight, color. 2.3 Draw Command - Line, arc, circle, rectangle, polygon, ellipse, spline, block, hatch 2.4 Enquiry commands – distance, area.
Unit– III Edit and Modify Commands	N.A.	3.1 Modify Command - Erase, trim, extend, copy, move, mirror, offset, fillet, chamfer, array, rotate, scale, lengthen, stretch, measure, break, divide, explode, and align. 3.2 Grips editing- Move, Copy, Stretch.
Unit– IV Dimensioning, Text and Plot Commands	N.A.	4.1 Dimensioning commands - Dimension styles, Dimensional Tolerances and Geometrical Tolerances, Modify dimension style. 4.2 Text commands - dtext, mtext command. 4.3 Plotting a drawing - paper space, model space, creating table, plot commands.
Unit– V Schematic Components	N.A.	5.1 Catalog browser, Circuit builder, insert pneumatic, hydraulic and P&ID components command.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
& Editing		5.2 Edit, Copy, Move, Delete, Scoot, Toggle NO/NC, Reverse connector, Retag and Swap command. 5.3 Insert- Wire, Multiple bus, 3-phase, Source arrow, Ladder. 5.4 Edit- Wire number, Wire trim. Add rung, Stretch wire, Toggle wire, Flip wire gap.

***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 Practical Marks			
			R Level	U Level	A Level	Total Marks
N.A.						

***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. Maintain a separate folder on Computer workstation allotted, in which all above mentioned practical's should be saved and will be submitted/ mailed (Google drive) as a part of term work.
b. Collect at least one 2D drawing like production/wiring/PLC/circuit drawings, Layouts from nearby workshops/industries/builders/contractors and develop them using computer aided drafting approach.
c. Explain at least one problem for drafting to all batch colleagues. Teacher will assign the problem to be explained by student.
d. Assess at least one 2D drawing of other students (A group of 5-6 students may be identified by teacher) and note down the mistakes committed by the group. Selected students will also guide other students for correcting mistakes, if any.

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. Bring real objects in the classroom for demonstration purpose.
g. Demonstrate use of various commands of CAD using LCD projector/ interactive board, during hands on sessions.
h. Show videos and animations to explain use of layers, blocks and other relevant commands.
i. Demonstrate use of hardware like plotter.

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:

1. Using CAD software prepare drawings of Machine components (any one).
   a. Fasteners
   b. Couplings
   c. Joints
   d. Linkages
   e. Mechanism

   (The figures should be labeled and dimensioned).

2. Using CAD software draw circuit drawings of (any one).
   a. Single/Dual regulated power supply
   b. RC coupled two stage amplifier
   c. ladder diagram for lift/washing machine/water level indicator
   d. function generator/ DMM
   e. AC/DC motor
   f. domestic/office/institute lab wiring diagram

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Engineering Drawing Practice for Schools and Colleges IS: SP-46	Bureau of Indian Standards	BIS, GOI, Third Reprint, October 1998. ISBN: 81-7061-091-2

S. No.	Title of Book	Author	Publication
2.	Engineering Drawing	Bhatt, N.D.	Charotar Publishing House, Anand, Gujarat, 2010, ISBN:978-93-80358-17-8
3.	Machine Drawing	Bhatt, N.D.; Panchal, V. M.	Charotar Publishing House, Anand, Gujarat, 2010, ISBN:978-93-80358-11-6
4.	Engineering Graphics with AutoCAD	Kulkarni D. M.; Rastogi A. P.; Sarkar A. K.	PHI Learning, New Delhi (2010), ISBN: 978-8120337831
5.	Essentials of Engineering Drawing and Graphics using AutoCAD	Jeyapoovan T.	Vikas Publishing House Pvt. Ltd, Noida, 2011, ISBN: 978-8125953005
6.	AutoCAD User Guide	Autodesk	Autodesk Press, USA, 2015
7	AutoCAD Electrical User Guide	Autodesk	Autodesk Press, USA, 2010
8.	AutoCAD 2016 for Engineers and Designers	Sham Tickoo	Dreamtech Press; Galgotia Publication New Delhi, Twenty Second edition, 2015, ISBN-13: 978-9351199113
9.	AutoCAD Electrical 2018 for Electrical Control Designers, 9th Edition	Sham Tickoo	CADCIM Technologies ISBN-13 978-9386551627

14. SOFTWARE/LEARNING WEBSITES

a. http://www.mycadsite.com/tutorials/
b. http://tutorial45.com/learn-autocad-basics-in-21-days/
c. https://www.lynda.com/AutoCAD-training-tutorials/160-0.html
d. http://www.investintech.com/resources/blog/archives/5947-free-online-autocad-tutorials-courses.html
e. http://www.cad-training-course.com/
f. http://au.autodesk.com/au-online/overview
g. https://www.youtube.com/watch?v=yruPUj_61bw
h. https://www.youtube.com/watch?v=xquI8gcdwbs
i. https://www.youtube.com/watch?v=JTOP6TV4Mvw
j. https://www.youtube.com/watch?v=x7X25Xpa07o
k. https://www.youtube.com/watch?v=Si93Y36tUmY
l. https://www.youtube.com/watch?v=D8dPWKihkEo
m. https://www.vtc.com/products/Autodesk-AutoCAD-Electrical-2010-Basic-Concepts-Tutorials.htm
n. https://knowledge.autodesk.com/support/autocad-electrical/learn-explore/caas/CloudHelp/cloudhelp/2019/ENU/AutoCAD-Electrical/files/GUID-4E5A0A7F-72C6-4866-AAA5-6825BA874EF5-htm.html
o. https://youtu.be/tHrfxjgFQt8?t=13
p. https://youtu.be/Ua2IK-PCfUU?t=110
q. https://youtu.be/KfkwXS3Tc6c?t=69
r. https://youtu.be/LYS7Jrcu3fM?t=6

STUDENT VESION OF AUTODESK AUTOCAD SOFTWARE DOWNLOAD LINK

https://www.autodesk.com/education/free-software/autocad