Program Name	: **Diploma in Industrial Electronics**
Program Code	: **IE**
Semester	: **Fifth**
Course Title	: **Microcontroller and Applications**
Course Code	: **22537**

1.   RATIONALE

Microcontroller is used in almost all the domestic, industrial, consumer goods and other high end products.Automation is used in every field of engineering and microcontroller is inbuilt element of these systems and devices. Diploma engineers have to deal with various microcontroller based systems and maintain them. This course is intended to develop the skills to maintain and solve the application problems related to microcontrollers.

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 Microcontroller based systems.**

3.   COURSE OUTCOMES (COs)

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

a.   Maintain architecture of microcontroller ICs.
b.   Debug program of 8051in assembly language for the given operations.
c.   Debug program by using timer, interrupt and serial ports /parallel ports.
d.   Interface the memory and I/O devices to 8051 microcontroller.
e.   Use microcontroller for the given 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
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

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

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

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

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

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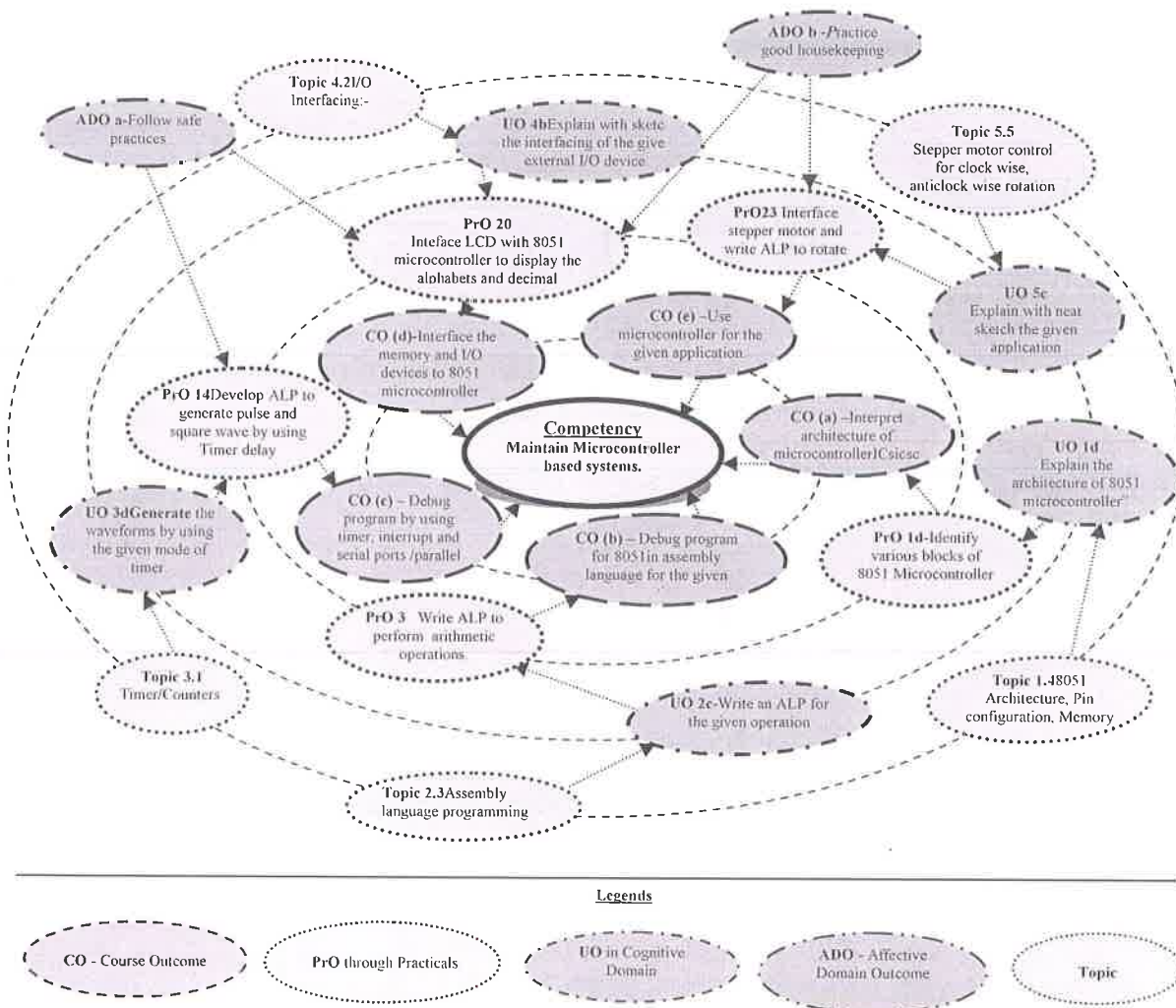

Figure 1 - Course Map

6.   SUGGESTED PRACTICALS/ EXERCISES

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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify various blocks of 8051 microcontroller.	I	02
2	Write assembly language program (ALP) to perform following arithmetic operations on 8-bit data:-addition, subtraction, multiplication and division.	II	02*
3	Write ALP to perform following arithmetic operations on 16-bit data:-addition, subtraction.	II	02
4	Write ALP to transfer data from source to destination location of internal data memory.	II	02
5	Debug ALP to transfer data from source to destination location of external data memory.	II	02*
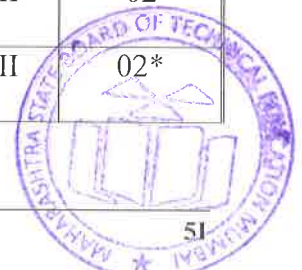
S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
6	Write ALP to exchange data from source to destination memory location.	II	02*
7	Write ALP to find smallest/largest number from the given data bytes stored in internal data memory locations.	II	02*
8	Debug ALP to find smallest/largest number from the given data bytes stored in external data memory locations.	II	02
9	Write ALP for arranging numbers in ascending /descending order stored in external memory locations.	II	02*
10	Write ALP to generate delay using register.	II	02
11	Write ALP to generate delay using Timer.	III	02*
12	Debug ALP to transfer 8 bit data serially on serial port.	III	02*
13	Write ALP to turn LED ON when microcontroller gets interrupted.	III	02*
14	Develop ALP to generate pulse and square wave by using Timer delay.	III	02
15	Debug ALP to turn ON and OFF all 8 LED s at given port.	III	02
16	Interface LED with 8051 to turn on the LED.	IV	02
17	Interface 7-segment display to display the decimal number from 0 to 9.	IV	02*
18	Write ALP to turn the relay ON and OFF.	IV	02
19	Interface the given 4X4 matrix keyboard with 8051and display the key pressed.	IV	02*
20	Interface LCD with 8051 microcontroller to display the alphabets and decimal numbers.	IV	02*
21	Interface ADC with 8051 microcontroller and verify input/output.	IV	02
22	Interface DAC with 8051 microcontroller and observe waveforms.	IV	02*
23	Interface stepper motor and write ALP to rotate stepper motor in clockwise and anti-clockwise direction at given angles.	V	02
	Total		**46**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

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

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

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. 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/ INSTRUMENTSREQUIRED

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

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Microcontroller kit :-single board systems with 8K RAM,ROM memory with battery back up,16X4, LCD display,7-segment Display,PC keyboard interfacing facility, 4X4 matrix keyboard, single user cross c-compiler,USB, interfacing facility with built in power supply.	All
2	Desktop PC with microcontroller simulation software	All
3	Stepper Motor, 50/100 RPM	18
4	CRO- Bandwidth AC 10Hz ~ 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe	16
5	Keyboard 4*4trainer board	11
6	7-segment LED Display:- 0.56 in 1-digit, common anode/common cathode	12
7	ADC (0808)trainer board	16
8	DAC (0808)trainer board	17
9	LCD trainer board	15
10	Voltmeter PMMC Type: DC, 0-150/300V, 0-250/500V,0-75/150V	13to 16

8.   UNDERPINNING THEORY COMPONENTS

The following topicsare to betaught 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	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Microprocess or and 8051 Microcontroll	1a. Describe with sketch the given type of bus. 1b. Explain with sketch the architecture of 8051 microcontroller.	1.1 Microprocessor ,microcomputers, and microcontrollers (basic introduction and comparison) 1.2 Types of buses,address bus,data bus and control bus

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
er	1c. Describe with sketch memory organization of 8051 microcontroller 1d. Explain with sketch stack operation in 8051 microcontroller. 1e. Explain with sketch the use of 8051 microcontroller as Boolean processor. 1f. Explain the given power saving options of 8051microcontroller.	1.3 Harvard and Von-neuman architecture 1.4 8051 microcontroller :Architecture ,pin configuration ,memory organization 1.5 Boolean processor , power saving options - idle and power down mode 1.6 Comparison between derivatives of 8051 (8951,8952,8031,8751)
Unit-II 8051 Instruction Set and programming	2a. Identify addressing mode of the given instruction. 2b. Describe function of given instruction with suitable examples. 2c. Write an assembly language program (ALP) for the given operation. 2d. Explain the function of given software development tools 2e. Explain the use of given assembler directives with examples	2.1 Addressing modes 2.2 Instruction set (Data transfer, Logical, Arithmetic, Branching, Machine control, Stack operation, Boolean) 2.3 Assembly language programming (ALP) 2.4 Software development cycle: editor, assembler, cross-compiler, linker, locator, compiler 2.5 Assembler Directives: ORG,DB, EQU,END,CODE,DATA
Unit III 8051 Timers,interr upts,serial and parallel communicati on	3a. Write an ALP to generate a delay for the given crystal frequency and the given mode. 3b. Explain with sketch the operation of the given mode for timer and counter. 3c. Explain with sketch the operation of the given mode for the specified communication. 3d. Generate the waveforms by using the given mode of timer. 3e. Write an ALP to generate the given waveform on given port.	3.1 Timer/Counters : SFRs:TMOD,TCON, Timer / counter - Logic and modes, Simple programs on timer to generate time delay 3.2 Interrupts- SFRs:- IE, IP, simple programs on interrupts 3.3 Serial communication- SFRs: - SCON, SBUF, PCON, modes of serial communication. Simple programs on serial communication 3.4 I/O port structure and configuration-P0,P1,P2,P3
Unit–IV 8051 Memory and I/O device Interfacing	4a. Describe with sketch the interfacing of the given external memory. 4b. Explain with sketch the interfacing of the given external I/O device. 4c. Write an assembly language program to operate the given I/O device. 4d. Draw the interfacing diagram of	4.1 Memory interfacing :-Program and data memory 4.2 I/O Interfacing:-LED, relays, keyboard, LCD, seven segment display,Stepper motor. 4.3 Interfacing DAC - 0808 with 8051 and its simple programming. 4.4 Interfacing ADC - 0808/09 with 8051 and its simple programming.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	ADC/DAC - 0808/09.	
Unit– V Applications of 8051 Microcontroller	5a. Generate the specified waveform using 8051 by the given method. 5b. Control the given parameter using 8051. 5c. Explain with sketch the given application of 8051. 5d. Debug the given program of 8051 for the given application.	5.1 Square wave generation using port pins of 8051. 5.2 Square and triangular waveform generation using DAC 5.3 Water level controller. 5.4 Temperature controller using ADC (0808/09). 5.5 Stepper motor control for clock wise, anticlock wise rotation 5.6 Traffic light controller.

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 Microprocessor and 8051 Microcontroller	16	04	06	08	18
II	8051 Instruction Set and programming	12	02	04	06	12
III	8051 Timers,interrupts ,serial and parallel communication	14	04	04	08	16
IV	8051 Memory and I/O device Interfacing	12	02	04	06	12
V	Applications of 8051 Microcontroller	10	02	04	06	12
	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 journals based on practical performed inlaboratory.
 b. Follow the safety precautions.
 c. Give seminar on relevant topic.
 d. Library/Internet survey regarding different data books and manuals.
 e. Prepare power point presentation on applications of microcontroller

f. Undertake a market survey of different microcontrollers.

11.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)
These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

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

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.

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

a. Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
b. Prepare a chart of stepper motor to display its features and steps for its operations using data sheets.
c. Prepare a chart of various features and operations of temperature sensors using data sheets.
d. Prepare a chart of various types of ADC and DAC to display its features and pin functions using data sheets.
e. Prepare a chart of various types of LCDs to display its features,pin functions and steps of operations using data sheets.
f. Prepare a chart of various types of seven segment displays,keyboard to display its features and steps for its operations using data sheets.
g. Build a circuit using 8051 microcontroller to blink LED
h. Build a circuit using 8051 microcontroller to blink LED in ring fashion.
i. Build a circuit to turn the buzzer ON after 10 seconds.
j. Build a circuit to turn the buzzer ON after a key pressed.
k. Build a circuit to display number 0 to 9 with a given delay.
l. Build a class period bell using microcontroller.

m. Build a room temperature measurement circuit using microcontroller.
n. Build a circuit to generate square waveform using DAC and microcontroller
o. Build stepper motor controller using microcontrollers
p. Build traffic light controller for specified delay.
q. Build a water level controller for given parameters.
r. Note: Use appropriate software for programming. Build the circuit on PCB.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller Architecture Programming and Application	Ayala, Kenneth	EEE/Prentice Hall of India, 2nd edition, New Delhi,1 July 2004, ISBN-13: 978-1401861582
2	The 8051 Microcontroller and Embedded system	Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; MckinlayRoline D.	Pearson /Prentice Hall, , 2nd edition, Delhi,2008, ISBN 978-8177589030
3	Microcontroller Principle and Application	Pal, Ajit	PHI Learning,New Delhi,2014, ISBN: 978-81-203-4392-4
4	Microcontroller Theory and Application	Ajay, Deshmukh	Tata Mc Graw Hill pvt. Ltd., New Delhi,2011, ISBN- 9780070585959
5	Microcontroller Architecture Programming, Interfacing and System Design	Raj ,Kamal	Pearson Education India, Delhi,2012, ISBN 13:9788131759905
6	Microprocessors and Microcontrollers	Mathur; Panda	PHI Learning Private Limited, 2016, ISBN:978-81-203-5231-5
7	Microprocessors and Microcontrollers:Architecture programming and System Design	Krishna,Kant	PHI Learning Private Limited, 2016, ISBN:978-81-203-4853-0

14. SOFTWARE/LEARNING WEBSITES

a. www.keil.com
b. www.faqs.org/microcontroller
c. www.nptel.ac.in/courses/Webcourse-contents/IITKANPUR/microcontrollers/micro/ui /Course_home2_5.htm
d. www.slideshare.net/aismahesh/memory-8051
e. www.intorobotics.com/8051-microcontroller-programming-tutorials- simulators-compilers-and-programmers/
f. www.electrofriends.com/articles/electronics/microcontroller-electronics-articles/8051-8951/80518951-microcontroller-instruction-set/
g. www.ikalogic.com/part-1-introduction-to-8051-microcontrollers
h. www.binaryupdates.com/switch-with-8051-microcontroller/
i. www.edsim51.com
j. www.mikroe.com/chapters/view/64/chapter-1-introduction-to-microcontrollers/
k. www.8051projects.net/download-c4-8051-projects.html