Program Name	: Electronics Engineering Programme Group
Program Code	: DE/EJ/ET/EN/EX/EQ/IS/IC/IE
Semester	: Fourth
Course Title	: Microcontroller and Applications
Course Code	: 22426

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.   Analyse architecture of microcontrollerICs.
b.   Interpret the program for 8051in assembly language for the given operations.
c.   Interpret the program by using timer; interrupt and serial ports /parallel ports.
d.   Interface the memory and I/O devices to 8051 microcontroller.
e.   Maintain microcontrollerused in differentapplication.

4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Paper Hrs.	Theory						Practical					
L	T	P			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.
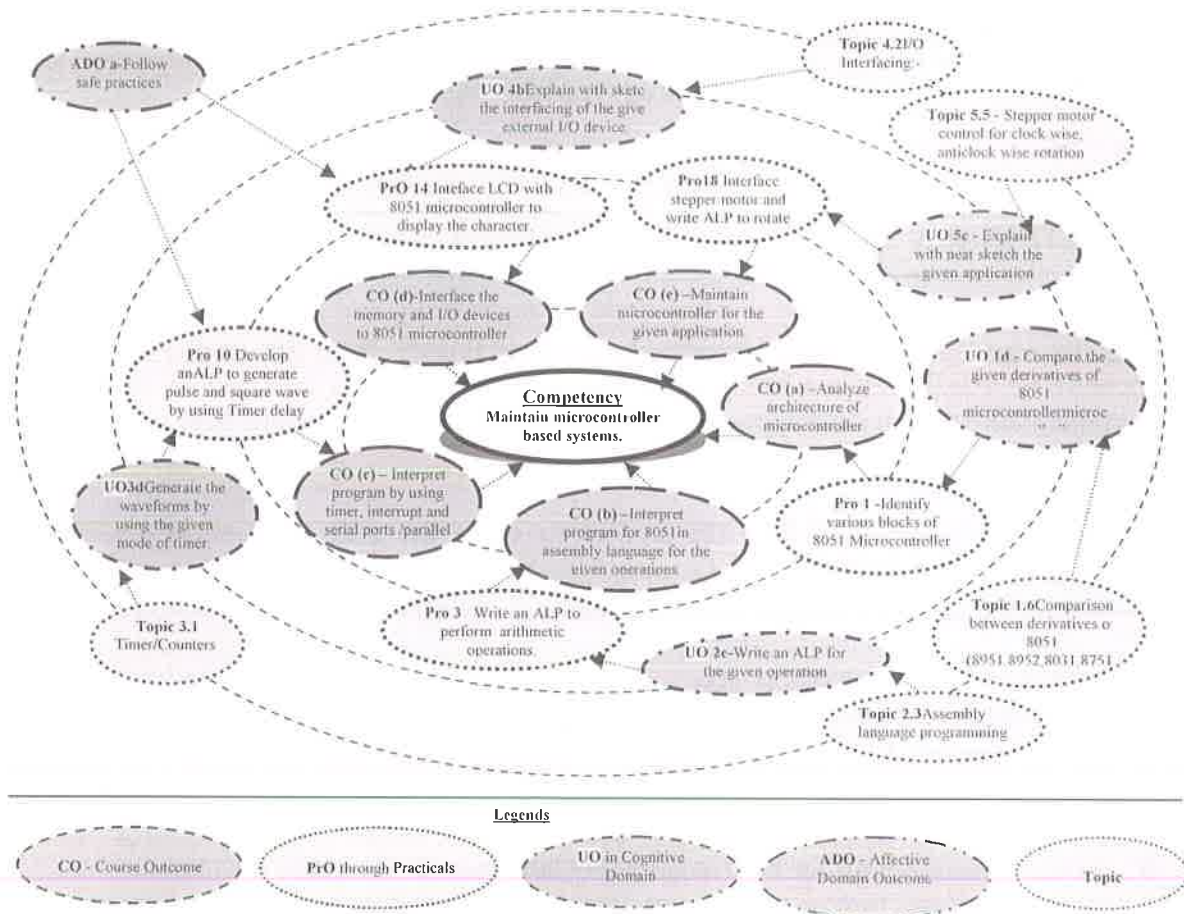

Figure 1 - Course Map

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 development board.	I	02*
2	Write sample assembly language program using various addressing modes and assembler directives.	I	02
3	Write an assembly language program (ALP) to perform arithmetic operationsaddition, subtraction, multiplication and division.	II	02
4	Write an ALP to transfer data from source to destination location of internal/external data memory.	II	02*
5	Write an ALP to find smallest/largest number from the given data bytes stored in internal/external data memory locations.	II	02
6	Write an ALP for arranging numbers in ascending /descending order stored in external memory locations.	II	02
7	Write an ALP to generate delay using register.	II	02*
8	Write an ALP to transfer 8 bit data serially on serial port.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	InterfaceLED with microcontroller and turn it ON with microcontroller interrupt.	III	02
10	Develop an ALP to generate pulse and square wave by using Timer delay.	III	02*
11	Interface 4 X 4 LED matrix with 8051 to display various pattern.	III	02*
12	Interface 7-segment display to display the decimal number from 0 to 9.	IV	02
13	Interfcerelay with microcontroller and turn it ON and OFF.	IV	02*
14	Interface LCD with 8051 microcontroller to display the character and decimal numbers.	IV	02*
15	Interface the given keyboard with 8051and display the key pressed.	IV	02
16	Interface ADC with 8051 microcontroller and verify input/output .	IV	02*
17	Interface DAC with 8051 microcontroller and observefollowingwaveforms: square wave, triangular wave, sawtooth wave.	IV	02*
18	Interface stepper motor to microcontroller and rotate in clockwise and anti-clockwise direction at the given angles.	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 need to be performed, out of which, the practicals marked as '' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

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

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

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

    a. Follow safe 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

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,16X4,16 X2, LCD display,PC keyboard interfacing facility, Hex keypad facility, single user cross c-compiler,RS-232,USB, interfacing facility with built in power supply or any other equivalent.	All
2	Desktop PC with microcontrollersimulation software.	All
3	Stepper Motor, 50/100 RPM	18
4	CRO- Bandwidth AC 10Hz ~ 20MHz (-3dB). DC ~ 20MHz (-3dB), X10 Probe	17
5	Keyboard 4*4trainer board	15
6	Relay trainer board suitable to interface with 8051 trainer kit	13
7	4 X 4 LED matrix suitable to interface with 8051 trainer kit	
8	7-segment LED Display:- 0.56 in 1-digit, common anode/common cathode	12
9	ADC (0808)trainer board	16
10	DAC (0808)trainer board	17
11	LCD trainer board	14

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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I **Basics of Microprocessor and 8051 Microcontroller**	1a. Compare salient features microprocessor, microcontroller and microcomputer for the given parameters. 1b. Describewith sketches the function of the specified blocks of the thegiven type of microcontroller architecture. 1c. Explain with sketches memory organization of 8051 microcontroller. 1d. Compare the given derivatives	1.1 Microprocessor ,microcomputers, and microcontrollers (basic introduction and comparison) 1.2 Types of buses,addressbus,data bus and control bus 1.3 Harvard and Von-neuman architecture; 8051 microcontroller:Architecture,Pin configuration, stack ,memory organization 1.4 Boolean processor , power saving options - idle and power down

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of the 8051 microcontroller. 1e. Describe with sketches the procedure to troubleshoot the simple given microcontroller-based circuit.	mode 1.5 Derivatives of 8051 (8951 , 8952 , 8031 ,8751)
Unit-II **8051** **Instruction Set** **and** **programming**	2a. Identify the addressing mode of the given instruction. 2b. Describe the function of the given instruction with suitable examples. 2c. Write an assembly languge program(ALP) for the given operation. 2d. Explain the function of the given software development tools. 2e. Explain the use of the given assembler directives with examples.	2.1 Addressing modes 2.2 Instruction set (Data transfer, Logical, Arithmatic, 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,** **Interrupts ,** **Serial and** **Parallel** **Communicatio** **n**	3a. Write an ALP to generate a delay for the given crystalfrequencyfor the specified waveform on the given port 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 serial communication. 3d. Generate the waveforms by using the given mode of timer. 3e. Describe with sketches the procedure to troubleshoot the simple given timer circuit.	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 languge program to operate the given I/O device. 4d. Describe with sketches the interfacing diagram of the given ADC chip. 4e. Describe with sketches the	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 itssimple programming 4.4 Interfacing ADC - 0808/09 with 8051 and its simple programming

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	procedure to troubleshoot the simple given I/O device.	
Unit– V Applications of 8051 Microcontroller	5a. Generate the specified waveform using 8051 by the given method. 5b. Control the given parameter using 8051microcontronller. 5c. Explain with sketch the given application which uses the specified microcontroller. 5d. Program 8051 for the given application. 5e. Describe with sketches the procedure to troubleshoot the simple given microcontroller-based application.	5.1 Square wave generation using port pins of 8051 5.2 Square and triangular Waveform genertion 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	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 students 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. Demonstrate students thoroughly before they start doing the practice.
   g. Encourage students to refer different websites to have deeper understanding of thecorse.
   h. Observe continuously and monitor the performance of students in Lab.

12.   SUGGESTED MICRO-PROJECTS

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

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

A suggestive list of micro-projects are given 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 temepature 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. Identify the advanced microcontrollers such as rasberipi,arduino
s. Build application based on advanced microcontroller such as rasberipi,arduino

Note: Use appropriate software for programming. Build the circuit on PCB.
Faculty may suggests other than above metionedmicroprojects.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	8051 Microcontroller Architecture, Programming and Application	Kenneth J.Ayala	PHI Learning New Delhi,July 2004, ISBN: 978-1401861582
2	Microcontroller Theory and Application	Ajay V.Deshmukh	McGraw Hill, New Delhi, 2011, ISBN- 9780070585959
3	Microcontrollers Principle and Application	AjitPal	PHI Learning,New Delhi, 2014, ISBN: 978-81-203-4392-4
4	The 8051 Microcontroller and Embedded system Using Assembly and C	Muhammad Ali Mazidi, Janice GillispieMazidi,Rolin D.Mckinlay	Pearson /Prentice Hall, , 2nd edition, Delhi,2008, ISBN 978-8177589030
5	Microcontroller Architecture Programming, Interfacing and System Design	Raj Kamal	Pearson Education, Delhi, 2012, ISBN:9788131759905
6	Microprocessors and Microcontrollers	Sunil Mathur, JeebanandaPanda	PHI Learning,NewDelhi, 2016,ISBN :978-81-203-5231-5
7	Microprocessors and Microcontrollers:Architecture programming and System Design	Krishna Kant	PHI Learning New Delhi, 2016,ISBN:978-81-203-48

14.   SUGGESTED SOFTWARE/LEARNING WEBSITES

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