Program Name	: Electrical Engineering Program Group
Program Code	: EE/EP/EU
Semester	: Fourth
Course Title	: Digital Electronics and Microcontroller Applications
Course Code	: 22421

1.   RATIONALE

In the present scenario most of the electronic equipment like computers. mobiles. music systems. ATM. automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and use them. Diploma engineers have to deal with various microcontroller based systems used in domestic, industrial and consumer goods. This course is intended to provide the back knowledge of digital electronics required to use microcontroller-based s systems.

2.   COMPETENCY

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

- **Used digital electronics and 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. Use Boolean expressions to realize logic circuits.
   b. Build simple combinational and sequential circuits.
   c. Analyse the architecture of microcontroller ICs .
   d. Write programs in assembly language for micro controllers.
   e. Interface the memory and I/O devices to microcontrollers.

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
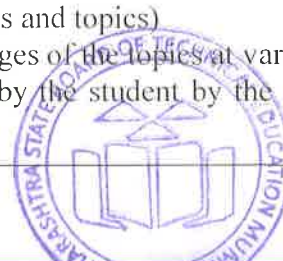
course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.
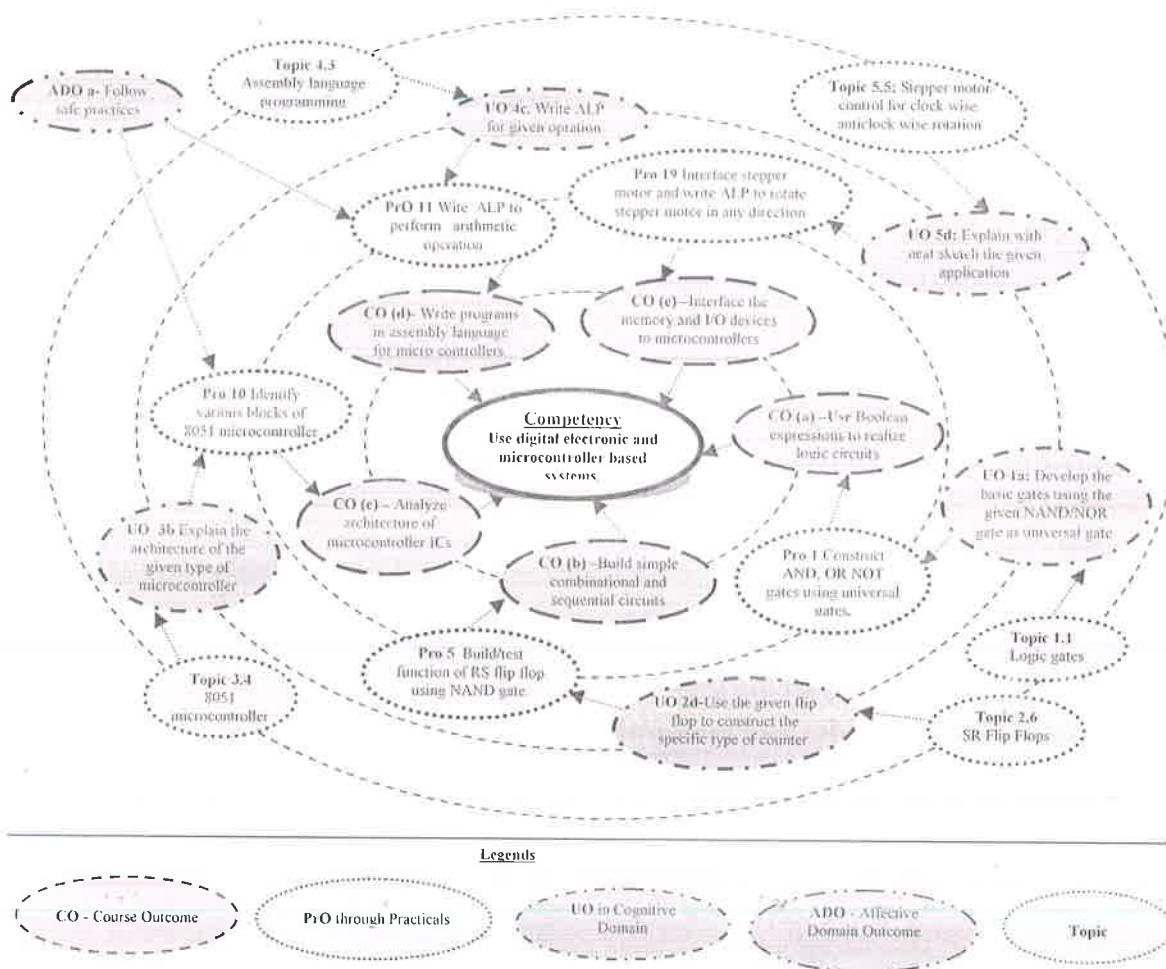
Figure 1 - Course Map

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	Construct AND, OR, NOT gates using universal gates.	I	02*
2	Build the logic circuit on breadboard to check the De Morgan's theorems.	I	02*
3	Design Half adder and Half subtractor using Boolean expressions.	II	02
4	Design Full adder and full subtractor.	II	02*
5	Build / test function of RS flip flop using NAND Gate.	II	02
6	Build / test function of MS JK flip flop using 7476.	II	02
7	Use IC 7476 to construct and test the functionality of D and T flip flop.	II	02*
8	Implement 4 bit ripple counter using 7476.	II	02
9	Implement 4 bit universal shift register.	II	02
10	Identify various blocks of 8051 microcontroller.	III	02*
11	Write an assembly language program (ALP) to perform following	IV	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	arithmetic operations on 8-bit data:-addition, subtraction, multiplication and division.		
12	Write an ALP to transfer data from source to destination location of internal data memory.	IV	02*
13	Write an ALP to transfer data from source to destination location of external data memory.	IV	02
14	Write an ALP to exchange data from source to destination memory location.	IV	02
15	Inteface LED with 8051 to turn on the LED.	V	02
16	Interface 7-segment display to display decimal number from 0 to 9.	V	02*
17	Inteface the given keyboard with 8051and display the key pressed.	V	02
18	Inteface LCD with 8051 microcontroller to display the alphabets and decimal numbers.	V	02
19	Interface stepper motor and write ALP to rotate stepper motor in clockwise and anti-clockwise direction at given angles.	V	02*
	Total		**38**

<u>Note</u>

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	Digital Multimeter: 3 and ½ digit with R. V. I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	01-09
3	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	01-09
4	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	01-09
5	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	01-09
6	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	01-09
7	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.	All
8	Desktop PC with microcontroller simulation software	All
9	Stepper Motor, 50/100 RPM	19
10	Keyboard 4*4trainer board	17
11	7-segment LED Display:- 0.56 in 1-digit, common anode/common cathode	16
12	LCD trainer board	18

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 – 1 Logic gates and logic families	1a. Develop the basic gates using the given NAND/NOR gate as universal gate. 1b. Simplify the given expression using Boolean laws. 1c. Develop the logic circuits using the given Boolean expressions. 1d. Compare the salient characteristics of the given digital logic families.	1.2 **Logic gates**: Symbol, diode/ transistor switch circuit and logical expression , truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR) 1.3 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 1.4 **Logic Families**: Characteristics of logic families : Noise margin, Power dissipation, Figure of merit , Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, ECL, types of TTL NAND gate
Unit– II Combinational Logic and Sequential Logic Circuits	2a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 2b. Minimize the given logic expression using K-map. 2c. Draw MUX/DEMUX tree for the given number of input and output lines. 2d. Use the given flip flop to construct the specified type of counter. 2e. Use excitation table of the given flip-flop to design synchronous counter. 2f. Construct asynchronous/ synchronous counter using the given flip-flop.	2.1 **Standard Boolean representation:** Sum of Product (SOP) and Product of Sum(POS) 2.2 K-map reduction technique for the Boolean expression 2.3 **Design of arithmetic circuits and code converter using K-map:** Half and full Adder, gray to binary and binary to gray (up to 4 bits) 2.4 **Multiplexer and Demultiplexer:** working , truth table and applications of Multiplexers and Demultiplexures 2.5 **Basic memory cell**: RS-latch using NAND and NOR 2.6 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 2.7 **JK Flip Flops**: Clocked JK Flip flop with preset and clear, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops 2.8 **Counters:** Asynchronous counter Synchronous counter
Unit – III Basics of Microprocessor and 8051 Microcontroller	3a. Compare the salient features of the microprocessor , microcontroller and microcomputer for the given parameters. 3b. Explain given type of microcontroller architecture using the block diagram. 3c. Describe with sketches the	3.1 Microprocessor ,microcomputers, and microcontrollers (basic introduction and comparison) 3.2 Types of buses,address bus,data bus and control bus 3.3 Harvard and Von-neuman architecture 3.4 8051 microcontroller Architecture , Pin configuration, stack ,memory organization

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	memory organization of 8051 microcontroller. 3d. Compare the salient features of the given derivatives of 8051 microcontroller.	3.5 Boolean processor , power saving options - idle and power down mode 3.6 Comparison between derivatives of 8051 (8951,8952,8031,8751)
Unit-IV 8051 Instruction Set and programming	4a. Identify addressing mode of the given instruction. 4b. Describe function of given instruction with suitable examples. 4c. Write an assembly languge program(ALP) for the given operation. 4d. Explain the use of given assembler directives with examples.	4.1 Addressing modes: Instruction set (Data transfer, Logical, Arithmatic, Branching, Machine control, Stack operation, Boolean) 4.2 Assembly language programming (ALP) 4.3 Software development cycle: editor,assembler,cross-compiler, linker,locator,compiler 4.4 Assembler Directives: ORG, DB, EQU, END, CODE, DATA
Unit–V 8051 Memory , device Interfacing And Application	5a. Describe with sketches the procedure to interface the given external memory. 5b. Explain with sketch the interfacing of the given external I/O device. 5c. Write an assembly languge program to operate the given I/O device. 5d. Explain with sketches the working of the given microcontroller application.	5.1 Memory interfacing :-Program and data memory 5.2 I/O Interfacing:-LED, relays, keyboard, LCD, seven segment display, Stepper motor. 5.3 Square wave generation using port pins of 8051 5.4 Water level controller 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 FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Logic gates and logic families	12	02	04	06	12
II	Combinational Logic and Sequential Logic Circuits	16	04	06	08	18
III	Basics of Microprocessor and 8051 Microcontroller	14	04	04	08	16
IV	8051 Instruction Set and programming	12	02	04	06	12
V	8051 Memory ,I/O device Interfacing and Applications	10	02	04	06	12
	Total	64	14	22	34	70

Legends: R=*Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
<u>*Note:*</u> *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 in laboratory.
  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 digital circuit microcontroller applications.
  f. Undertake a market survey of different IC and 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 the subject.
  h. Observe continuously and monitor the performance of students in Lab.

12.   SUGGESTED MICRO-PROJECTS

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

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

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

a. Build a circuit to test 7 segment display.
b. Build a circuit to implement debounce switch.
c. Build a circuit for LED flasher using D/T flip flop and continuous pulse using NOT/NAND gate.
d. Build a circuit for LED flasher using ring counter and negative edge triggering pulse.
e. Build a circuit for LED flasher using twisted ring counter and continuous pulse using NOT/NAND gate.
f. Build a circuit for object counter using 7490. Use LED-LDR or LED-Photodiode combination as clock input.
g. Build a circuit for water level indicator.
h. Prepare a chart of various features using data sheets of 8051 microcontroller and its derivatives.
i. Prepare a chart of stepper motor to display its features and steps for its operations using data sheets.
j. Prepare a chart of various features and operations of temepature sensors using data sheets.
k. Prepare a chart of various types of LCDs to display its features,pin functions and steps of operations using data sheets.
l. Prepare a chart of various types of seven segment displays,keyboard to display its features and steps for its operations using data sheets.
m. Build a circuit to turn the buzzer ON after 10 seconds.
n. Build a class period bell using microcontroller.
o. Build a room temperature measurement circuit using microcontroller.
p. Build stepper motor controller using microcontrollers.
q. Build traffic light controller for specified delay.
r. Build a water level controller for given parameters.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009; ISBN: 9780070669116
2	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, , 2016, ISBN: 97800746331751
3	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
5	8051 Microcontroller Architecture Programming and Application	Kenneth, Ayala	EEE/Prentice Hall of India, , New Delhi, 2004, ISBN: 978-1401861582
6	The 8051 Microcontroller and Embedded system	Mazidi, Mohmad Ali; Mazidi, Janice Gelispe; Mckinlay Roline D.	Pearson Education, Delhi,2008, ISBN 978-8177589030
7	Microcontroller Principle and Application	Pal, Ajit	PHI Learning,New Delhi,2014, ISBN: 978-81-203-4392-4

S. No.	Title of Book	Author	Publication
8	Microcontroller Theory and Application	Deshmukh, Ajay	Mc Graw Hill., New Delhi,2011, ISBN- 9780070585959
9	Microcontroller Architecture Programming, Interfacing and System Design	Kamal, Raj	Pearson Education India, Delhi,2012, ISBN: 9788131759905
10	Microprocessors and Microcontrollers	Mathur:Panda	PHI Learning. 2016, ISBN:978-81-203-5231-5
11	Microprocessors and Microcontrollers:Architecture programming and System Design	Krishna Kant	PHI Learning, 2016, ISBN:978-81-203-4853-0

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php

b. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf

c. Simulation software:-www.keil.com

d. Microcontroller:- www.faqs.org/microcontroller

e. Microcontroller:- www.nptel.ac.in/courses/Webcourse-contents/IITKANPUR/microcontrollers/micro/ui /Course_home2_5.htm

f. Memory:- www.slideshare.net/aismahesh/memory-8051

g. 8051 microcontroller:- www.intorobotics.com/8051-microcontroller-programming-tutorials- simulators-compilers-and-programmers/

h. Microcontroller instructions:-www.electrofriends.com/articles/electronics/microcontroller-electronics-articles/8051-8951/80518951-microcontroller-instruction-set/

i. Microcontroller:- www.ikalogic.com/part-1-introduction-to-8051-microcontrollers

j. Microcontroller:- www.binaryupdates.com/switch-with-8051-microcontroller/

k. Software:-www.edsim51.com

l. Microcontroller:- www.mikroe.com/chapters/view/64/chapter-1-introduction-to-microcontrollers/

m. Microcontroller project:- www.8051projects.net/download-c4-8051-projects.html