GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester – V

Course Title: Micro Controller in Instrumentation
(Course Code: 4351707)

Diploma programmer in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	5th Semester

1. RATIONALE

Microcontroller is used in all the domestic, industrial, consumer goods and other high end products in the area of Instrumentation and automation. Diploma engineers have to equip various microcontroller based systems and maintain them. In addition this course covers general hardware aspects along with some applications and interfacing of microcontrollers in instrumentation and control discipline.

2. COMPETENCY

The aim of this course is to help the students to attain industry identified competency through various teaching learning methods:

i. Design microcontroller based systems.
ii. Operate and Maintain microcontroller based process instruments.

3. COURSE OUTCOMES (COs)

On completion of this course, the student should be able to:

a) Identify features of various microcontrollers.
b) Interpret the program for 8051 in assembly language for the given operations.
c) Interpret the program by using timer, interrupt and serial communication.
d) Interface I/O devices with microcontroller for instrumentation applications.
e) Maintain microcontroller used in instrumentation applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the subcomponents of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Study family of microprocessor and microcontroller.	1	2
2	Identify various blocks of microcontroller development board.	1	2
3	Write sample assembly language programs using various addressing modes.	2	2
4	Execute assembly language programs to transfer data from source to destination location. (Internal/ External Memory)	2	2
5	Execute assembly language programs to perform arithmetic operations. e.g. addition, subtraction, multiplication, division	2	2
6	Execute assembly language programs to perform logical operations.	2	2
7	Execute assembly language programs to perform SWAP and Rotate instruction.	2	2
8	Execute assembly language programs to perform branching instructions.	2	2
9	Execute an assembly language program to generate delay using a timer.	3	2
10	Execute an assembly language program to generate pulse and square wave using timer.	3	2
11	Execute assembly language programs on serial transmission with different baud rates.	3	2
12	Execute assembly language programs on interrupts.	3	2

13	Interface matrix keypad with microcontroller and display the key pressed.	4	2
14	Interface relay with microcontroller and turn it ON and OFF.	4	2
15	Interface seven segment display with microcontroller to display decimal number from 0 to 9.	4	2
16	Interface LCD with microcontroller to display the character and decimal numbers.	4	2
17	Interface ADC with microcontroller to receive analog input data.	4	2
18	Interface DAC with microcontroller to send analog output data.	4	2
19	Interface temperature sensor with microcontroller to measure ambient temperature.	4	2
20	Interface Stepper motor/ DC motor with microcontroller to rotate clockwise or anticlockwise.	5	2
21	Execute an assembly language program to perform traffic light control system.	5	2
22	Develop an assembly language program to maintain a water level control system.	5	2
Total Hours (perform practical form every unit so that 28 hours are utilized)			**44**

Note

1. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list**.** A suggestive List of PrOs are given above. More such PrOs can be added to attain the COs and competency.*
2. *Above PrOs (Sr. No. 4 to 22) can be either conducted using hardware interfacing modules or using simulated software also. A judicial mix of more practicals need to be performed, so the student reaches 'Psychomotor Domain Taxonomy' as generally required by industry.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparation of experimental set up	10
2	Setting and Operation	20
3	Safety Measures	10
4	Development of logic and troubleshooting	20
5	Interpretation of the result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to the user in uniformity of practical's in all institutions across the state.

1. Microcontroller Trainer kit
2. Computer System with microcontroller simulation software
3. Function Generator
4. CRO
5. Stepper motor
6. DC motor
7. 4*4 matrix keypad for interfacing with microcontroller
8. 7 segment LED display (common anode , common cathode) kit
9. Other peripheral Interfacing Trainer kits like ADC trainer kit, DAC trainer kit, LCD trainer kit, Relay trainer kit

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.
b) Follow safety practices while using electrical, electronics devices
c) maintain tools and equipment
d) follow ethical practices
e) Realize the importance of E-waste management. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that is formulated for the development of COs and competency. If required,

more such UOs could be included by the course teacher to focus on the attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I Introduction to Microcontroller	1a. Compare microprocessor and microcontroller with its features. 1b. Describe the architecture of microcontroller with function of each blocks. 1c. Describe pin diagram of microcontroller with function of each pin. 1d. Explain Memory organization of 8051 with sketches. 1e. List the family of microcontroller. 1f. List application of microcontroller.	1.1 Comparison of microprocessor and Microcontroller. 1.2 Types of buses: Address bus, Data bus, Control bus. 1.3 Block diagram and function of each block of 8051. 1.4 Pin diagram and function of each pin of 8051. 1.5 Memory organization of 8051: Internal RAM, The stack and stack pointer, Special function registers, Internal ROM. 1.6 Major manufacturers of microcontroller and family of microcontroller 1.7 Application of microcontroller in home, office and industries
Unit-II 8051 Assembly Language Programming	2a. Classify addressing modes of 8051 microcontroller with examples. 2b. List the types of instruction set. 2c. Explain function of given instructions with suitable examples. 2d. Write an assembly language program (ALP) for the given operation. 2e. Explain the use of given assembler directives with examples.	2.1 Addressing modes: immediate, Register, Direct, Indirect,, Indexed, Relative and bit addressing, external data moves, PUSH and POP opcodes 2.2 Instructions: Moving data, Arithmetic operation, Logical operation, stack operation, Jump, Loop and Call instructions 2.3 The structure of Assembly Language Programming with examples 2.4 Assembling and running an 8051 program 2.4.1 The step of Assembly language program: editor, assembler, cross-compiler, linker, locator, compiler 2.4.2 The program counter and ROM space in 8051 2.4.3 8051 flag bits and PSW register 2.4.4 8051 register bank and stack 2.5 8051 data types and directives: DB, ORG, EQU, END

Unit-III 8051 timer, interrupt and serial communication	3a. Explain functions and operation of Timer/ Counters and its application . 3b. Explain various timer modes of 8051. 3c. Develop a program to generate delay for the given crystal frequency using a timer. 3d. Develop a program to generate square wave for the given crystal frequency. 3d. Explain with the sketch operation of a given mode of serial communication. 3e. Develop a program for transmitting and receiving a single word. 3f. Explain interrupts of 8051. 3g. Explain IP and IE registers.	3.1 Configuration and programming of Timer/Counter using SFRs: TMOD, TCON, THx, TLx. 3.2 Modes of timer 3.3 Simple Programs on timer 3.4 Serial Communication of 8051: Basics, SBUF register, SCON and PCON registers 3.5 Modes of operation for serial communication 3.6 Simple program of serial communication 3.7 Generalized data transfer using RS 232 3.8 8051 Interrupts: Types of interrupt, steps in executing an interrupt, Interrupt priority and interrupt vector, IP and IE register
Unit-IV 8051 interfacing with I/O devices	4a. Interface the given external memory with 8051 microcontroller 4b. Interface Input Devices with 8051 microcontroller 4c. Interface Output Devices with 8051 microcontroller 4d. Interface A/D converter and D/A converter with 8051 microcontroller 4e. Interface analog input devices and analog output devices with 8051 microcontroller. 4f. Draw interfacing diagram 8051 with I/O devices (4.2 to 4.5) 4g. Develop an assembly language program to operate the given I/O devices (4.2 to 4.5)	4.1 Memory Interfacing: Program and data memory 4.2 Interfacing of 8051 with input devices: Pushbutton, 4*4 matrix keypad 4.3 Interfacing of 8051 with output devices : Relay, LED, 7 segment LED, LCD 4.4 Interfacing of 8051 with A/D converter: ADC 0804 and D/A converter: DAC 0808 4.5 Interfacing of 8051 with analog input/ output device: Temperature sensor LM35, DC Motor, Stepper Motor

Unit-V Microcontroller Applications in Instrumentation	5a. Select appropriate microcontroller for given applications. 5b. Describe applications of microcontroller in Instrumentation. (5.2) 5c. Develop assembly language programs for given instrumentation applications. 5d. State the procedures to maintain the above (5.2) instrumentation applications	5.1 Criteria for choosing a microcontroller (https://www.microcontrollertips.com/key-factors-consider-choosing-microcontroller/) 5.2 Applications in Instrumentation: - Room Temperature Indicator - Level detection application - Water level Controller - Car parking - (Motion and obstacle sensing) - Traffic light controller - Stepper motor control for clockwise and anticlockwise rotation

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Microcontroller	7	4	6	2	**12**
II	8051 Assembly Language Programming	12	4	8	6	**18**
III	8051 timer, interrupt and serial communication	9	2	8	6	**16**
IV	8051 interfacing with I/O devices	8	2	4	8	**14**
V	Microcontroller Applications in Instrumentation	6	2	2	6	**10**
	Total	**42**	**14**	**28**	**28**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Teachers guided self-learning activities.
b) Prepare mini projects on industry defined problems.
c) Explore the internet to remain up-to-date with the latest upgraded versions and facilities related to microcontrollers.
d) Give seminars for relevant topics.

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/ subtopics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4*** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Arrange an industrial visit to relevant industry.
g) Prepare power point presentation on application of microcontroller.
h) Undertake market survey of different microcontrollers

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-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14**-**16** ***(fourteen to sixteen) student engagement hours*** during the course. The students 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. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Prepare a chart evolution of microprocessor and microcontroller.
b) Prepare a chart of various features of 8051 microcontroller.
c) Prepare a chart of seven segment LED interfacing with microcontroller.
d) prepare a chart of ADC 0804 and DAC 0808 interfacing with microcontroller.
e) Prepare a chart of analog input/ analog output devices interfacing with microcontroller. (Temperature sensor, DC motor, Stepper motor)
f) Build a circuit using 8051 to blink LEDs.
g) Build a circuit to turn the buzzer ON after 5 seconds.
h) Build a circuit to turn the buzzer ON after the key is pressed.
i) Build a circuit of traffic light controller for specified given time delay.
j) Build a circuit of water level controller for specified given parameters.
k) Build a circuit to measure room temperature using a microcontroller.
l) Build a circuit to rotate Stepper motor clockwise / anticlockwise for specified angle using a microcontroller.

m) Build a circuit to rotate the DC motor clockwise / anticlockwise using a microcontroller.
n) Prepare a list of various advanced microcontrollers used in industries. e.g. PIC microcontroller family, ARM microcontroller family,raspberry pi, arduino.
o) Prepare features of advanced microcontrollers e.g. PIC microcontroller family, ARM microcontroller family,raspberry pi, arduino.
p) Build applications based on advanced microcontrollers used in industries. e.g. PIC microcontroller family, ARM microcontroller family,raspberry pi, arduino.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of book	Author	Publication with place, year and ISBN
1	The 8051 microcontroller	Ayala, Kenneth	Cengage learning, New Delhi , Year-2007 ISBN: 978-8131502006
2	The 8051 microcontroller and embedded systems	Mazidi Ali, Muhammad Mazidi Gillispie Janice	PHI, New Delhi, (Latest edition), Year-2007 ISBN: 978-0199681273
3	The 8051 microcontroller	Mackenzie, I.S.	Pearson, New Delhi Year-1998 ISBN:978-0137800087
4	8051 Microcontroller: Internals, Instructions, Programming and Interfacing	Ghoshal, Subrata	Pearson Education, New Delhi, Year-2014 ISBN: 978-93-325-3575-6
5	The 8051 Microcontrollers: Architecture, Programming and Applications	Rao, K. Uma Andhe Pallavi	Wiley, Year- 2019 ISBN: 978-8126577545
6	Microcontroller Theory and Application	Ajay V. Deshmukh	McGraw Hill, New Delhi Year-2017 ISBN: 978-0070585959

14. SOFTWARE/ LEARNING WEBSITES

- https://www.geeksforgeeks.org/pin-diagram-of-8051-microcontroller/?ref=lbp
- https://www.electronicshub.org/microcontrollers/
- https://www.elprocus.com/8051-assembly-language-programming/
- https://microcontrollerslab.com/category/8051-microcontroller/
- https://www.elprocus.com/types-interfacing-devices-applications-with-microcontroller/
- https://nptel.ac.in/courses/117104072
- https://www.engineersgarage.com/8051-microcontroller/
- VLAB : http://vlabs.iitkgp.ac.in/rtes/#
- https://www.youtube.com/watch?v=0SZPr4iGACg
- https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers

15. PO-COMPETENCY-CO MAPPING

Semester V	MICRO CONTROLLER IN INSTRUMENTATION (Course Code: 4351707)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency							
Course Outcomes CO 1) Identify features of various microcontrollers	2	1	1	1	2	-	1
CO 2) Interpret the program for 8051 in assembly language for the given operations.	2	1	1	1	1	2	1
CO 3) Interpret the program by using timer, interrupt and serial communication	2	2	2	2	1	2	1
CO 4) Interface I/O devices with microcontroller for instrumentation applications	2	1	2	2	2	2	2
CO 5) Maintain microcontroller used in instrumentation applications	2	3	2	3	2	2	3

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Member – Board of Studies (GTU), Electrical and Allied branches

Prof. Suresh Z. Shyara, IC Engineering, AVPTI, Rajkot.

Prof. Mahesh J. Vadhavaniya, IC Engineering, Government Polytechnic, Palanpur.

GTU Resource Persons

Prof. M. A. Modi, IC Engineering, Government Polytechnic, Ahmedabad.

Prof. D. M. Makwana, IC Engineering, Government Polytechnic, Gandhinagar.