GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester - V

Course Title: Embedded System & Microcontroller Application
(Course Code: 4351102)

Diploma programme in which this course is offered	Semester in which offered
Electronics & Communication Engineering	5th Semester

1. RATIONALE

The knowledge of embedded system and microcontrollers is essential in the field of electronics as the world is migrating towards automation rapidly in every field. By learning this course students can develop their own embedded system using microcontrollers which is application specific to solve given real time problems. Thus this course is an important course for students who want to work in the automation sector of the electronic industry.

2. COMPETENCY

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

- **Develop embedded systems for microcontroller application.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Select appropriate microcontroller for given embedded system.
ii. Explain architecture and working of AVR microcontroller.
iii. Write and execute embedded C program for given application.
iv. Interface AVR microcontroller with hardware for given embedded system.
v. Develop small embedded system using AVR microcontroller.

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	-	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 of 11 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

The following practical outcomes (PrOs) are the subcomponents of the COs. . These PrOs need to be attained to achieve the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Explore various blocks of Embedded System.	I	02
2	Learn architecture of ATMega32 Microcontroller.	II	02
3	Learn pin diagram of ATMega32 Microcontroller.	II	02
4	Write and execute C program to configure and access I/O ports of ATmega32.	III	02
5	Write and execute C programs to perform bit-wise logic operations for bit manipulation.	III	02
6	Write and execute C programs to access EEPROM.	III	02
7	Write and execute C programs to generate delays using timers.	III	02
8	Write and execute C programs for serial data transmission.	III	02
9	Write and execute C programs to read data from ADC channel using polling method.	IV	02
10	Develop C program to interface LM35 with ATMega32	IV	02
11	Write and execute C programs to configure SPI.	IV	02
12	Develop C Program to interface 7 segment display using MAX7221 with ATMega32.	IV	02
13	Write and execute C programs to configure Two wire serial interface (I2C) for sending and receiving data.	IV	02
14	Write and execute C program to control speed of DC motor using PWM mode in 8 bit timer.	V	02
	Total		**28**

Note

i. 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**.**

ii. 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.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Lab Records	05
2	Question answer or Writing steps exercise	20
3	Executing of exercise	40
4	Printout/ Result	20
5	Viva voice	15
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

I. Computer

II. Projector

III. Trainer Kit

LIST OF SOFTWARE

I. Free Simulation tools

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 competency.

a) Work as a leader/a team member.

b) Follow ethical practices.

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

Only the major Underpinning Theory is formulated as higher level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit – I Overview of Embedded System	1.a Define basic concept of embedded system. 1.b Explain Characteristics of embedded system. 1.c Explain Characteristics of real time operating system. 1.d Compare different AVR microcontrollers.	1.1 Embedded system: Definition, General block diagram, working and characteristics. 1.2 Real Time Operating System: Definition, Characteristics. 1.3 Microcontrollers for embedded system: Criteria for choosing microcontroller. 1.4 History of AVR microcontroller. 1.5 AVR family overview.
Unit – II AVR Microcontroller Architecture and Pin diagram	2.a Explain function of each block of ATmega32 microcontroller. 2.b Explain data memory organization of ATmega32. 2.c Differentiate between SRAM and EEPROM. 2.d Explain purpose of Status Register. 2.e Describe how code is fetched from program memory. 2.f With a sketch, identify pin of ATmega32. 2.g Describe configuration of each port.	2.1 AVR Microcontroller architecture: ATmega32 2.2 Data memory: General Purpose Registers, I/O Memory, Internal SRAM 2.3 EEPROM Memory 2.4 Status Register 2.5 Program Memory and Program Counter 2.6 ATmega32 pin configuration 2.7 I/O port configuration 2.8 AVR Fuse bits

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
	2.h Describe different ways of Power-On Reset. 2.i Describe different oscillator clock source. 2.j Describe mode of operation of Timers/Counters. 2.k Describe features and hardware consideration of on-chip ADC.	2.9 Clock and Reset Circuits 2.10 Timers/Counters and its operation in various modes 2.11 On-chip ADC in ATmega32: Features, Hardware considerations
Unit– III AVR Programing in C	3.a Distinguishes different data types for programming AVR in C. 3.b Write C program to configure and access I/O ports of ATmega32. 3.c Use bit-wise logic operations for bit manipulation. 3.e Write C programs to access EEPROM. 3.f Write C programs to generate delays using timers. 3.g Explain function of MAX232. 3.h Write C programs for serial data transmission.	3.1 Data types and time delays 3.2 I/O port programing in C: Byte size and bit size I/O 3.3 Bit-wise Logic operation in C: AND, OR, EX-OR, Invert and Shift operation 3.5 Memory Allocation in C 3.6 Timer programing in C 3.7 Serial Communication: RS232 standard, MAX232
Unit– IV AVR Interfacing	4.a Read ADC using polling method. 4.b Interface LM35 with ATmega32. 4.c Interface Relay with ATmega32. 4.d Describe SPI working. 4.e Interface multiple 7-segment displays using MAX7221. 4.f Explain functions of I2C(TWI) registers in AVR.	4.1 On-chip ADC programing: Polling Method 4.2 Interfacing LM35 4.3 Interfacing Relay using ULN2803 4.4 SPI programing in C 4.5 Interfacing MAX7221 4.6 I2C-Two Wire Serial Interface (TWI).
Unit-V Embedded System Applications	5.a Describe function of L293D. 5.b Control DC motor using PWM modes in 8-bit timer. 5.c Explain basic block diagram of Weather monitoring System. 5.d Explain basic block diagram of Automatic Juice vending machine. 5.e Explain basic block diagram of GSM based security system.	5.1 Motor Driver L293D 5.2 Speed control of DC motor using 8-bit timer in AVR. 5.3 Weather Monitoring System. 5.4 Automatic Juice vending machine 5.5 GSM based Security system

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit	Unit Title	Teaching	Distribution of Theory Marks

No.		Hours	R Level	U Level	A Level	Total Marks
1	Overview of Embedded System	6	4	4	2	10
2	AVR Microcontroller Architecture and Pin diagram	12	8	6	4	18
3	AVR Programing in C	8	6	5	5	16
4	AVR Interfacing	10	5	6	5	16
5	Embedded System Applications	6	2	4	4	10
Total		**42**	**25**	**25**	**20**	**70**

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

10. SUGGESTED STUDENT ACTIVITIES

Other than the 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 each activity.

i) Prepare journals based on practical performed in laboratory.

ii) Prepare chart to represent the block diagram of different interfacing chips. Develop a practical application using ATMega32 Microcontroller

iv) Prepare General purpose board with all ports available as connector v) Prepare/Download a dynamic animation to illustrate the following

- Timer operation
- Two Wire serial Interface (I2C)
- MAX 7221 Interfacing.
- DC Motor Interfacing

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) Guide student(s) in undertaking micro-projects.

c) Some ***of the topics/sub-topics*** is relatively simple and very easy to the students for ***self-learning***, but to be assessed using different assessment methods.

d) With respect to ***section No.09***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

e) Guide students for using latest Technical Magazine.

f) Arrange visit to relevant industry

g) Show video lectures on Microcontroller Applications with help of internet.

h) Programming practices on simulators (free downloadable).

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 is 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. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher.

MICRO PROJECT 1: Prepare following Items.

1. Prepare Specification Table for AVR microcontroller family.
2. Design a chart of ATMega32 Architecture.

MIICRO PROJECT 2: Prepare following Designs.

1. Design minimum hardware system for ATMega32 circuit.
2. Develop ATMega32 based application board/circuit on PCB.

MICRO PROJECT 3: Design Application oriented basic Project using ATMega32.

1. Design and Implement LED flasher circuit.
2. Design and Implement circuit for relay-based operation using switch.
3. Design and Implement Room Temperature Monitor/Controller System.
4. Design and Implement Water Level Indicator/controller circuit.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	The AVR microcontroller and Embedded System.	Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi	Pearson Publication
2	Embedded C Programming and the Atmel AVR	Richard Barnett, Larry O'cull, Sarah Cox	Cengage Learning India
3	Programming and Interfacing ATMEL AVR Microcontrollers	Thomas Grace	Cengage Learning India

14. SOFTWARE/LEARNING WEBSITES

a) www.tutorialspoint.com
b) www.javatpoint.com
c) www.electronicshub.org
d) www.circuitdigest.com

15. PO-COMPETENCY-CO MAPPING

Program Outcomes (POs):

1. **Basic & Discipline specific knowledge**: An apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.
2. **Problem Analysis:** Identify and analyze well defined engineering problems using codified standard methods.
3. **Design/ Development of Solution:** Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs.
4. **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and relevant technique to conduct standard tests and measurements.
5. **Engineering practices for Society, Environment and sustainability**: Apply relevant technology in context of Society, sustainability, environment and ethical practices.
6. **Project Management**: Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.
7. **Life-long learning**: Ability to analyze individual needs and engage in updating in the context of context of technological changes.

Program Specific Outcomes (PSOs):

1. Develop proficiency in Installation, maintenance and troubleshooting of electronics and communication systems.
2. Create customized solution of real-life problems using hardware and software.

Semester V	**Embedded System & Microcontroller Application(Code: 4351102)**								
	POs and PSOs								
Competency & Course Outcomes	**PO 1** Basic & Discipline specific knowledge	**PO 2** Problem Analysis	**PO 3** Design/ development of solutions	**PO 4** Engineering Tools, Experimentation &Testing	**PO 5** Engineering practices for society, sustainability & environment	**PO 6** Project Management	**PO 7** Life-long learning	**PSO 1**	**PSO 2**
Competency ***Use fundamentals of computer applications in various engineering applications***	**Develop embedded systems for microcontroller application.**								
Select appropriate microcontroller for given embedded system.	3	2	1	1	2	2	2	2	3
Explain architecture and working of AVR microcontroller	3	2	1	1	-	1	1	1	1
Write and execute embedded C program for given application.	3	2	2	2	-	2	3	1	3
Interface AVR microcontroller with	3	3	3	3	1	3	3	2	3

hardware for given embedded system.									
Develop small embedded system using AVR microcontroller.	3	3	3	3	2	3	3	2	3

Legend: '**3**' for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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