GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Semester-VI

Course Title: Embedded Systems

(Course Code: 4361705)

Diploma programmer in which this course is offered	Semester in which offered
INSTRUMENTATION AND CONTROL ENGINEERING	Sixth

1. RATIONALE

The knowledge of embedded system is essential in the field of instrumentation as the world is migrating towards automation rapidly in every field. By learning this course students can develop their own embedded system using any controllers 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 instrumentation 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	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 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:

Sr.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 program to configure and access I/O ports ofATmega32.	III	02
5	Write and execute programs to perform bit-wise logic operations for bit manipulation.	III	02
6	Write and execute programs to access EEPROM.	III	02
7	Write and execute programs to generate delays using timers.	III	02
8	Write and execute programs to count external events using timers.	III	02
9	Write and execute programs to receive external hardware interrupts.	III	02
10	Write and execute programs for LCD interfacing.	III	02
11	Write and execute C programs to read data from ADC channel.	IV	02
12	Develop C program to interface LM35 with ATMega32	IV	02
13	Develop C Program to interface 7 segment display using MAX7221 with ATMega32.	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

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.
2. 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

Sr.No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer	1 to 14
2	Projector	1,2,3
3	Trainer Kit	4,5,6
4	Free Simulation tools	4 to 14

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	2.a Explain function of each block of ATmega32 microcontroller. 2.b Explain data memory organization	2.1 AVR Microcontroller architecture: ATmega32 2.2 Data memory: General

Architecture and Pin diagram	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.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.	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 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 LCD interfacing	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 3.8 LCD interfacing using 8pin mode only.
Unit– IV AVR Interfacing	4.a Read ADC using polling method. 4.b Interface LM35 with ATmega32. 4.c Interface Relay with ATmega32.	4.1 On-chip ADC programing: Polling Method 4.2 Interfacing LM35 4.3 Interfacing Relay using ULN2803
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.	5.1 Motor Driver L293D 5.2 Speed control of DC motor using 8bit timer in AVR. 5.3 Weather Monitoring System.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN: NA

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			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 • 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 PROJECT LIST

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

www.tutorialspoint.com
www.javatpoint.com
www.electronicshub.org
www.circuitdigest.com

15. PO-COMPETENCY-CO MAPPING:

Semester VI	**Embedded Systems (Course Code:** 4361705**)**						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Anal ysis	PO 3 Design/ develop ment of solution	PO4 Engineering Tools, Experimen-tation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	**Develop embedded systems for automation application.**						
CO1 Select appropriate microcontroller for given embedded system.	3	2	1	1	2	2	2

CO2 Explain architecture and working of AVR microcontroller	3	2	1	1	-	1	1
CO3 Write and execute embedded C program for given application.	3	2	2	2	-	2	3
CO4 Interface AVR microcontroller with hardware for given embedded system.	3	3	3	3	1	3	3
CO5 Develop small embedded system using AVR microcontroller.	3	3	3	3	2	3	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

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