GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: EMBEDDED SYSTEM
(COURSE CODE: 3361105)

Diploma Programme in which this course is offered	**Semester in which offered**
Electronics and Communication Engineering	Sixth

1. RATIONALE

To add luxury to any product requires fully automation and for that we need embedded system, where we don't need user intervention. By learning this course students can develop their own embedded system which is application specific to solve given real time problem by using open source platform. Thus this course is an important course for students who want to work in the automation sector of electronic industry.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

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

3. COURSE OUTCOMES

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. Maintain microcontroller based system.
ii. Select appropriate family of microcontroller for different application.
iii. Interface relevant hardware for given application.
iv. Develop programme for given application.
v. Integrate hardware and software for embedded system for given application.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			**Total Credits (L+T+P)**	**Examination Scheme**				
				Theory Marks		**Practical Marks**		**Total Marks**
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	150
4	0	2	6	70	30	20	30	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Overview of Embedded System	1a. Define basic concept of embedded system. 1b. Explain Characteristics of embedded system.	1.1 Embedded system: Embedded System Characteristics 1.2 Examples: Washing Machine, Chocolate Vending Machine, Room Temperature Controller
	1c. Compare different Operating Systems used for embedded system designing.	1.3 Operating System(OS): Types of OS, Types of Mobile OS 1.4 Characteristics of Real Time Operating System
Unit– II 8-bit Microcontrollers Architecture (Atmega 8,AVR)	2a Compare different micro controllers used for embedded system designing. 2b Describe AVR microcontroller with its functional diagram .	2.1 Microcontroller Types: PIC, AVR, ARM: features and applications 2.2 AVR microcontroller: Types , Architecture
	2c Describe block diagram of Atmega 8. 2d With a sketch, identify pins of ATmega 8.	2.3 Internal Architectural ,Block diagram of controller (Atmega 8) 2.4 Functions of each pins of ATmega 8
	2e Introduce time delay using Timers and counters.	2.5 Configuration of Two 8-bit and One 16-bit Timers and Counters
	2f Describe Operation of Analog to Digital Converter.	2.6 6-channel ADC Working
	2g Describe Basic peripheral circuits connection required for the operation of 8 bit microcontroller (ATmega8). 2h Explain basic circuit and code required for programming (Boot Code). 2i Compare basic features specifications of microcontrollers Atmega 8 and Atmega 328	2.7 Essential Peripheral circuits: Crystal Circuit, Power supply, Oscillator Circuit 2.8 Initial programming configurations of Atmega8: port, counter, timer 2.9 Bootloader Circuit 2.10 ISP of Atmega 8 2.11 Tmega8 and ATmea328

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit– III Open Source Embedded Development Board (Arduino)	3a Overview of open source embedded development board (Arduino). 3b Explain working of open source embedded development board using block diagram. 3c Identify pins of embedded development board. 3d Explain circuit diagram of open source embedded Hardware. 3e Describe the features of open source tool used for programming a development board. 3f Describe programming of embedded development board. 3g Interface Serial Port with embedded development board. 3h Make a Basic Circuit of embedded development Board.	3.1 Arduino: Birth, Open Source community 3.2 Functional Block Diagram of Arduino. 3.3 Functions of each Pin of Arduino 3.4 Arduino Development Board diagram (including different blocks only): IDE, I/O Functions, Looping Techniques, Decision Making Techniques 3.5 Designing of 1st sketch 3.6 Programming of an Arduino (Arduino ISP) 3.7 Arduino Boot loader 3.8 Serial Protocol (serial port Interfacing) 3.9 Initialization of Serial Port using Functions 3.10 Basic Circuit For Arduino
Unit–IV Interface Digital and Analog I/O Devices (Arduino Interfacing)	4a Explain concept of input and output port of embedded development board (Arduino Interfacing Concept). 4b Explain Interfacing of Digital I/O devices with program (Digital I/O Interfacing). 4c Explain Interfacing of Analog I/O devices program (Analog I/O Interfacing). 4d Explain interfacing of Keypad with programming (Keypad Interfacing).	4.1 Basic Interfacing and I/O Concept 4.2 Interfacing LED,Switch,7seg LED its and Code 4.3 Interfacing POT,LM35,Acelerometer (ADXL3C5C) and its Code 4.4 Interfacing keypad and Code for it

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	4e Explain Interfacing of Serial port with programming (Serial Port Interfacing). 4i Explain Interfacing of DC motor with programming. 4k Explain Interfacing of 16x2 LCD with programming.	4.5 Initialization for serial port and code for it 4.10 Interfacing DC motor and its Code 4.12 Interfacing 16x2 LCD and its code
Unit-V Embedded system Applications (Arduino)	5a. Explain functional blocks of Line Follower Robot using Arduino. 5b. Explain functional blocks of Accelerometer Based Gesture Control Robot. 5c. Explain functional blocks of Home Automation using RF control. 5d. Design Basic ATmega8 Circuit 5e. Design an embedded development board (Arduino) . 5f. Test the designed circuit	5.1. Motor Driver L293D, IR Sensor 5.2. Interfacing L293D with Arduino 5.3. Code for Line Follower Robot 5.4. Interfacing Accelerometer with Arduino 5.5. Record Gestures, Code For Accelerometer based Robot 5.6. Interfacing of RF Tx/RF Rx with Arduino 5.7. Interfacing of Relay Driver ULN2803 with Arduino 5.8. Code for Home automation and its Control 5.9. Basic ATmega8 Circuit 5.10. Upload Bootcode for ATmega8 5.11. Interfacing of USB-UART

Note: IDE commands are for programming only and for theory portion of subject (ch-4 and ch-5), students should draw the logical diagrams of different applications with digital and analog I/O connections.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Overview of Embedded System	08	04	04	02	10
II	8 Bit Microcontrollers Architecture (Atmega 8,AVR)	10	04	04	02	10
III	Open Source Embedded Development Board (Arduino)	14	06	06	07	19
IV	Interface Digital and Analog I/O devices (Arduino Interfacing)	14	06	06	07	19
V	Embedded System Applications (Arduino)	10	02	04	06	12
	Total	**56**	**22**	**24**	**24**	**70**

Legends: R = Remember **U** = Understand; **A** = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED EXERCISES/PRACTICALS

The practical should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical. However, if these practical are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

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S. No.	Unit No.	**Practical Exercises** (Outcomes in Psychomotor Domain**)**	**Approx Hours. required**
1	II	Test AVR Micro-Controller Architecture.	2
2	II	Identify each block of ATmega8 with Pins.	2
3	III	Use Arduino Architectural diagram .	2
4	III	Test the different Arduino Boards, Open-Source and Arduino Shields.	2
5	III	Install Arduino IDE and its development tool.	2
6	V	Design an embedded development Board.(arduino)	6
7	III	Develop a program to Blink LED for 1second.	2
8	III	Develop a program to interface Input Switches and output LEDs with development board (arduino).	2
9	III	Interface 7 seg display with development board(arduino) and Write a program to count and display 0 to 9 on it.	2
10	IV	Develop a program to generate led pattern using computer serial control.	2
11	IV	Interface potentiometer with development board (arduino) and write a program to generate Led pattern on it.	2
12	IV	Interface LM35 temperature sensor with arduino and monitor temp. on serial monitor.	2
13	IV	Interface DC motor using L293D Motor Driver.	2
14	IV	Interface RF Tx/RF Rx with Arduino	4
15	IV	Interface 16x2 LCD and Display “HELLO WORLD”.	2
16	IV	Make Line-Follower Robot using Arduino.	4
17	V	Build Digital thermometer using LM35 and LCD 16x2.	4
18	V	Build Gesture Control Robot using Accelerometer.	4
Total Hours			**48**
Note: Perform any of the practical exercises from above list (depending upon the availability of resources) for total of minimum 28 hours so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Prepare journals based on practical performed in laboratory.
ii. Do assignments on theory
iii. Prepare chart for different interfacing block diagram
iv. Develop a practical application using Arduino
v. Prepare your own Atmega8 Board with all ports available as connector

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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i. Show video/animation film on Embedded Systems Applications with help of internet.
ii. Arrange a visit to IITRAM, IGTR, nearby Centre of Excellence setup by CTE, Gujarat (in Engg. College etc.) or any such laboratory. Arrange a visit to a plant/ manufacturer having automatic assembly line. Arrange at least one of the above visits.
iii. Give Mini projects to students.
iv. Arrange expert lectures by engineers working in the area of embedded systems.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1.	Exploring Arduino	Jeremy Blum.	Wiley
2.	30 Arduino Projects for Evil Genius	Simon Monk	McGraw-Hill Professional
3.	Beginning Arduino	Michael McRobetrs	Technology in Action
4.	Arduino For Teens	Kathleen Patterson	Course Technology
5.	Make: Arduino Bots and Gadgets	Kimmo and Tero Karvine	O'REILLY
6.	Arduino Cookbook	Michael Margolis	O'REILLY
7.	Arduino Internas	Dale Wheat	Technology in Action
8.	Arduino Projects to save the world	Brian Evans	Emery Premeaux
9.	Arduino Robotics	John-david, Warren Josh Adams, Harald Molle	Technology in Action
10	Beginning Arduino Programming	Brian Evans	Technology in Action
11	Getting Started with Arduino	Massimo Banzi	O'REILLY
12	Practical Arduino : Cool Projects for open source hardware	Jonathan Oxer, Hugh Blemings	Technology in Action
13	Practical Arduino Engineering	Harold Timmis	Technology in Action

S. No.	Title of Book	Author	Publication
14	Learn Electronics with Arduino	Don wilcher	Technology in Action

B) Major Equipment/ Instrument with Broad Specifications

i. Embedded development board (Arduino Board) - 20
ii. Open Source IDE for embedded systems (Arduino)
iii. Computer System - 20
iv. Consumable as needed in application suggested by concern Faculty.

C) Software/Learning Websites

i. http://arduino.cc
ii. www.instructables.com/id/Arduino-Projects/
iii. http://www.jeremyblum.com/category/arduino-tutorials/
iv. https://learn.sparkfun.com/tutorials/what-is-an-arduino
v. http://en.wikibooks.org/wiki/Embedded_Systems
vi. https://www.udemy.com/blog/embedded-c-tutorial/

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R D Raghani** HOD EC ,LE College Morbi
- **Prof. T P Chanpura** Lecturer EC ,Government Polytechnic,Ahmedabad
- **Prof. N M Rindani**, Lecturer EC ,AVPTI Rajkot
- **Prof. Kunal Pithadiya**, Lecturer EC,B and B Polytechnic,Vallabh Vidhyanagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Sanjeet Kumar**, Assistant Professor, Department of Electrical and Electronics Engineering**.**
- **Dr. Anjali Potnis**, Assistant Professor, Department of Electrical and Electronics Engineering