



Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electronics and Communication	Semester	IV
Course Code	20EC43P	Type of Course	Programme Core
Course Name	Embedded C Programming	Contact Hours	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	Credits	6
CIE Marks	60	SEE Marks	40

1. Rationale

C is a general purpose programming language which is robust and highly portable used for scripting system applications which form a major part of all operating systems. C language is available on a very wide range of platforms, from embedded microcontrollers to supercomputers. Microcontroller is a compressed microcomputer manufactured to control the functions of embedded systems in various fields such as automobile, aeronautics, robotics, mobile communication, electronic appliances, industrial processing, defense, space, medical applications etc. The future of the micro controller depends on machine learning in embedded systems.

2. Course Outcomes: On successful completion of the course, the students will be able to:

CO1	Write the code using C constructs for a given requirement, execute the program, debug and to demonstrate that the program produces the required result/output.
CO2	List the various components and the characteristics of each component in a 8051 Microcontroller.
CO3	Write an embedded program for a given requirement, test and troubleshoot to obtain the desired output.
CO4	Identify the right microcontroller/peripheral device using data sheets / specification sheets for a given application.

3. Course Content

Week	C O	PO	Lecture (Knowledge Criteria)	Tutorial (Activity Criteria)	Practice (Performance Criteria)
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
1	1	1,2, 3	1. Introduction to C - features, compilation process. 2. C tokens, variables and identifiers, constants. 3. Data types - classification, memory requirement, range of values, usage.	Refer Table 1	1. Familiarisation of TURBO C. 2. Programs to illustrate the use of different data types and verify their memory size.

2	1	1,2,3	<p>1. Operators and Operands- Arithmetic, logical, relational operators.</p> <p>2. Unary, conditional, assignment and special operators, precedence and associativity.</p> <p>3. Basic input and output functions, format specifiers, preprocessor directive & library functions</p>	Refer Table 1	<p>1a. Compute simple interest given the principal, interest rate and duration.</p> <p>b. Compute compound interest given P,t,r,n.</p> <p>2a. Compute the area of a circle, square, rectangle and triangle.</p> <p>b. Swap contents of two variables without using intermediate variables.</p>
3	1	1,2,3	<p>1. Flowchart and Algorithm, Structure of a C program, simple C programs.</p> <p>2. Branching- conditional -if, if-else, example programs.</p> <p>3. Nested if-else, switch, example programs.</p>	Refer Table 1	<p>1a. Compute the largest of three numbers using if-else and ternary operators.</p> <p>b. Compute the result of a student using nested if.</p> <p>2. Given the resistance and tolerance, generate the color bands of the resistor using a switch statement.</p>
4	1	1,2,3	<p>1. Looping- for, while, do-while loops.</p> <p>2. Example programs on looping.</p> <p>3. Arrays- definition, declaration, initializing single dimensional arrays. Examples.</p>	Refer Table 1	<p>1a. Compute factorial of a single digit number.</p> <p>b. Compute the sum of digits of a given 3 digit number reducing it to a single digit.</p> <p>2. Sort an array of numbers in ascending order and descending order.</p>
5	1	1,2,3	<p>1. Strings- declaration, initialization with an example. Two dimensional arrays- declaration, initialization with an example.</p> <p>2. Functions- elements of user defined functions, example.</p> <p>3. Pointers- introduction with example. Structures- introduction with example.</p>	Refer Table 1	<p>1a. Compute the length of a string and reverse the string using string functions.</p> <p>1b. Compute the sum of two matrices.</p> <p>2a. Compute cube of a number using a function.</p> <p>2b. Store the details of an employee using a structure and print the details</p>
6	2	1	<p>1. Introduction to the concepts of embedded systems, microprocessors, microcontrollers.</p> <p>2. Selection of 8 bit, 16 bit, 32 bit, 64 bit microcontrollers. Introduction to 8051 microcontroller.</p> <p>3. Architecture of 8051 microcontroller, PSW and special function registers.</p>	Refer Table 1	<p>1. Identification of program development tools.</p> <p>2. Familiarization of program development using Keil.</p>
7	2	1,2,3	<p>1. Memory organization, general purpose RAM, bit addressable RAM.</p> <p>2. Register banks, Pin details of 8051.</p>	Refer Table 1	<p>1. Familiarize with the structure of the 8051 assembly program and executing it.</p>

			3. Interfacing external data and code memory.		2. Write and execute simple ALP to understand different addressing modes.
8	3	1,2,3	<p>1.8051 Addressing modes.</p> <p>2. Instruction set- classification, syntax and function of data transfer instructions,</p> <p>3. Arithmetic instructions, Logical instructions.</p>	Refer Table 1	<p>1. Write and execute an ALP to</p> <p>(a) Move a block of data within internal RAM</p> <p>(b) Exchange a block of data between internal RAM and external memory.</p> <p>2. Write an ALP to</p> <p>(a) evaluate simple arithmetic expression such as $y = (((5*2)-(4+1))/3) \% 2$.</p> <p>(b) Perform addition of three 8-bit BCD numbers to result in BCD form.</p>
9	3	1,2,3	<p>1. Bit level instructions, jump instructions.</p> <p>2. Introduction to Embedded C and its applicability to 8051.</p> <p>3. General structure of embedded C program, data types.</p>	Refer Table 1	<p>1. Write an ALP to</p> <p>(a) Rotate or shift 16-bit data.</p> <p>(b) Evaluate simple logical expression such as $Y = a \& b c \wedge !d$ where a, b, c and d are 8-bit data.</p> <p>2. Write and execute an assembly and embedded C program to convert</p> <p>(a) Packed BCD to unpacked BCD</p> <p>(b) Unpacked BCD to packed BCD.</p>
10	3	1,2,3	<p>1. Memory types and models, pointers, pointer's memory type.</p> <p>2. Time-delay generation using loops, example program.</p> <p>3. Arithmetic and logical operators, example programs.</p>	Refer Table 1	<p>1. Write and execute a program to search a given 8-bit number in an array of N numbers using embedded C.</p> <p>2. Write and execute a program to toggle a particular bit in the internal RAM with the use of delay subroutine.</p>
11	3,4	7	<p>1. Features of I/O ports. Interface I/O devices such as LED, buzzer with programs.</p> <p>2. Polling & interrupt methods, executing an interrupt, IE and IP registers.</p> <p>3. Enabling, disabling and priority setting, example programs.</p>	Refer Table 1	<p>1. Write and execute an embedded C program to toggle the LED/buzzer with tone using push-button switch.</p> <p>2. Write ALPs to enable, disable and priority setting of interrupts and</p>

					verify it in IE and IP registers.
12	3,4	7	1. Bit structure and function of TMOD and TCON registers, mode 1 operation of timers. 2. Time delay generation & example programs. 3. Bit structure of SCON register, SBUF register, TI and RI flags, working of serial port for data transmission and reception.	Refer Table 1	1. Write and execute an embedded C program to generate a square wave on P1.2 using timer 0 in mode 1 to generate delay. 2. Observe the square wave of the above program on CRO by downloading the program to the microcontroller kit.
13	3,4	5,7	1. Interfacing 8051 to Multiplexed seven-segment display with assembly/C program. 2. Interfacing 8051 to ADC 0804, waveform generation using DAC 0808 with assembly/C program. 3. Interfacing 8051 to DC motor, Stepper motor with assembly /C program.	Refer Table 1	Interfacing experiments 1. Program to control direction and speed of a stepper motor/ dc motor. Study the data sheets of stepper motor/dc motor. 2. Program to control traffic lights OR Program to generate sine/ rectangular / triangular wave-forms.
Total in hours			39	13	52

TABLE 1: Suggested activities for tutorials

The list is shared as an example and not inclusive of all possible activities of the course.

The list of activities for one week can be shared among teams in a batch of students.

Week No.	Suggested Activities for Tutorials
01	1. Give a presentation on comparison of different high level languages. 2. Prepare a report on advantages and applications of C.
02	1. Write a program to print a pyramid number pattern and explain it. 2. Explain operator precedence and associativity with examples. 3. Demonstrate implicit and explicit type conversions.
03	1. Write and explain algorithms and flowcharts for simple programs.

	<p>2. Give a presentation on comparison of switch and if-else statements.</p> <p>3. Demonstrate the use of break, continue and goto statements in C.</p>
04	<p>1. Demonstrate the comparison of while, do-while and for loop with an example.</p> <p>2. Write and explain a program to print multiplication tables from 1 to 5.</p>
05	<p>1. Write and explain a program to check whether a given string is palindrome or not.</p> <p>2. Write and explain a program to multiply two matrices.</p> <p>3. Give a presentation on advantages of user defined functions.</p> <p>4. Give a presentation on usage of pointers in C.</p>
06	<p>1. Give a presentation to differentiate RISC & CISC.</p> <p>2. Discuss variants of MCS-51 family and their features.</p>
07	<p>1. Give a presentation on applications of microcontrollers.</p> <p>2. Prepare and explain the memory organization diagram.</p> <p>3. Explain bit structure of PSW and PCON registers.</p>
08	<p>1. Write and explain examples for different addressing modes.</p> <p>2. Find the addressing mode, no. of bytes and no. of machine cycles for different instructions.</p>
09	<p>1. Compare different types of JUMP instructions.</p> <p>2. Explain the pros and cons of embedded C.</p>
10	<p>1. Write embedded C programs for time delay generation using loops.</p> <p>2. Write and explain instructions for arithmetic and logical operations.</p>
11	<p>1. Give a presentation on the importance of I/O ports in microcontrollers and write programs using I/O ports.</p> <p>2. Give a presentation on the need of interrupts in microcontrollers.</p>
12	<p>1. Write and explain bit structures of TCON, TMOD and SCON registers.</p> <p>2. Give a presentation on comparison of mode 1 and mode 2 operations of timers.</p>
13	<p>1. Study the latest technological changes in this course and present the impact of these changes on industry.</p> <p>2. List any 5 other microcontrollers used in real world applications and interpret their datasheets.</p>

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill tests 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Activity through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					100

5. Format for CIE (1, 2, 3) Written Test

Course Name	Embedded C Programming	Test	I/II/III	Sem	III/IV
Course Code	20EC43P	Duration	80 Min	Marks	30
Note: Answer any one full question from each section. Each full question carries 10 marks.					
Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks	
I	1				
	2				
II	3				
	4				
III	5				
	6				
Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional Questions in each section carry the same weightage of marks, Cognitive level and course outcomes.					

5.(a) Format for CIE-4 Skill Test - Practice.

SL. No.	COs	Particulars/Dimension	Marks
1	1	<u>C Programming</u> Writing two C programs - 30 Marks Entry & Execution - 30 Marks Output -10 Marks	70
2	2	List the various components and the characteristics of each component in a 8051 Microcontroller.	20
3	1,2	Portfolio evaluation of Practice sessions through Rubrics	10
Total Marks			100

5. (b) Format for CIE-5 Skill Test - Practice.

SL. No.	COs	Particulars/Dimension	Marks
1	2	List the various components and the characteristics of each component in a 8051 Microcontroller.	10
2	3	<u>8051 ALP /8051 C programs for a desired output</u> Writing program - 20 Marks Output - 20 Marks	40
3	4	<u>Interfacing program for an application</u> Writing program - 20 Marks Downloading to kit and Output - 20 Marks	40
4	2,3,4	Portfolio evaluation of Practice sessions through Rubrics	10
Total Marks			100

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
Average Marks= (8+6+2+2)/4=4.5							5

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	C Programming By Kernighan and Dennis Ritchie 04.
2	C Programming By Balaguruswamy, TMH Publishers, ISBN-10: 8131716813, 2009.I
3	Scott MacKenzie and Raphael C.W. Phan. The 8051 Microcontroller. (4/e), Pearson education, 2008.
4	Kenneth J Ayala, The 8051 Microcontroller, (3/e), Thomson Delmar Learning.

8. SEE Scheme of Evaluation

SL No.	COs	Particulars/Dimension	Marks
1	1	<u>C Programming</u> Writing Program - 10 Marks Entry & Execution -10 Marks Output - 5 Marks	25
2	2	Identify & Explain the functionality of various components in a 8051 Microcontroller	10
3	3	<u>8051 ALP /8051 C programs for a desired output</u> Writing program - 15 Marks Output - 5 Marks	20
4	4	<u>Interfacing program for an application</u> Writing program - 10 Marks Downloading to kit and Output- 15 Marks	25
5	1,2,3,4	Viva-Voce	20
Total Marks			100

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	Computers	Intel Core i5 11th gen/8GB RAM/1 TB HDD/256GB SSD/ Graphics 2 GB	20
2	TURBO C		
3	8051 Microcontroller kits		20
4	Interfacing kits		5 each