SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर - ४१६००४, महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी विभाग ०२३१–२६०९०९४

Estd. 1962
"A++" Accredited by
NAAC(2021)
With CGPA 3.52

जा.क्र.शिवाजी वि./अमं/732 दिनांक. 09/10/ 2023

प्रति,

मा. अध्यक्ष व सदस्य,
सर्व अभ्यास/अस्थायी मंडळे (सायन्स)
शिवाजी विद्यापीठ, कोल्हापूर

विषय :– शैक्षणिक वर्षे 2023–24 पासून एम.एस्सी. अभ्यासक्रमाच्या आराखडया (Structure) बाबत.

महोदय/महोदया,

उपरोक्त विषयास अनुसरून आदेशान्वये कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण, 2020 ची राज्यातील अंमलबजावणीच्या अनुषंगाने विद्यापीठ अधिकार मंडळाच्या निर्णयानुसार शैक्षणिक वर्षे 2023–24 पासुन एम.एस्सी. अभ्यासक्रमासाठी सोबत जोडलेला कॉमन आराखडा **(Structure)** व **Formatting (Templet)** लागू करण्यात आले आहे याची नोंद घ्यावी.

सदरची बाब सर्व शिक्षक, विद्यार्थी व संबंधीतांच्या निदर्शनास आणावी.

कळावे,

आपला विश्वासू

(डॉ. एस. एम. कुबल)
उपकुलसचिव

प्रतः–

प्र.अधिष्ठाता विज्ञान व तंत्रज्ञान विद्याशाखा
मा.संचालक परीक्षा व मुल्यमापन मंडळ
परीक्षक नियुक्ती विभाग–1,2
सर्व परीक्षा विभाग (ऑन)
माहितीसाठी व पुढील योग्य त्या कार्यवाहीसाठी.

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दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९३/९४

SU/BOS/Science/499 **Date: 10/07/2023**

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.

Subject: Regarding syllabi of **M.Sc. Part-I (Sem. I & II) as per NEP-2020** degree programme under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of M.Sc. Part-I (Sem. I & II) as per NEP-2020 degree programme under the Faculty of Science and Technology.

M.Sc.-Part I (Sem. I & II) as per NEP-2020			
1.	Microbiology (HM)	10.	Data Science
2.	Pharmaceutical Microbiology (HM)	11.	Computer Science
3.	General Microbiology	12.	Information Technology (Entire)
4.	Electronics	13.	Food Science & Technology
5.	Embedded Technology	14	Food Science & Nutrition
6.	Geology	15.	Biochemistry
7.	Sugar Technology (Entire)	16.	Biotechnology
8.	Alcohol Technology (Entire)	17.	Medical Information Management
9.	Agro Chemical & Pest Management (AGPM)	18.	Environmental Science
		19.	Physics

This syllabus, nature of question and equivalence shall be implemented from the academic year 2023-2024 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in**)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2023 & March/April 2024. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	8	P.G. Admission/Seminar Section
2	Director, Board of Examinations and Evaluation	9	Computer Centre/ Eligibility Section
3	The Chairman, Respective Board of Studies	10	Affiliation Section (U.G.) (P.G.)
4	B.Sc. Exam/ Appointment Section	11	Centre for Distance Education

Shivaji University, Kolhapur

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Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

M.Sc. Embedded Technology

Faculty of Science and Technology

(To Be Implemented From Academic Year 2023-24)

INDEX

M.Sc. Embedded Technology

1. **Title of the Course:** M.Sc. Embedded Technology
2. Preamble**:**

M.Sc. Embedded Technology, an innovative programme, is introduced in **Smt. Kasturbai Walchand College of Arts and Science Sangli** from June 2021 and opened the doors of ubiquitous technology knowledge. It is also proposed to disseminate knowledge of the subject from fundamental concepts to State-of- Art technologies. Indeed, it helps to keep pace with global requirements. With the view to provide exposure to the recent technologies of various sectors of the Electronics and to empower the students to make them competent for industrial needs, R & D sectors and self- employment the curriculum is framed. Indeed, the curriculum encompasses knowledge of Embedded System and Instrumentation, Analog and Mixed signal Based SoC design, Wireless Sensor Network, Internet of Things and VLSI design and technologies. Therefore, the students may have better job opportunities. The course is of interdisciplinary relevance. Incorporation of practical examples and case studies to take students on a journey from microcontroller and AMS devices through to real-world applications of technology. The course helps to build your own technical skills in embedded systems, the IoT and AI, as well as enable you to bring this to life. The Choice Based Credit System (CBCS) is implemented for this course.

Objectives of the course:

Following are major objectives of the course.

- To provide exposure to the students to the recent technologies.
- To provide the knowledge of design and implementation of embedded systems for dedicated applications.
- To inculcate awareness among the student to perform the projects of industrial standards, which could also, ensures the interdisciplinary approach.

- To empower the students to cater the needs of industrial sectors. It is also attempted to expose the students to the research activities and to inculcate the research awareness.
- To expose the students to the industrial environment, on job training and internship may be provided
- To expose the students to the facets of real time systems

Advantages of the Course:

M.Sc. Embedded Technology is the subject, which ensures wide application potential in diverse sectors. Along with the basic sciences, it bears the knowledge of recent technologies. Therefore, it depicts the tremendous opportunities in the electronic industrial sectors. It ensures well confluence of Science and Technology. Therefore, the course helps to achieve all round development. Moreover, the students can also opt for education field for their career.

Intake Capacity : 20

Fee Structure:

This is non-grantable course. Therefore, fee structure is as per Rules and Regulations of Shivaji University, Kolhapur

3) Duration **:** 2 Years – 4 Semesters

4) **Eligibility :**

- B. Sc. with Electronics subject at Principal / Interdisciplinary /Allied/ Applied level.
- B. Sc. with Electronics subject at Subsidiary level.
- B.Sc. with Computer Science/ B.Sc. Entire Computer Science(BCS)

5) Medium of Instruction : English

6) Program structure NEP-2020

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (**Embedded Technology**) Part – I (Level-6.0)

M.Sc.-I Semester –I

Course Type	Course Code	Title of the course	Teaching Scheme Theory and Practicals			Examination Scheme					
						University Assessment (UA)			Internal Assessment (IA)		
			Lectures per week	Practicals per week	Credits	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Major Mandatory	MMT-101	Fundamentals of Embedded System Design	4	-	4	80	32	3	20	8	1
	MMT-102	CMOS Analog Circuit Design	4	-	4	80	32	3	20	8	1
	MMT-103	Architecture and programming with AVR Microcontroller	2	-	2	40	16	2	10	4	1
	MMPR-104	Practical Course	-	16	4	80	32	3	20	8	1
Major Elective	MET -105	1. Advanced Microcontroller Based Embedded system Design 2. Programming with Python	4	-	4	80	32	3	20	8	1
RM	RM-106	Research Methodology	4	-	4	80	32	3	20	8	1
Total					**22**	**440**	**176**		**110**	**44**	
									Total Marks	**550**	

M.Sc.-I Semester –II

Course Type	Course	Title of the course	Teaching Scheme Theory and Practicals			Examination Scheme					
						University Assessment (UA)			Internal Assessment (IA)		
			Lectures per week	Practicals per week	Credits	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Major Mandatory	MMT -201	Real Time Operating System	4	-	4	80	32	3	20	8	1
	MMT -202	Mixed Signal Based PSoC Design	4	-	4	80	32	3	20	8	1
	MMT -203	Embedded System Design with FPGA	2	-	2	40	16	2	10	4	1
	MMPR -204	Practical Course	-	16	4	80	32	3	20	8	1
Major Elective	MET -205	1. Device Drivers and Embedded System 2. Internet of Things	4	-	4	80	32	3	20	8	1
OJT/FP	OJT/FP-206	On Job Training /Field project l	-	-	4	80	32	3	20	8	1
Total					**22**	**440**	**176**		**110**	**44**	

				Total Marks	**550**
	Credit for PG Diploma	**44**		**1100**	
		Exit option at Level 6 : Student can exit, after achieving 44 credits, with Post Graduate Diploma in Embedded Technology			

- MMT – Major Mandatory Theory
- MMPR – Major Mandatory Practical
- MET – Major Elective Theory
- MEPR – Major Elective Practical
- RM - Research Methodology
- OJT/FP- On Job Training/ Field Project

- Total Marks for M.Sc.-I : **1100**
- Total Credits for M.Sc.-I (Semester I & II) : 44
- ***Separate passing is mandatory for University and Internal Examinations***

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (Embedded Technology) Part – II (Level-6.5)

Course Type	Course Code	T. itle of the course	Teaching Scheme Theory and Practicals			Examination Scheme					
						University Assessment (UA)			Internal Assessment (IA)		
			Lectures per week	Practicals per week	Credits	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Major Mandatory	MMT-301	Wireless Sensor Network	4	-	4	80	32	3	20	8	1
	MMT-302	Programming with Verilog HDL	4	-	4	80	32	3	20	8	1
	MMT-303	Instrumentation Design	2	-	2	40	16	2	10	4	1
	MMPR-304	Practical Course	-	16	4	80	32	3	20	8	1
Major Elective	MET -305	1. Industry 4.0 2. Embedded system for Agro instrumentation	4	-	4	80	32	3	20	8	1
RP	**RP-306**	Research Project 1			4						
Total					**22**	**440**	**176**		**110**	**44**	
									Total Marks	**550**	

M.Sc.-II Semester –IV											
Course Type	**Course**	**Title of the course**	**Teaching Scheme Theory and Practicals**			**Examination Scheme**					
						University Assessment (UA)			**Internal Assessment (IA)**		
			Lectures per week	**Practicals per week**	**Credits**	**Maximum Marks**	**Minimum Marks**	**Exam. Hours**	**Maximum Marks**	**Minimum Marks**	**Exam. Hours**
Major Mandatory	MMT -401	Signals and Systems	4	-	4	80	32	3	20	8	1
	MMT -402	ARM Microcontroller and System Design	4	-	4	80	32	3	20	8	1
	MMT -403	Interfacing and communication protocols	4	-	4	40	16	2	10	4	1
Major Elective	MET -404	1. Artificial Intelligence & Machine Learning 2. Smart Fusion Technology Based Embedded System Design	4	-	4	80	32	3	20	8	1
RP	RP-205	Research Project 2	-	-	6						
Total					**22**	**440**	**176**		**110**	**44**	
										Total Marks	**550**
		Credit for PG Diploma			**44**					**1100**	
		Total Marks for 2 Years- 4 Semester PG degree (88 Credits)									**2200**

- MMT – Major Mandatory Theory
- MMPR – Major Mandatory Practical
- MET – Major Elective Theory
- MEPR – Major Elective Practical
- RM - Research Methodology
- OJT/FP- On Job Training/ Field Project

- Total Marks for M.Sc.-II : **1100**
- Total Credits for M.Sc.-II (Semester III & IV) : 44
- ***Separate passing is mandatory for University and Internal Examinations***

7. **Programme Outcomes (POs)**

Programme Outcomes (POs):

At the end of the Master of Science (**Embedded Technology**) Programme, the student should be able to:

1. Understand the facets of an embedded technology and its suitability to innovate new ideas and solutions to existing problems. solution to various issues.
2. To design hardware and develop necessary firmware.
3. Design instruments of high accuracy and preciseness.
4. Design IoT enabled devices and infrastructure as well.
5. Use embedded technology for research and development purpose.

8. Course Codes

M.Sc. (**Embedded Technology**) Part – I **M.Sc.-I Semester –I**			
Sr. No.	**Course Name**	**Credit**	**Course Code**
1.	Fundamentals of Embedded System Design	4	**MSU0325MML913G1**
2.	CMOS Analog Circuit Design	4	**MSU0325MML913G2**
3.	Architecture and programming with AVR Microcontroller	2	**MSU0325MML913G3**
4.	Practical Course	4	**MSU0325MMP913G1**
5.	Advanced Microcontroller Based Embedded system Design	4	**MSU0325MEL913G1**
6.	Programming with Python	4	**MSU0325MEL913G2**
7.	Research Methodology	4	**MSU0325RML913G**
M.Sc. (**Embedded Technology**) Part – I **M.Sc.-I Semester –II**			
Sr. No.	**Course Name**	**Credit**	**Course Code**
1.	Real Time Operating System	4	**MSU0325MML913H1**
2.	Mixed Signal Based PSoC Design	4	**MSU0325MML913H2**
3.	Embedded System Design with FPGA	2	**MSU0325MML913H3**
4.	Practical Course	4	**MSU0325MMP913H1**
5.	Device Drivers and Embedded System	4	**MSU0325MEL913H1**
6.	Internet of Things	4	**MSU0325MEL913H2**
7.	On Job Training /Field project l	4	**MSU0325OJ913H**
M.Sc. (**Embedded Technology**) Part – I **M.Sc.-II Semester –III**			
Sr. No.	**Course Name**	**Credit**	**Course Code**
1.	Wireless Sensor Network	4	**MSU0325MML913I1**
2.	Programming with Verilog HDL	4	**MSU0325MML913I2**
3.	Instrumentation Design	2	**MSU0325MML913I3**
4.	Practical Course	4	**MSU0325MMP913I1**
5.	Industry 4.0	4	**MSU0325MEL913I1**
6.	Embedded system for Agro instrumentation	4	**MSU0325MEL913I2**
7.	Research Project 1	4	**MSU0325RP913H**
M.Sc. (**Embedded Technology**) Part – I **M.Sc.-II Semester –IV**			
Sr. No.	**Course Name**	**Credit**	**Course Code**
1.	Signals and Systems	4	**MSU0325MML913J1**
2.	ARM Microcontroller and System Design	4	**MSU0325MML913J2**

3.	Interfacing and communication protocols	4	**MSU0325MML913J3**
4.	Artificial Intelligence & Machine Learning	4	**MSU0325MEL913J1**
5.	Smart Fusion Technology Based Embedded System Design	4	**MSU0325MEL913J2**
6.	Research Project 2	6	**MSU0325RP913J**

9) Scheme of Examination :

A. **Theory Examination :**

i) There shall be 100 marks for each course (paper). For each course 80:20 pattern shall be applicable, wherein 80 marks shall be for University Assessment (UA) and 20 marks for internal assessment (IA).

ii) There shall be separate passing for theory as well as internal examinations. Minimum 32 marks out of 80 required for passing UA and minimum 8 marks out of 20 required for passing

iii) The total marks for each semester examination is shall be 600.

B. **Internal Examination:** Scheme of internal assessment :

i) As per UGC guidelines there shall be continuous internal assessment for M.Sc. Programme. Internal Examination will be compulsory for all students. If a student fails/remains absent in internal Examination then he / she will have to clear the internal Examination in subsequent attempt/s.

ii) ii) The internal examination of 20 Marks shall be conducted at the mid of the each semester. The nature of questions shall be MCQ / true / false /one sentence answer type question/ short answer type questions.

C. Practical Examination:

i) The core course practical (CCPR) examination shall be conducted annually/ semester wise with individual heads of passing with minimum 40% marks.

ii) The rules for practical examinations shall be as per respective BOS guidelines.

D. Standard of passing

i) The standard of passing shall be 40% where the student shall have to score 32 marks out of 80 and 8 Marks out of 20 in each paper There shall be a separate head of passing for Theory, Practical and Internal Examination.

ii) ATKT rules shall be followed in respect of Theory and Practical only.

Gradation Chart :

Marks Obtained	Numerical Grade (Grade Point)		CGPA	Letter Grade
Absent	Zero		-	-
0 – 39	Zero		0.0 – 4.99	**F (Fail)**
40 – 49	5		5.00 – 5.49	**C**
50 – 54	6		5.50 – 6.49	**B**
55 – 64	7		6.50 – 7.49	**B+**
65 – 74	8		7.50 – 8.49	**A**
75 – 84	9		8.50 – 9.49	**A+**
85 – 100	10		9.50 – 10.0	**O(Out Standing)**

Class Chart :

The candidate securing minimum of 40% marks in each head of passing shall be declared as successful candidate and the class shall be as follows :

	The percentage of marks	**Class**
i)	40-49.99% ...	Pass Class
ii)	50-54.99% ...	Second Class
iii)	55-59.99% ...	B+ Second Class
iv)	60-69.99% ...	First Class
v)	70% and above ...	First Class with Distinction.

10 . Syllabus :

M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester I)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Fundamentals of Embedded System Design**
Course Code: **MSU0325MML913G1** Total Credits: **04**

Course Objectives :

1. To expose the students to facets of embedded system design.
2. To expose the students to advanced computing devices.
3. To make students competent to develop embedded firmware.
4. To develop the skills to design an embedded system for dedicated applications.

Course Outcomes :

1. Understand basic concept of an Embedded System.
2. Able to develop firmware in embedded C structure.
3. Understand architecture of AVR family microcontroller.
4. Able to configure on chip resources and to interface devices.
5. Able to develop embedded system for dedicated applications

Module 1: Fundamentals of Embedded Systems design (15)

Definition of an embedded system, Basic architecture of embedded system, characteristics of embedded systems, Challenges in Embedded System Design, real time consideration, need of processor, Applications of embedded systems. AVR microcontroller based minimum hardware for general embedded system.

Module 2: Programming with Embedded C: (15)

Overview of C programming, Basic Structure of C program, character set, keywords and identifiers, constants and variables, concept of global declaration and local declaration, data types and data ranges, expressions and operators. Study of IO statements, Control Statements, Arrays, Loops, User`s defined functions.

Embedded firmware, Basic Structure of Embedded C program, Comparison of Embedded C with C, Need of Operating System, Concept of Super loop. An embedded C programs for Generation of Time delay with and without use of timers, Square wave generation, Programming of I/O port and Serial Port, Interrupts.

Module 3: Interfacing of devices: The Hardware and Embedded Firmware Design(15)

Development of both Hardware and software for interfacing of Switches, Thumbwheel switch, Relays, LEDs, Transistor, Opto-coupler, Seven Segment Display, 16 X 2 LCD, Stepper Motor, Configuration of on-chip resources such as ADC, DAC, timers/counters etc of AVR ATmega 8L microcontroller. Designing of ISP, ICSP modules for programming and debugging

Module 4: Designing of an Embedded System (15)

1. Designing of AVR ATmega 8L an based embedded system for Measurement of Temperature of an environment
2. Designing of AVR ATmega 8L an based embedded system for Measurement of humidity of an environment.
3. Designing of AVR ATmega 8L based embedded system for DAC using PWM technique.

Reference Books: -

1. Embedded C - Michael J Point
2. Embedded C Programming and the Atmel AVR, Richard H. Banett, Sarah A. Cox, Larry D. O'Cull, Thomson.
3. Programming and customizing The AVR Microcontroller, Dhananjay Gadre, TMH.

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M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester I)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **CMOS Analog Circuit Design**
Course Code: **MSU0325MML913G2** Total Credits: **04**

Course Objectives :

1. To expose the students conduction mechanism in MOS device and its approach to analog circuit design..
2. To realize the use of MOS device for design of analog circuit components.
3. To study design of operational amplifier using MOS device
4. To expose the students to switched capacitor technique for analog design

Course Outcomes :

1. Understand conduction mechanism in MOS transistors and its use for analog circuit design.
2. Designing of design CMOS based analog circuits
3. Designing of CMOS based operational amplifier.
4. Able to design configurable analog circuits using switched capacitor techniques.

Module 1: Fundamentals CMOS Analog Design: 15

Biasing of n and p channel MOS transistors, Conduction mechanism in MOS device, Drain current relation, Effect of gate, drain and source potential, channel width modulation, Need of analog Integrated circuit design, Single Stage Amplifiers, CS amplifier, Large signal model, small signal model. BiCMOS. transistor.

Module 2: Analog CMOS circuit elements 15

MOS Switch and its characteristics, MOS Resistor, MOS Capacitors, MOS Diode, Current sink and current source circuits, Current mirrors, passive and active current mirrors. References for Analog MOS circuits, Voltage and Current reference, Band gap reference. CMOS Amplifier : CMOS amplifiers, frequency response of CMOS amplifier, Cascode amplifier, class A Amplifiers, Push-pull CS amplifier, differential amplifier.

Module 3:CMOS Operational Amplifiers 15

Design of CMOS OP Amps, Single stage Op amp, Block diagram of two stage Op amp, Op am design requirements, Concept of High performance CMOS op amp, CMOS open loop Comparator.

Module 4. Switched Capacitor circuits 15

Basic principle of switching capacitor, Resistor emulation, series capacitor and parallel capacitors, effect frequency and phase of clock, switch capacitor amplifiers, inverting, non-inverting, summing amplifiers, difference amplifier, Integrator, differentiator, Low pass filter.

Reference Books:

1. CMOS Analog Circuit Design, P. E. Allen, D. R. Holberg, International students edition Oxford, 2009
2. CMOS Analog Circuit Design, P. E. Allen, D. R. Holberg, Indian students edition Oxford, 2013
3. Design of analog CMOS integrated circuits, B. Razavi, TMH, 2013
4. CMOS Circuit design layout and simulation, R. J. Baker, H. W. Li and D. E. Boyce, PHI, 2005

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M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester I)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Architecture and Programming with AVR Microcontrollers**
Course Code: **MSU0325MML913G3** Total Credits: **04**

Unit – I AVR Microcontrollers **10**

Introduction to AVR: General architecture of AVR microcontroller family. Salient features, AVR Series.

Architecture: Architecture and hardware resources of AVR ATMega 8L, The arithmetic logic unit, program memory & data memory, Downloadable Flash program memory, SRAM data memory, General- purpose register file, SFRs, I/O register, EEPROM data memory, IO port structure, Peripherals, timer and counters, watchdog timer, Serial Peripheral interface, universal asynchronous receiver and transmitter, Analog comparator, reset and interrupt, interrupt vector table, reset sources. On chip ADC and DAC, Reset circuit and clock circuit.

Unit – II Programming and interfacing with AVR **10**

Interfacing of IO devices to the ports. Memory interface I/O Interface Interfacing smart LCD, relay, opto-coupler, Programming with Timers and serial IO ports.

Unit – III Development of embedded system for: **10**

a. Temperature controlling,
b. Measurement of pH and
c. DC Motor controlling by using PWM techniques.

Reference Books:

1. Microcontrollers Theory and Application – Ajay V. Deshmukh TMH New Delhi
2. Embedded C Programming and the Atmel AVR, R. H. Banett, S. A. Cox, Larry D. O'Cull, Thomson.
3. Programming and customizing The AVR Microcontroller, Dhananjay Gadre, TMH.

M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester I)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Advanced Microcontroller Based Embedded system Design**
Course Code: **MSU0325MEL913G1** Total Credits: **04**

Course Objectives :

1. To study Advanced Microcontroller, the PIC microcontroller Cores.
2. To expose the students architectural details of PIC microcontrollers.
3. To study integrated development environment for PIC based embedded firmware design.
4. To Develop an embedded system for dedicated applications.

Course Outcomes :

1. Students may realize configuration of on chip resources of PIC microcontroller.
2. Co-design of hardware and firmware for PIC based embedded system.
3. Interfacing different peripherals to PIC microcontrollers.
4. Design of PIC based autonomous embedded systems.

Module 1: PIC Microcontrollers **20**

Introduction: Advantages of PIC microcontrollers over MCS-51 series. PIC microcontroller features, Architecture of PIC microcontrollers, Pin Description, 16F8XX series. Architecture of 16F877. Memory structure, Resisters, Register file structure, Register banks, program and data memory, Use of EEPROM, SFRs, W-register, Status register, Option register etc. Interrupts in PIC microcontrollers, IO ports of 16F877.

Timers of PIC Microcontrollers, Compare capture mode, PWM mode, I2C bus , On Chip ADC and DAC facility. USART the serial IO, watchdog timer, Power up timer, Sleep mode, Reset, and clock circuits, types of the RESET. Interrupt vector table. Addressing modes, Instruction set architecture.

Module 2: Integrated Development Tools for PIC **10**

Overview of MPLAB the IDE for Assembly language. Micro C the IDE for embedded C programming. Developing, compiling, and programming the microcontroller.

Module 3 : Embedded C programming and interfacing with PIC 15

Minimum Embedded system with PIC microcontroller, Serial programming, SPI programming. Embedded C programs for configuration of IO port, on chip timers and serial IO peripherals. Interfacing smart LCD, relay, opto-coupler, configuration of ADC & DAC etc. Designing of ISP, ICSP modules for programming and debugging

Module 4 : Development of PIC based an embedded system for **15**

i. Monitoring of environmental parameters
ii. Monitoring and controlling Industrial parameters

Reference Books:

1. PIC Microcontrollers and Embedded systems using Assembly and C for PIC18 – M.A. Mazidi, R. D. Mckinlay and D. Causey - Pearson Education, New Delhi-2009.
2. Embedded design with PIC18F452, John B.Peatman
3. Embedded C programming and the Microchip PIC – Richard Barnet, L.O.Cull and S. Cox Delmer.-2004.

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M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester I)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Programming with Python**
Course Code: **MSU0325MEL913G2** Total Credits: **04**

Unit 1: Introduction to Python **15**

Python, Features of Python, Execution of a Python Program, Flavors of Python Structure of Python program, Comparisons between C and Python, Comparisons between Java and Python, writing a program in python.

Unit 2: Data types and Operators in Python **10**

Data types in Python: Built-in data types, bool Data type, Sequences in Python, Sets, Literals in Python, Determining the Data type of a Variable, User-defined Data types Constants in Python, Identifiers and Reserved words,

Operators in Python: Arithmetic, logical, Boolean, Bitwise Operators, membership, Operator precedence and Associativity.

Unit 3: Control Statements and **Arrays in Python** **15**

The control statements, if , if … else, Case,The Loops, While, for, nested loops.

Array in Python: Advantages of Arrays, Creating an Array, Importing the Array Module, Indexing and Slicing on Arrays, Processing the Arrays, Types of Arrays,Working with Arrays using numpy, Creating Arrays using array(), linspace, logspace, arange() Function, Creating Arrays using zeros() and ones() Functions, Dimensions of Arrays, Attributes of an Array, The reshape() Method, The flatten() Method,Working with Multi-dimensional Arrays

Unit 4: Functions and Files in Python **10**

Difference between a Function and a Method, Defining a Function, Calling a Function, Returning Results from a Function, Returning Multiple Values from a Function, Functions are First Class Objects, Pass by Object Reference, Formal and Actual Arguments, Positional Arguments, Keyword Arguments, Recursive Functions, Anonymous Functions or Lambdas.

Files : Types of Files in Python, Opening a File, Closing a File, Working with Text Files, Containing Strings, The with Statement Pickle in Python, The seek() and tell() Methods

Unit 5: Data Structures in Python **10**

Structures, Linked Lists, types of link lists, insertion and deletion of nodes, Stacks, Queues

Reference Books

1. Core Python Programming- Dr. R. Nageswara Rao- Dreamtech Press, 2017
2. LEARNING TO PROGRAM WITH PYTHON- Richard L. Halterman,
3. http://www.davekuhlman.org/python_book_01.pdf , 2011
4. Core Python Programming, Wesley J. Chun, PHI, 2006
5. A Python Book: Beginning Python, Advanced Python, and Python Exercises- Dave Kuhlman www.opensource.org/licenses/mitlicense.php, 2013

M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester II)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Real Time Operating System**
Course Code: **MSU0325MML913H1** Total Credits: **04**

Course Objectives :

1. To expose the students to basic concept of RTOS.
2. To study RTOS kernel and Kernel objects.
3. To study scheduling mechanism and concept of preemption.
4. To Develop real time embedded systems.

Course Outcomes :

1. Should get acquainted with basic concept of RTOS.
2. Should understand RTOS structure, RTOS kernel and task scheduling mechanism.
3. Writing embedded firmware in RTOS.
4. Design of real time based an embedded systems using advance microcontrollers.

Module 1: Fundamentals of Real Time Operating System 20

a) **Introduction:** Concept of Real Time, Real Time operating System, Characteristics of Real-Time operation system, Hard and Soft Real Time Systems.
b) **Structure of RTOS:** Structure of RTOS, RTOS Kernel, Kernel Objects, Services of Scheduler.
c) **Task :** Task, Task structure, Creation of task, types of task, Task Control block, context, States of task and FSM, idle task, Priority, Static and dynamic priority, Resources, Sharing of resources, ISR, Task Management.
d) **Scheduling Algorithm :** Task scheduling Algorithm, preemption, FIFO, Round Robin scheduling, priority based preemptive scheduling. Priority Inversion, Software and hardware time Ticks, context switching.

Module:2 Task Synchronization and Intertask communication 15

a) **Synchronization of task :** Concept of Sharing of resources, Race condition, Critical condition, deadlocks, spinlocks,
b) **Semaphores and mutexes :** Concept of semaphore, Binary semaphore, Counting semaphore, Semaphore management,
c) **Mutexes :** Concept of mutex, mutex management.
d) **Intertask communication:** Intertask Communication, Messages, Queues, Mailboxes.

Module:3 The RTOS Kernel MicroC/OS-II 15

MicroC/OS-II kernel, creation of task, task management, Simple programs on creation of task. RTLinux Kernel, POSIX Pthreads, Processes and Threads, Thread Basics, Process management, semaphores, mutexes. Simple programs on creation of threads. Introduction to FreeRTOS.

Module 4 : RTOS Based Embedded System design using advanced microcontrollers 10

Simple programs based on Tiny RTOS, Vxworks/FreeRTOS for AVR microcontrollers, Design of real time embedded system for monitoring and control of environmental parameters. Design of real time embedded system for industrial parameters.

Reference Books:

1. Embedded C - Michael J Pont
2. Embedded C Programming and the Atmel AVR - R. H. Barnett, S. Cox and L. O'Cull
3. Real-Time Systems – C.M. Krishna and K.G. Shin
4. Embedded / Real Time Systems – Concepts design – programming- KVVK Prasad.
5. MicroC/OS-II, The Real Time Kernel, - J.J. Labrosse, 2nd Edn. (2006) CMP Books

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M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester II)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Mixed Signal Based SoC Design**
Course Code: **MSU0325MML913H2** Total Credits: **04**

Course Objectives :

1. To study concept of Analog and Mixed Signal based PSoC.
2. To study architecture of PSoCs.
3. To study IDEs for design and development of PSoC.
4. To Develop PSoC based embedded systems for dedicated applications.

Course Outcomes :

1. Understanding of architecture of PSoC and configuration features of both on chip analog and digital resources.
2. Able to configure communication perpherals.
3. Writing firmware for PSoC based embedded design.
4. Design of mixed signal based SoC for dedicated applications.

Module : 1 Mixed-signal embedded SoC architectures. 15

Concept of mixed signal design. Design Issues of Mixed Signal VLSI, Mixed-signal SoC ,architectures. Microcontroller M8C core. Instruction set. RAM and flash memory system. I/Os. System buses. Interrupt subsystem. Interrupt Service Routine (ISR). Boot program, Static & Dynamic reconfiguration.

Module :-2 Programmable Digital subsystem. 15

Performance improvement through architecture customization. Profiling. Performance profiling. PSoC programmable digital building blocks (timers, counters, CRC generator, PWM). Data communication in embedded systems. Serial communication using SPI and UART.

Module : 3 Continuous Time and Switched capacitor analog building blocks. 15

Basics of continuous time analog circuits. Presentation of basic building blocks, i.e., ideal op amps, comparators, PGA, Instrumentation amplifier, integrators, etc. Basics of switched capacitor analog circuits. Presentation of basic building blocks, i.e., ideal op amps, comparators, gain, integrators, etc. Application of Switch-Capacitor circuits.

Module : 4 Delta-Sigma Analog to digital converters. 10

Basics of Delta-Sigma converters (DS). Sampling. Quantization. Oversampling. Noise shaping. Performance of DS ADC. First-order DS ADC. Second-order DS ADC. Implementation using PSoC. Impact of circuit non-idealities on ADC performance.

Module : 5 Design of Mixed signal based system 20

Design of mixed signal based system for

a) Temperature, Humidity and CO2 measurement
b) Interfacing of PIR sensor
c) Touch sensing

Reference Books:

1. Introduction to Mixed signal, Embedded Design A. N. Doboli and E. H Currie Cypress semiconductor corporation (2007)
2. Designers Guide to the Cypress PSoC by Robert Ashby Elsevier
3. CMOS Circuit design, Layout and Simulation, R. J. Baker, WSE, Willey (2009)

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M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester II)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Embedded System Design with FPGA**
Course Code: **MSU0325MML913H3** Total Credits: **04**

Course Objectives :

1. To study the architectures of FPGA devices
2. To study basic of CMOS design flow.
3. To study interfacing of the peripheral devices FPGA

Course Outcomes :

1. Ability of co-design of Hardware and software for embedded design with FPGA
2. Design and simulation of circuits with FPGA
3. Students should able to interface peripheral devices to the FPGA.

UNIT-I: Embedded System Overview **10**

General Architecture of Embedded system design, Design Challenges and Design Life Cycle, Hardware, Software and FPGA platform. FPGA: Function Generators, Storage Elements, Logic Cells, Logic Blocks, I/O Blocks, Special-Purpose Function Blocks. Hardware Description Languages: VHDL, Verilog and Other High-Level HDLs, Configuration of Bit-stream. Types of ASICs, Design Flow, CMOS transistors, CMOS design rules, Combinational Logic Cell, Sequential logic cell, Data path, logic cell, Library cell design

UNIT-II: System Design using FPGA **10**

Principles of system design: Design quality, Modules and interfaces, Abstraction and state, Cohesion and coupling, Control flow graph. Digital clock Managers, Clock management, Regional clocks, Block RAM, Distributed RAM, Configurable Logic Blocks, LUT based structures, Phase locked loops, Select I/O resources, Anti fuse, static RAM, EPROM and EEPROM technology Hardware Design: Platform FPGA Components, Adding to Platform FPGA Systems, Assembling Custom Compute Cores. Software Design: System Software Options, Root File system, Cross-Development Tools, Monitors and Bootloader.

UNIT-III: FPGA Devices, Architecture and Interfacing **10**

Device Architecture, Spartan 6, Vertex 4 architecture, Altera Cyclone and Quartus architectures. Verilog and VHDL logic synthesis, Interfacing of the peripherals to FPGA, Interfacing of ADC, DAC, Serial Data Communication, Physical Layer for Serial Communication: RS-232 and RS-485 based Communication. Serial Peripheral Interface (SPI), Signal Conditioning with FPGAs. Embedded System design with FPGA Case Studies.

REFERENCE BOOKS

1. M.J.S. SMITH, "Application Specific Integrated Circuits", Addison Wesley Longman Inc., 1997
2. Wolf Wayne, "FPGA Based System Design", Pearson Education.
3. Design manuals of Altera, Xilinx and Actel.
4. Embedded System Design with FPGA: Principles and Practices by Ron Sass and Andrew G. Schmidt.
5. Introduction to Embedded System Design Using Field Programmable Gate Arrays by Rahul Dubey.

M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester II)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Device Drivers and Embedded System**
Course Code: **MSU0325MEL913H1** Total Credits: **04**

Course Objectives :

1. To study the concept device driver for embedded design.
2. To study hardware and software for device programmer
3. To develop device drivers for embedded system.

Course Outcomes :

1. To understand the facets of device drivers.
2. Able to design hardware for device programmer.
3. Able to develop middle ware for device driver.

Module : 1 Fundamentals of Device Drivers for Embedded System. 15

Meaning and need of device drivers/programmers for embedded system development, Hardware for devices drivers in UART, SPI, I2C communications, Basic software architecture of device driver as middle ware, types of device drivers. Device driver architecture for 89S51 microcontroller based embedded system design. Boot programming and Application program.

Module :-2 Polling mode device drivers. 15

Basic concept, hardware design, embedded C program for device driver, communication with PC, communication with microcontroller, Baud rate setting, use of SFRs, buffer registers, setting and resetting of the flag bits, Programming the target device.

Module : 3 Interrupt driven device drivers. 15

Interrupt mode of data transfer, flags to check, accessing of the flags during data communication, handshaking of the signals, hard for device programmer, software for data communication in serial mode, SPI mode and I2C mode, Programming the target device.

Module : 4 Device driver designing 15

Design of device driver for AVR ATmega8L based embedded system design in SPI and I2C mode.

Design of device driver for PIC 18F877microcontroler based embedded system

Reference Books:

1. "Embedded Systems - Architecture, Programming and Design", Raj Kamal, Publs.: McGraw-Hill Education 2015.
2. Master Microcontroller and Embedded Driver Development, Kiran Nayak Embedded Brain Academy,2021
3. Linux Driver Development for Embedded Processors - Second Edition: Learn to develop Linux embedded drivers with kernel 4.9 LTS, Alberto Liberal de los Ríos, 2018

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M.Sc. Embedded Technology (Part I) (Level-6.0) (Semester II)
(NEP-2020) (Introduced from Academic Year 2023-24)

Title of Course: **Device Drivers and Embedded System**
Course Code: **MSU0325MEL913H2** Total Credits: **04**

Unit 1: Introduction to Internet of Things (IoT) 15

Internet of Things (IoT), Definition, concept, Characteristics, Block diagram and Architectural view, Things in IoT, Sensor Technology, Actuators, Domestics IoT, Industrial IoT and Automotive IoT, Physical Design of IoT, IoT Protocols, Logical design of IoT, functional blocks, communication model, Comparison of IoT with WSN. Difference between IoT and M2M.

Unit 2: Design Principles for Web connectivity 10

Introduction, Web communication protocols for connected Devices, Network using Gateways, SOAP, REST, HTTP and Websockets. Internet based communication, IP addressing in the IoT, MAC and PHY layers for IoT.

Unit 3 : Data collection, Storage and Computing using cloud platform 10

Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service model, Nimbits platform.

Unit 4 Prototyping of Embedded Devices for IoT 10

Introduction, Basic block diagram, Prototype hardware for IoT, Connectivity of the device to
Internet or cloud. Development of embedded software for internet and cloud services.

Unit 5: IoT Case Studies 15

Development of IoT system for following applications.
1. IoT for smart home.
2. IoT for smart city Streetlights controlling
3. IoT for environmental monitoring and agricultural applications
4. IoT for medical application and patient monitoring

Reference Books:

1. Internet of Things, Architecture and Design Principles – Raj Kamal, McGraw Hill Education, Chennai, 2017
2. Internet of Things, A Hands-on Approach- Arshdeep Bahga and Vijay Madisetti, University Press, (India) 2017.
3. Internet of Things, Key Applications and Protocols- Olivier Hersent, David Boswarthick and Omar Elloumi, Wiley Student Ediation, 2012.