University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Course Specification of

Embedded Systems and Interfacing

Course Code (BE354)

I. Course Identification and General Information:						
1	**Course Title:**	Embedded Systems and Interfacing				
2	**Course Code & Number:**	BE354				
3	**Credit hours:**	C.H				TOTAL
		Th.	Seminar	Pr	Tr.	
		2	--	2	--	3
4	**Study level/ semester at which this course is offered:**	4th Level / 2nd Semester				
5	**Pre –requisite (if any):**	BE353 (Microprocessor and Microcontrollers) & BE223 (Electronics 2)				
6	**Co –requisite (if any):**	None				
7	**Program (s) in which the course is offered:**	Biomedical Engineering Program				
8	**Language of teaching the course:**	English				
9	**Location of Teaching the Course:**	Faculty of Engineering				
10	**Prepared by:**	Assoc. Prof. Dr. Farouk Al-Fahaidy				
11	**Reviewed by:**	Assoc. Prof. Dr. Radwan AL Bouthigy				
12	**Date of Approval:**					

Academy Development Center & Quality Insurance | Dean of Engineering | Quality Insurance Unite | Prepared By

Assoc. Prof. Dr.
Farouk Al-Fahaidy

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

I. Course Description:

This course provides students the principles, theories and practical skills to be applied to the design & implementation of embedded systems & interfacing, to meet higher requirements of Embedded systems as an essential-part to different biomedical arrangement & devices, automation & control systems, and smart devices. Course topics include, an overview on microcontrollers types, features & applications, Assembly & Mikro-C Programming, as well as, the design and implementation of embedded systems with interfacing capabilities. Through hands-on practical & computer-based labs works, students will verify the learned theoretical concepts and develop their problem-solving & design skills related to embedded systems based on real platforms and simulation environments.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		**Referenced PILOs** (Only write code number of referenced Program Intended learning outcomes)
Knowledge and Understanding: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
a1	Explain principles, theories and electronic & mechanical concepts related to the design of embedded systems and their applications to the Biomedical Engineering context.	A1 Describe and explain the underlying mathematical methods and theories; life scientific-principles; and engineering core concepts related to the Biomedical Engineering context.
a2	Recognize design methods, programming & simulation tools and appropriate electromechanical elements to be applied for the suggestion of creative embedded systems solutions to biomedical engineering problems.	A4 Understand and give examples of design methods, knowledge tools, analytical skills, measurement techniques and methodologies for innovative and creative engineering solutions applied to healthcare problems and quality of life issues.

B. Cognitive/ Intellectual Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
b1	Solve domain problems related to biomedical engineering creatively, using modern programming tools, suitable electromechanical elements and digital ICs. .	B2 Identify, formulate and solve the complex problems related to the Biomedical Engineering fields in a creative and innovative manner by using a systematic and analytical thinking methods.
b2	Design an embedded system with interfacing capability within realistic constraints such as, environmental, safety, manufacturability and sustainability.	B3 Design the biomedical systems or processes within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.
C. Professional and Practical Skills: Upon successful completion of the undergraduate Biomedical Engineering Program, the graduates will be able to:		
c1	Use professional and modern software packages, to write and develop desired computer programs, for modeling & solving Biomedical Engineering problems.	C2 Use a wide range of analytical tools, techniques, IT, modern engineering tools, software packages and develop required computer programs to solve, modeling and analyzing Biomedical Engineering problems.
c2	Conduct experiments using laboratory equipment to design, integrate, analyze and interpret data and present results in the embedded systems & interfacing practice.	C3 Use computational facilities and techniques, measuring instruments, workshops and laboratory equipment to design and conduct experiments, collect, analyse and interpret data and present results in the biomedical systems practice.
D. Transferable Skills: Upon successful completion of the undergraduate Biomedical Engineering		

Program, the graduates will be able to:		
d1	Function effectively either individually or within team, by sharing clear ideas, preparing desired tasks and creating cooperative team work.	D1 Lead and motivate individuals, show capability to work in stressful environments and within constraints, collaborate effectively within multidisciplinary team.
d2	Engage in life-long self-learning by, following new technologies and tools applied in embedded systems solutions related to biomedical engineering.	D3 Recognize the needs for, and engage in life-long self-learning.

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1. Explain principles, theories and electronic & mechanical concepts related to the design of embedded systems and their applications to the Biomedical Engineering context.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works,	• Written tests (mid and final terms and quizzes), • Coursework activities assessment, • Home works and assignments,.
a2. Recognize design methods, programming & simulation tools and appropriate electromechanical elements to	• Interactive lectures & examples, • Interactive class discussions, • Case studies,	• Written tests (mid and final terms and quizzes), • Short reports, • Coursework activities

be applied for the suggestion of creative embedded systems solutions to biomedical engineering problems.	• Exercises and home works.	assessment, • Home works and assignments.

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Solve domain problems related to biomedical engineering creatively, using modern programming tools, suitable electromechanical elements and digital ICs.	• Interactive lectures & examples, • Interactive class discussions, • Exercises and home works, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions,	• Written tests (mid and final terms and quizzes), • Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Home works and assignments,
b2 Design an embedded system with interfacing capability within realistic constraints such as, environmental, safety, manufacturability and sustainability.	• Interactive lectures & examples, • Interactive class discussions, • Case studies, • Exercises and home works, • Computer laboratory-based sessions.	• Written tests (mid and final terms and quizzes), • Lab\Project report • Coursework activities assessment, • Home works and assignments,

(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1. Use professional and modern software packages, to write and develop desired computer programs, for modeling & solving Biomedical Engineering problems.	• Interactive class discussions, • Computer laboratory-based sessions, • Problem based learning, • Team work (cooperative learning), • Mini/major project.	• Lab\Project report • Practical lab performance assessment, • Coursework activities assessment, • Home works and assignments,
c2. Conduct experiments using laboratory equipment to design, integrate, analyze and interpret data and present results in the embedded systems & interfacing practice.	• Interactive lectures & examples, • Interactive class discussions, • Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Problem based learning, • Team work (cooperative learning), • Mini/major project.	• Lab\Project report • Practical lab performance assessment, • Coursework activities assessment,.

(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1. Function effectively either individually or within team, by	• Interactive class discussions,	• Short reports, • Lab\Project report

sharing clear ideas, preparing desired tasks and creating cooperative team work.	• Laboratory/Practical experiments based session, • Computer laboratory-based sessions, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Mini/major project.	• Practical lab performance assessment, • Coursework activities assessment, • Home works and assignments, • Presentations.
d2. Engage in life-long self-learning by, following new technologies and tools applied in embedded systems solutions related to biomedical engineering.	• Presentation/seminar, • Case studies, • Directed self- study, • Problem based learning, • Team work (cooperative learning), • Mini/major project.	• Short reports, • Coursework activities assessment, • Home works and assignments, • Presentations.

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	**Introduction to Embedded Systems**	**a1, a2**	– Course Orientations: Aims & Objectives, – Introduction to Embedded & Interfacing Systems: Definitions, Electromechanical Elements & Components	1	2

			Requirements, Programming Techniques & Simulation Environments and Issues & Applications to variant Environments.		
2	**Embedded Systems' Microcontrollers & Peripherals**	**a1, a2, b1**	– Overview on MCs: Types, Architectures and MCs Developers, – PIC16F MCs: Versions of PIC16-MCs, their Characteristics & Features, Internal Features and IC's External Pins' Interfacing, – PIC16F84-MC's Internally: Internal Organization, Memories Organization & Addressing Modes, – Input/ Output Devices Interfacing: LEDs & Switches, Different Types of Switches, Electronic Interfacing of LEDs & Switches with PIC16F84-MC.	2	4
3	**PIC16F-MCs-based Embedded Systems Programming**	**a2, b1, b2**	– Overview on Different Programming Techniques: Assembly & C Programming, – PIC16F-MCs Assembly	2	4

			Programming: Demonstration on the 35-Assembly Instructions Supported by PIC16F-MCs, – Structured Programming: Concepts, Design Methods, Flow-chart & State Machine, – Assembly Subroutines & Macros: software Delay Generation using Subroutines, Look-Up Table in Assembly, – Case Study: Examples for Building Complete Assembly Structures Programs for PIC16F-MCs programming based on Macros, Procedures, and Look-Up Tables.		
4	**Embedded Systems Automation (Timer and Interrupts)**	**a1, a2, b1, b2**	– PIC16F84-Mc's Interrupts: Concepts of Interrupts, Structures & Types of PIC16F84MC's Interrupts, – Interrupts Programming: Single & Multi Interrupts Demonstration, Configuration & Programming, – PIC16F84-MC Timer0, Timers Concepts &	2	4

			Applications, The Timer0 Block Diagram, Configuration & Programming of Timer0 in Timing and Counting Applications.		
5	**Mid-Term Theoretical Exam**	**a1, a2, b1, b2**	– All Previous Topics	1	2
6	**Embedded Systems Interfacing with Human**	**a2, b1, b2**	– Overview on PIC16F877-MC: New Features, External Interfacing, Additional Internal Modules, Memory Organization, – Physical & Human Interfacing: Input & Output Devices, 7-Segment, LCD & Keypad Interfacing with PIC16F877-MC, Interfacing & Programming of the Keypad & LCD with MC, – Interfacing of MC with Sensors & Actuators: Sensors Types and Operation Characteristics, Signals Distortion Problems and their Hardware/Software Solving, Motors Concepts, Types and	2	4

			Hardware Interfacing with PIC using (Driver Txs or Electronic IC Like L293D).		
7	**PIC16F877-Mc IC's On-Chip Modules (Timers & CCP)**	**a1, b1, b2**	– The PIC16F877-MC's Timers: Timers 0, 1 & 2 Block Diagrams, Operations, Characteristics, Configuration and Programming, – The CCP Module: Modes of Operation & their Applications, – Capture Mode: Block Diagram & Operation, Configuration & Assembly Programming, – Compare Mode: Block Diagram & Operation, Configuration & Assembly Programming, – PWM Mode: Block Diagram & Operation, Configuration & Assembly Programming, – Case Study: Applications of CCP in PWM for Frequency Measurement and Digital to Analog Conversion.	2	4
8	**Data Acquisition**	**a1, b1, b2**	– Data Acquisition System:	1	2

	and Analog-to-Digital On-Chip Module		the Block Diagram, Different Electromechanical Components of Data Acquisition System and their Operational Characteristics and Specifications, – ADC & DAC: Concepts & Parameters, Sample & Hold ADC Circuit Operation, – Digital-to-Analog On-Chip Module on the PIC16F877-MC: the Block Diagram of the ADC On-Chip Module and its Configuration and Assembly Programming.		
9	**Serial Communications & New Trends in Embedded Systems**	**b1, b2**	– Overview on Parallel & Serial Communications, Concepts & Applications, Advantages & Disadvantages, – Interfacing of Multiple Microcontrollers together or to another Controlling Devices in Serial Communications, – SPI Serial Communication on PIC16F877-Mc, Concepts, Block	2	4

			Diagram, Configuration & Programming, – I2C Serial Communication on PIC16F877-Mc, Concepts, Block Diagram, Configuration & Programming, – New Trends in Embedded & Interfacing Systems, Hardware Controllers (PIC18F, ARM, Arduino & Raspberry-Pi), Programming Techniques (Python Programming) Features & Variant Supported Libraries.		
10	**Final Theoretical Exam**	**a1, a2, b1, b2**	ALL Topics	1	2
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect: (if any)

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1	**Pre-laboratory Hardware/Software Orientations:** – Computer-based Lab Orientation: Programming tools	1	2	b1, c1, d1

	& IDE, Simulation Software such as Proetus, Preparation & Installation**,** – Practical Lab Orientations: Benches, Boards' Equipment & Components.			
2	**Computer & Embedded Systems based Labs:** – Demonstration of the Assembly 35-Instructions, – Generating Delay Time, Look-Up Tables, and Macros using Assembly Procedure, – Building Assembly Structured Program Employing Procedures, Look-Up, and Macros for Interfacing PIC16F84-MC with LEDs & Switches, – Use of the IDE to Build & Integrate the Previous	4	8	b2, c1, c2, d1

	Assembly Program on the PIC-MC's Flash-ROM.			
3	**Computer & Embedded Systems based Labs:** – Exploring interrupt and Timing work and Function them using PIC16-MCs to Build Automated/Control Embedded and Interfacing Systems to Monitor some Phenomena like motion-Detection and Self-react to the Action.	1	2	c1, c2, d1
4	**Computer & Embedded Systems based Labs:** – Physical-Human Interfacing, Simulation & Practice Interfacing of 7-Segments, LEDs, and LCD with PIC16F-Mc. – Motors Interfacing Hardware Experimental Lab..	2	4	c1, c2, d1
5	**Mid-Term Practical Exam** (if any)	1	2	c1, c2

6	**Computer & Embedded Systems based Labs:** - Demonstration of CCP Module: Capture & Compare Modes, - CCP in PWM Mode: Speed Control of the Motor, - PWM Mode: Frequency Measure & DAC applications of PWM using CCP, - ADC PIC16F877-MC On-Chip Module.	3	6	b1, b2, c1, c2, d1
7	**Computer & Embedded Systems based Labs:** - Serial Communication Experiments to Interface External Modules/ICs Such as Memory or another Microcontrollers using SPI and I2C Serial Communication Protocols.	1	2	b1, b2, c1, c2, d1
8	**Term Project Presentation & Discussion** (Students work in groups	1	2	a1, a2, b1, b2, c1, c2, d1, d2

	of 2 or 3 from the 4th week in solving & preparing solutions to practical & applications problems)			
9	**Final Practical Exam**	1	2	c1, c2
Number of Weeks /and Units Per Semester		**15**	**30**	

C. Tutorial Aspect:

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	NONE			
15				
Number of Weeks /and Units Per Semester				

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Interactive class discussions,
- Case studies,
- Exercises and home works,
- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Directed self- study,
- Problem based learning,
- Team work (cooperative learning),
- Mini/major project.

Academy Development Center & Quality Insurance Dean of Engineering Quality Insurance Unite Prepared By

Assoc. Prof. Dr.
Farouk Al-Fahaidy

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Short reports,
- Lab\Project report
- Practical lab performance assessment,
- Coursework activities assessment,
- Home works and assignments,
- Presentations.

VII. Assignments & Reports:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	**Assignment 1:** PIC16F-MC Assembly Programming	a2, b1, d1	4th & 5th	1
2	**Assignment 2:** Interrupts & Embedded System Automation and Physical Human Interfacing	a1, a2, b1, b2, d1	6th, 7th & 9th	2
3	**Assignment 3:** CCP Module, ADC & Serial Communications **Short Report:** Search the web for modern programming, simulation, equipment in Embedded Systems development or in Trends as assigned by the course instructor	a1, a2, b1, b2, c1, d1, d2	10th to 13th	3
4	**Lab Reports**	c1, c2, d1, d2	4th to 12th	4
Total				10

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	**Assignments & Reports**	4th to 13th	10	6.67%	a1, a2, b1, b2, c1, c2, d1, d2
2	**Quizzes**	6th & 12th	10	6.67%	a1, a2, b1, b2, d1
3	**Midterm Theoretical Exam**	8th	20	13.33%	a1, a2, b1, b2
4	**Midterm Practical Exam**	9th	20	13.33%	c1, c2
5	**Final Practical Exam (including Project Evaluation)**	15th	30	20%	a1, a2, b1, b2, c1, c2, d1, d2
6	**Final Theoretical Exam**	16th	60	40%	a1, a2, b1, b2
Total			150	100%	

IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

Example

1- Niku, Saeed B., 2011, **Introduction to Robotics: Analysis, Control, Applications**, 2nd Edition, USA, Wiley.

1- Required Textbook(s) (maximum two).

1. Tim Wilmshurst, 2010, **Designing Embedded Systems with PIC Microcontrollers Principles and applications**, 2nd edition, Elsevier Ltd, USA
2. Park & Mackay, 2003, **Practical Data Acquisition for Instrumentation and Control Systems**, Newns, USA.

2- Essential References.

1. Muhamad Ali Mazidi, 2012, **Embedded Systems Design Using PIC18"**, 1st, Prentice

	Hall, USA 2. Kevin James, 2000, **PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control**, Newnes, USA 3. Michael Barr, O'Reilly, **Programming Embedded Systems in C and C++**, Media USA.
3- Electronic Materials and Web Sites *etc*.	
	Websites: 1- Embedded Systems http://www.embedded.com/ 2- Courses: https://ocw.mit.edu/courses 3- Other: http://nptel.iitm.ac.in 4- Lectures that may be prepared by the lecturer

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects:** In general one assignment is given to the students after each chapter; the student has to submit

	all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating:** For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments might be given directly to students using soft or hard copy.

University of Sana'a
Faculty of Engineering
Department: Biomedical Engineering
Title of the Program: Biomedical Engineering

Template for Course Plan (Syllabus)

Embedded Systems & Interfacing
BE354

I. Course Identification and General Information:					
1	**Course Title:**	Embedded Systems and Interfacing			
2	**Course Code & Number:**	BE354			
3	**Credit Hours:**	**Credit Hours**	**Theory Hours**		**Lab. Hours**
			Lecture	**Exercise**	
		3	2	--	2
4	**Study Level/ Semester at which this Course is offered:**	4^{th} Level / 2^{nd} Semester			
5	**Pre –Requisite (if any):**	BE353 (Microprocessor and Microcontrollers) & BE223 (Electronics 2)			
6	**Co –Requisite (if any):**	None			
7	**Program (s) in which the Course is Offered:**	Bachelor of Biomedical Engineering			
8	**Language of Teaching the Course:**	English			
9	**Location of Teaching the Course:**	Faculty of Engineering			
10	**Prepared by:**	Assoc. Prof. Dr. Farouk Al-Fahaidy			
11	**Reviewed by:**	Assoc. Prof. Dr. Radwan AL Bouthigy			
12	**Date of Approval:**				

II. Course Description:

This course provides students the principles, theories and practical skills to be applied to the design & implementation of embedded systems & interfacing, to meet higher requirements of Embedded systems as an essential-part to different biomedical arrangement & devices, automation & control systems, and smart devices. Course topics include, an overview on microcontrollers types, features & applications, Assembly & Mikro-C Programming, as well as, the design and implementation of embedded systems with interfacing capabilities. Through hands-on practical & computer-based labs works, students will verify the learned theoretical concepts and develop their problem-solving & design skills related to embedded systems based on real platforms and simulation environments.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)

A. Knowledge and Understanding: Upon successful completion of the course, students will be able to:	
a1	Explain principles, theories and electronic & mechanical concepts related to the design of embedded systems and their applications to the Biomedical Engineering context.
a2	Recognize design methods, programming & simulation tools and appropriate electromechanical elements to be applied for the suggestion of creative embedded systems solutions to biomedical engineering problems.
B. Intellectual Skills: Upon successful completion of the course, students will be able to:	
b1	Solve domain problems related to biomedical engineering creatively, using modern programming tools, suitable electromechanical elements and digital ICs.
b2	Design an embedded system with interfacing capability within realistic constraints such as, environmental, safety, manufacturability and sustainability.
C. Professional and Practical Skills: Upon successful completion of the course, students will be able to:	
c1	Use professional and modern software packages, to write and develop desired computer programs, for modeling & solving Biomedical Engineering problems.
c2	Conduct experiments using laboratory equipment to design, integrate, analyze and interpret data and present results in the embedded systems & interfacing practice.

III. Course Intended Learning Outcomes (CILOs): (مخرجات تعلم المقرر)	
D. Transferable Skills: Upon successful completion of the course, students will be able to:	
d1	Function effectively either individually or within team, by sharing clear ideas, preparing desired tasks and creating cooperative team work.
d2	Engage in life-long self-learning by, following new technologies and tools applied in embedded systems solutions related to biomedical engineering.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction to Embedded Systems**	– Course Orientations: Aims & Objectives, – Introduction to Embedded & Interfacing Systems: Definitions, Electromechanical Elements & Components Requirements, Programming Techniques & Simulation Environments and Issues & Applications to variant Environments.	1	2
2	**Embedded Systems' Microcontrollers & Peripherals**	– Overview on MCs: Types, Architectures and MCs Developers, – PIC16F MCs: Versions of PIC16-MCs, their Characteristics & Features, Internal Features and IC's External Pins' Interfacing, – PIC16F84-MC's Internally: Internal Organization, Memories	2	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		Organization & Addressing Modes, – Input/ Output Devices Interfacing: LEDs & Switches, Different Types of Switches, Electronic Interfacing of LEDs & Switches with PIC16F84-MC.		
3	**PIC16F-MCs-based Embedded Systems Programming**	– Overview on Different Programming Techniques: Assembly & C Programming, – PIC16F-MCs Assembly Programming: Demonstration on the 35-Assembly Instructions Supported by PIC16F-MCs, – Structured Programming: Concepts, Design Methods, Flow-chart & State Machine, – Assembly Subroutines & Macros: software Delay Generation using Subroutines, Look-Up Table in Assembly, – Case Study: Examples for Building Complete Assembly Structures Programs for PIC16F-MCs programming based on Macros, Procedures, and Look-Up Tables.	2	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
4	**Embedded Systems Automation (Timer and Interrupts)**	– PIC16F84-Mc's Interrupts: Concepts of Interrupts, Structures & Types of PIC16F84MC's Interrupts, – Interrupts Programming: Single & Multi Interrupts Demonstration, Configuration & Programming, – PIC16F84-MC Timer0, Timers Concepts & Applications, The Timer0 Block Diagram, Configuration & Programming of Timer0 in Timing and Counting Applications.	2	4
5	**Mid-Term Theoretical Exam**	– All Previous Topics	1	2
6	**Embedded Systems Interfacing with Human**	– Overview on PIC16F877-MC: New Features, External Interfacing, Additional Internal Modules, Memory Organization, – Physical & Human Interfacing: Input & Output Devices, 7-Segment, LCD & Keypad Interfacing with PIC16F877-MC, Interfacing & Programming of the Keypad & LCD with MC, – Interfacing of MC with Sensors & Actuators: Sensors Types and	2	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		Operation Characteristics, Signals Distortion Problems and their Hardware/Software Solving, Motors Concepts, Types and Hardware Interfacing with PIC using (Driver Txs or Electronic IC Like L293D).		
7	**PIC16F877-Mc IC's On-Chip Modules (Timers & CCP)**	– The PIC16F877-MC's Timers: Timers 0, 1 & 2 Block Diagrams, Operations, Characteristics, Configuration and Programming, – The CCP Module: Modes of Operation & their Applications, – Capture Mode: Block Diagram & Operation, Configuration & Assembly Programming, – Compare Mode: Block Diagram & Operation, Configuration & Assembly Programming, – PWM Mode: Block Diagram & Operation, Configuration & Assembly Programming, – Case Study: Applications of CCP in PWM for Frequency Measurement and Digital to Analog Conversion.	2	4
8	**Data Acquisition**	– Data Acquisition System: the	1	2

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
	and Analog-to-Digital On-Chip Module	Block Diagram, Different Electromechanical Components of Data Acquisition System and their Operational Characteristics and Specifications, – ADC & DAC: Concepts & Parameters, Sample & Hold ADC Circuit Operation, – Digital-to-Analog On-Chip Module on the PIC16F877-MC: the Block Diagram of the ADC On-Chip Module and its Configuration and Assembly Programming.		
9	**Serial Communications & New Trends in Embedded Systems**	– Overview on Parallel & Serial Communications, Concepts & Applications, Advantages & Disadvantages, – Interfacing of Multiple Microcontrollers together or to another Controlling Devices in Serial Communications, – SPI Serial Communication on PIC16F877-Mc, Concepts, Block Diagram, Configuration & Programming, – I2C Serial Communication on	2	4

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		PIC16F877-Mc, Concepts, Block Diagram, Configuration & Programming, – New Trends in Embedded & Interfacing Systems, Hardware Controllers (PIC18F, ARM, Arduino & Raspberry-Pi), Programming Techniques (Python Programming) Features & Variant Supported Libraries.		
10	**Final Theoretical Exam**	ALL Topics	1	2
Number of Weeks /and Units Per Semester			**16**	**32**

B. Case Studies and Practical Aspect:

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	**Pre-laboratory Hardware/Software Orientations:** – Computer-based Lab Orientation: Programming tools & IDE, Simulation Software such as Proetus, Preparation & Installation**,** – Practical Lab Orientations: Benches, Boards' Equipment & Components.	1	2
2	**Computer & Embedded Systems based Labs:** – Demonstration of the Assembly 35-Instructions, – Generating Delay Time, Look-Up Tables, and	4	8

B. Case Studies and Practical Aspect:			
No.	**Tasks/ Experiments**	**Number of Weeks**	**Contact Hours**
	Macros using Assembly Procedure, – Building Assembly Structured Program Employing Procedures, Look-Up, and Macros for Interfacing PIC16F84-MC with LEDs & Switches, – Use of the IDE to Build & Integrate the Previous Assembly Program on the PIC-MC's Flash-ROM.		
3	**Computer & Embedded Systems based Labs:** – Exploring interrupt and Timing work and Function them using PIC16-MCs to Build Automated/Control Embedded and Interfacing Systems to Monitor some Phenomena like motion-Detection and Self-react to the Action.	1	2
4	**Computer & Embedded Systems based Labs:** – Physical-Human Interfacing, Simulation & Practice Interfacing of 7-Segments, LEDs, and LCD with PIC16F-Mc. – Motors Interfacing Hardware Experimental Lab..	2	4
5	**Mid-Term Practical Exam** (if any)	1	2
6	**Computer & Embedded Systems based Labs:** - Demonstration of CCP Module: Capture & Compare Modes, - CCP in PWM Mode: Speed Control of the Motor, - PWM Mode: Frequency Measure & DAC applications of PWM using CCP, - ADC PIC16F877-MC On-Chip Module.	3	6

B. Case Studies and Practical Aspect:			
No.	**Tasks/ Experiments**	**Number of Weeks**	**Contact Hours**
7	**Computer & Embedded Systems based Labs:** - Serial Communication Experiments to Interface External Modules/ICs Such as Memory or another Microcontrollers using SPI and I2C Serial Communication Protocols.	1	2
8	**Term Project Presentation & Discussion** (Students work in groups of 2 or 3 from the 4th week in solving & preparing solutions to practical & applications problems)	1	2
9	**Final Practical Exam**	1	2
Number of Weeks /and Units Per Semester		**15**	**30**

C. Tutorial Aspect:			
No.	**Tutorial**	**Number of Weeks**	**Contact Hours**
1	NONE		
15			
Number of Weeks /and Units Per Semester			

V. Teaching Strategies of the Course:

- Interactive lectures & examples,
- Interactive class discussions,
- Case studies,
- Exercises and home works,

V. Teaching Strategies of the Course:

- Laboratory/Practical experiments based session,
- Computer laboratory-based sessions,
- Directed self- study,
- Problem based learning,
- Team work (cooperative learning),
- Mini/major project.

VI. Assessment Methods of the Course:

- Written tests (mid and final terms and quizzes),
- Short reports,
- Lab\Project report
- Practical lab performance assessment,
- Coursework activities assessment,
- Home works and assignments,
- Presentations.

VII. Assignments & Reports:

No.	Assignments	Week Due	Mark
1	**Assignment 1:** PIC16F-MC Assembly Programming	4th & 5th	1
2	**Assignment 2:** Interrupts & Embedded System Automation and Physical Human Interfacing	6th, 7th & 9th	2
3	**Assignment 3:** CCP Module, ADC & Serial Communications **Short Report:** Search the web for modern programming, simulation, equipment in	10th to 13th	3

VII. Assignments & Reports:

No.	Assignments	Week Due	Mark
	Embedded Systems development or in Trends as assigned by the course instructor		
4	**Lab Reports**	4th to 12th	4
Total			**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	**Assignments & Reports**	4th to 13th	10	6.67%
2	**Quizzes**	6th & 12th	10	6.67%
3	**Midterm Theoretical Exam**	8th	20	13.33%
4	**Midterm Practical Exam**	9th	20	13.33%
5	**Final Practical Exam (including Project Evaluation)**	15th	30	20%
6	**Final Theoretical Exam**	16th	60	40%
Total			**150**	**100%**

IX. Learning Resources:

- *Written in the following order:*
  - *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

IX. Learning Resources:

Example

1- Niku, Saeed B., 2011, **Introduction to Robotics: Analysis, Control, Applications**, 2nd Edition, USA, Wiley.

1- Required Textbook(s) (maximum two):

1- Tim Wilmshurst, 2010, **Designing Embedded Systems with PIC Microcontrollers Principles and applications**, 2nd edition, Elsevier Ltd, USA

2- Park & Mackay, 2003, **Practical Data Acquisition for Instrumentation and Control Systems**, Newns, USA.

2- Essential References:

1- Muhamad Ali Mazidi, 2012, **Embedded Systems Design Using PIC18"**, 1st , Prentice Hall, USA

2- Kevin James, 2000, **PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control**, Newnes, USA

3- Michael Barr, O'Reilly, **Programming Embedded Systems in C and C++**, Media USA.

3- Electronic Materials and Web Sites etc.:

Websites:

1- Embedded Systems http://www.embedded.com/

2- Courses: https://ocw.mit.edu/courses

3- Other: http://nptel.iitm.ac.in

4- Lectures that may be prepared by the lecturer

X. Course Policies:

1	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise

	he/she will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic. If the absent is more than 25% of a course total contact hours, student will be required to retake the entire course again.
2	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class, he/she will be considered as absent.
3	**Exam Attendance/Punctuality:** A student should attend the exam on time. He/she is permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam
4	**Assignments & Projects**: In general one assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time, mostly one week after given the assignment.
5	**Cheating**: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6	**Plagiarism**: Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he/she will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university or according to the university roles.
7	**Other policies**: - Mobile phones are not allowed to use during a class lecture. It must be closed; **otherwise** the student will be asked to leave the lecture room. - Mobile phones are not allowed in class during the examination.

	- Lecture notes and assignments might be given directly to students using soft or hard copy.