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|  | **AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)**  Faculty of Engineering  Department of EEE and CoE  Undergraduate Program |  |

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| **COURSE PLAN FALL 2021-2022 SEMESTER** |

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| **I.** Course Core and Title  **EEE 4103 : Microprocessor and Embedded System**  **II.** Credit  **3 credit hours (2 hours of theory per week)**  **III.** Nature  **Core Course for EEE/CoE**  **IV.** Prerequisite  **EEE 3101: Digital Electronics,**  **CSC 2207: Programming Language 2** |  | **V. Mission of Faculty of Engineering**: To develop engineers with highest level of commitment toward the betterment of the society by applying science and technology.  To nurture young leaders with perspectives and ethics.  To create and disseminate state of the art knowledge and technical skills with problem solving attitude for a sustainable society.  **VI. Vision of Faculty of Engineering:** The Faculty of Engineering will endeavor to nurture young engineers for innovation and creativity dedicated to problem solving and lifelong learning for research, entrepreneurship, and professionalism with respective communities. |

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| **VII - Course Description:** |

This is a core course of Electrical and Electronic Engineering & Computer Engineering program.

The goal of this course is to:

* Introduction to microprocessor and microcontroller, understanding their basic differences and applications. Introduction to embedded systems and their applications. Understanding principles of operation of microcontrollers, including assembly language programming as well as internal architecture of processors and microcontroller. Learning about hardware-software interfacing and different interfacing techniques.
* Introduction to the commonly used modules of a microcontroller.
* Introduction to serial communication and different protocols. Emphasis will be given on RS-232 communication, understanding the principle of RS-232 communication and its implementation. Introduction to SPI and I2C protocols.
* Introduction to ADC conversion, principle of operation and implementing an ADC converter using Arduino. Understanding the basics of pulse-width modulation (PWM), duty cycle and observing the effect of PWM through a stepper motor.
* Introduction to Embedded systems, a brief overview of the system and internal architecture, state of the art technology.

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| **VIII – Course Outcomes (CO) Matrix:** |

By the end of this course, students should be able to –

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| **COs** | **Details** | **Level of Domain** | | | **K** | **P** | **A** | **Delivery methods**  **and activities** | **Assessed Program Outcomes**  **(PO)#** | **Assessment** |
| C | P | A |
| CO1 | Apply information and concepts in *specialized engineering sciences* with the in-depth of analysis of a complex engineering problem | **3** |  |  | K4 | P1, P3,P7 |  |  | P.a.4.C3 |  |
| CO2 | Analyze solutions for  complex engineering  problem reaching  substantiated  conclusion. | 5 |  |  | K3 | P1, P3,P7 |  |  | P.b.3.C5 |  |
| CO3 | Function as effective team leader/member in multi- disciplinary problems. |  |  | 2 |  |  |  |  | P.i.1.A2 |  |
| *Level of Domain (C: Cognitive; P: Psychomotor; A: Affective)*  *K:* *Knowledge Profile; P: Range of Complex Engineering Problem Solving; A: Range of Complex Engineering Activities*  *\* Culminating CO for PO attainment*  # *For details please check the appendix A* | | | | | | | | | | |

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| **IX – Topics to be Covered\*:** |

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| **Time Frame** | **CO** | **Topics** | **Teaching Activities** | **Assessment** | **Evidence** |
| **Week 1** |  | Mission & Vision of AIUB, Dept. of EEE; OBE Assessment, Objective of Microprocessor and Embedded System Course.  Introduction to microprocessor, Historical background, Evolution of Intel microprocessors (4004 to modern microprocessors/Pentium 4), Applications of microprocessors in our day to day lives, Some modern microcontrollers- (Arduino, Pic, Raspberry pi, ARM), Difference between a microprocessor and a microcontroller, A brief introduction of embedded systems, Applications of microcontrollers in our daily lives | Lecture Tutorial | **\*Calculation-based question:**  **Test,**  **mid exam**  **\*Theoretical-based question:**  **Test,**  **mid exam** |  |
| **Week 2** |  | Review of number systems, ASCII, Unicode, BCD, Architecture of a modern computer (Intel Pentium 4), Programming model (Memory, Registers, General/multipurpose registers, Segment registers, Flag register and status flags) Flow of information and logical flow,Architecture of a modern microcontroller (Arduino), Learning about the Arduino launchpad, Learning about the ATMega IC chip (Pin configuration, Internal architecture), Architecture of the entire system, Architecture of the AVR processor (Memory, Registers, ALU, Status flags, Basic functions) |  |
| **Week 3** |  | Introduction to assembly language and its advantages, Comparison of assembly with high level languages, The assembly process (assembler, compiler etc.), Instruction set, Applications of assembly language, Learning to write simple programs using assembly, Performance analysis | Quiz 1(not accessed) |
| **Week 4** |  | Interrupts and traps, Interrupts in an Intel processor, Basic interrupt Processing, Hardware interrupts, Interrupts in a modern microcontroller (Software interrupt, External hardware interrupt),Implementation of interrupts in microcontroller, Information flow and logic flow, Rules of interrupt implementation, Interrupt modules, Necessary resources for interrupts, Programming an interrupt, Performance analysis with and without interrupts. | Quiz 2(not accessed) |
| **Week 5** |  | Introduction to basic Input/ Output Techniques, Types of I/O Devices- Logical and Physical I/O. Discussion on Types of Physical I/O, Interrupt Driven I/O Types, Interrupt Management with Processor Hardware System. Direct Memory Access (DMA), simplified logical structure of a system with DMA, Execution of a DMA-operation (single block transfer), Completion Signaling of DMA operation. | Quiz 3 (not accessed) |
| **Week 6** |  | Architecture, Instruction Set and Programming of SAP 1, Timing Diagram & State Function, Control Signals, Fixed and Variable Machine Cycle of SAP 1, Determining contents of different SAP 1 components by running a particular SAP1 Instruction/Program. Implementation of HLT instruction, Microprogramming, Design of Micro-programmed Controller Circuit. | Midterm assignment (not accessed) |
| **Week 7** | **MID-TERM EXAM WEEK/** **theory based presentation**  **and viva (not accessed)** | | | | |
| **Week 8** |  | Processor Bus Organization, Brief Discussion on Scratchpad Memory, Design of Arithmetic Unit, Design of Logic Unit (Revision of K-Map) | Lecture Tutorial | **\*Calculation-based question:**  **Quiz, final exam**  **\*Theoretical-based question:**  **Quiz, final exam** |  |
| **Week 9** |  | Design of the combined ALU, Processor Unit, Status Registers. Design of Shifter.  Design of Processor unit with control variables, Micro operations for processor |  |
| **Week 10** |  | Flowchart, State diagram and Micro-programmed Control Unit Design for addition/subtraction of signed numbers | Quiz 1(not accessed) |
| **Week 11** |  | Flowchart, State diagram and Micro-programmed Control Unit Design for calculating number of 1’s & 0’s in a register , Develop processor & control logic for arithmetic & logic instructions | Quiz 2 (not accessed) |
| **Week 12** |  | Evolution of ARM Processor, ARM Architecture, Micro-operations, Exynos Cortex 7 Big and Small Architecture Pipelining, pipelining Hazards and solution , Basics of MIPS Processor, MIPS Architecture | Quiz 3 (not accessed) |
| **Week 13** |  | Single Instruction Set, Architecture along modification of Forwarding and Stall Technique  MIPS Instruction Sets for Coding generic algorithm  Memory Management & Virtual Memory  Virtual Machines |  |  | Final term assignment (not accessed) |
| **Week 14** | **FINAL-TERM EXAM WEEK** | | | | |

\* The faculty reserves the right to change, amend, add or delete any of the contents.

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| **X – Course Requirement:** |

At least **80% class attendance** is necessary to sit for the exam. If there is any assignment given to the students, they have to submit it before the deadline decided by the course teacher.

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| **XI – Evaluation Grading System:** |

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| **Letter** | **Grade Point** | **Numerical %** |
| A+ | 4.00 | 90-100 |
| A | 3.75 | 85-<90 |
| B+ | 3.50 | 80-<85 |
| B | 3.25 | 75-<80 |
| C+ | 3.00 | 70-<75 |
| C | 2.75 | 65-<70 |
| D+ | 2.50 | 60-<65 |
| D | 2.25 | 50-<60 |
| F | 0.00 | <50(Failed) |

The evaluation system will be strictly followed as par the AIUB grading policy. The following grading system will be strictly followed in this class.

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| **Marking system For theory Classes (Midterm and final term)** | |
| Attendance | 10% |
| Quiz | 20% |
| Assignment | 30% |
| Final term exam/ midterm theory based presentation and viva | 40% |
| **Total** | 100% |
| **Final Grade/ Grand Total** | |
| Midterm: | 40% |
| Final Term: | 60% |

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| **XII – COs and POs Assessment** |

**COs Assessment Tools for Mid-Term and Final-term**

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| **Assessment Tools** | **CO1 Marks** | **CO2 Marks** | **CO3 Marks** | **Marks for Grading** |
| Attendance | Not accessed for OBE | | | 10 |
| Quiz | 20 |
| Assignment | 30 |
| Midterm theory based presentation and viva /final term | 40 |
| **Total** |  | | | **100** |

**XIII – Teaching Method**

Formal lectures will provide the theoretical base for the subject as well as covering its practical application. A set of lecture notes, tutorial examples with subsequent discussion and explanation, together with suggested reading will support and direct the students in their own personal study.

Maximum topics will be covered from the textbooks. For the rest of the topics, reference books will be followed. Some Class notes will be uploaded on the web. White board will be used for most of the time.

For some cases, multimedia projector will be used for the convenience of the students.

Students must study up to the last lectures before coming to the class and it is suggested that they should go through the relevant chapter before coming to the class. Just being present in the class is not enough- students must participate in classroom discussions.

Few assignments will be given to the students based on that class to test their class performance. Students must write lab reports and submit that during next week’s lab experiments.

**XIV – Textbook/ References**

**Textbooks:**

1. Jeremy Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry
2. Ytha Yu, Charles Marut-Assembly Language Programming Organization of the IBM PC (1992)
3. Barry B. Brey, “The Intel Microprocessors”, Fourth Edition, Prentice-Hall of India, ISBN 81-203-2158-8.
4. The ATMega328P datasheet

**References:**

1. Douglas V. Hall, “Microprocessors and Interfacing – Programming and Hardware”, Second Edition, TATA McGRAW-HILL, ISBN 0-07-463639-1.
2. Albert Paul Malvino, Jerald A. Brown, “Digital Computer Electronics”, Third Edition, Tata McGraw-Hill Publishing Company Ltd.
3. William Buchanan and Austin Wilson, “Advanced PC Architecture”.
4. Michael J. Debenham, “Microprocessors: Principles and Applications”.
5. N Senthil Kumar, M Saravanan and S Jeevananthan, “Microprocessors and Microcontrollers”.
6. Walter A. Triebel and Avtar Singh, “The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications”, Fourth Edition.
7. (2015) MIT Open Courseware [Online]. Available: <http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-823-computer-system-architecture-fall-2005/lecture-notes/> [Cited: August 30, 2015]
8. [John Uffenbeck](http://www.bestwebbuys.com/John_Uffenbeck-author.html?isrc=b-compare-author),"The 8086/8088 Family: Designing, Programming and Interfacing”, Second Edition, Prentice Hall, ISBN: 0132467526.
9. Microprocessor and Microcomputer-based System Design – by Mohammad Rafiquzzaman.
10. Digital Logic and Computer Design – by M. Morris Mano

**XV - List of Faculties Conducting Theory**

1. Mr. Ali Noor
2. Ms. Nadia Nowshin
3. Dr. Nadia Anam
4. Dr. Ferdous Jahan Shaun
5. Dr. Mohammad Shidujaman
6. Mr. Sujan Howlader
7. Ms. Tahseen Asma Meem (co-ordinator)

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| Prepared by:  ………………………………...  Ms. Tahseen Asma Meem  (Course Co-ordinator)  Date: …………………………. | Checked and certified by:  ..........................................................  Nafiz Ahmed Chisty  Head (UG), Department of EEE, Faculty of Engineering  Date: ............................................... | Approved by:  ..........................................................  Prof. Dr. A B M Siddique Hossain  Dean, Faculty of Engineering  Date: ............................................... |
|  | Moderated by:  …………………….  Date: …………………………. | Moderated by:  ……………………….  Date: …………………………. |

**XVI – Verification:**

# Appendix A

*Table 1: Knowledge Profile*

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| **Indicator** | **Attribute** |
| **K1** | A systematic, theory-based understanding of the natural sciences applicable to the discipline |
| **K2** | Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline |
| **K3** | A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline |
| **K4** | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline |
| **K5** | Knowledge that supports engineering design in a practice area |
| **K6** | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline |
| **K7** | Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer’s professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability |
| **K8** | Engagement with selected knowledge in the research literature of the discipline |

*Table 2: Range of Complex Engineering Problem Solving***Complex Engineering Problems** have characteristic P1 and some or all of P2 to P7

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| **Indicator** | **Title** | **Description** |
| **P1** | Depth of knowledge required | Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach |
| **P2** | Range of conflicting requirements | Involve wide-ranging or conflicting technical, engineering and other issues |
| **P3** | Depth of analysis required | Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models |
| **P4** | Familiarity of issues | Involve infrequently encountered issues |
| **P5** | Extent of applicable codes | Are outside problems encompassed by standards and codes of practice for professional engineering |
| **P6** | Extent of stakeholder involvement and conflicting requirements | Involve diverse groups of stakeholders with widely varying needs |
| **P7** | Interdependence | Are high level problems including many component parts or sub problems |

*Table 3: Range of Complex Engineering Activities***Complex activities** means (engineering) activities or projects that have some or all of the following  
characteristics

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| **Indicator** | **Title** | **Description** |
| **A1** | Range of resources | Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies) |
| **A2** | Level of interaction | Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues |
| **A3** | Innovation | Involve creative use of engineering principles and research-based knowledge in novel ways |
| **A4** | Consequences for society and the environment | Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation |
| **A5** | Familiarity | Can extend beyond previous experiences by applying principles-based approaches |

**PO-a: Engineering Knowledge**Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering  
specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.a.1.C3** | Apply information and concepts in *natural science* with the familiarity of issues. | Cognitive Level 3 (Applying) | EEE1203: Electrical Circuits – 1 (DC) | EEE3213: Electrical Properties of Material | K1 |  |  |
| **P.a.2.C3** | Apply information and concepts of *mathematics* with the familiarity of issues. | Cognitive Level 3 (Applying) | EEE2209: Analog Electronics | EEE2213: Signals and Linear Systems | K2 |  |  |
| **P.a.3.C3** | Apply information and concepts in *engineering fundamentals* to solve complex engineering problems with a range of conflicting requirements. | Cognitive Level 3 (Applying) | EEE2105: Electrical Machines 1 | EEE3101: Digital Logic and Circuits | K3 | P1, P2, P6 |  |
| **P.a.4.C3** | Apply information and concepts in *specialized engineering sciences* with the in-depth of analysis of a complex engineering problem. | Cognitive Level 3 (Applying) | EEE3105: Industrial Electronics and Drives | EEE4101: Modern Control Systems | K4 | P1, P3, P7 |  |

**PO-b: Problem Analysis**Identify, formulate, research literature and analyze complex engineering problems reaching substantiated  
conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4).

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.b.1.C2** | Identify first principles of natural sciences and engineering sciences in practical applications. | Cognitive Level 2 (Understanding) | EEE2101: Electrical Circuits 2 (AC) | EEE2103: Electronic Devices | K1 |  |  |
| **P.b.2.C4** | Formulate solutions, procedures, and methods using first principles of mathematics for engineering sciences. | Cognitive Level 4 (Analyzing) | EEE3101: Digital Signal Processing | EEE3107: Electromagnetics Fields and Waves | K2 |  |  |
| **P.b.3.C5** | Analyze solutions for complex engineering problem reaching substantiated conclusion. | Cognitive Level 5 (Evaluating) | EEE3211: Power Systems Analysis | EEE2207: Electrical Machines 2 | K3 | P1, P3, P7 |  |
| **P.b.4.C4** | Research literature and analyze the validity and accuracy of existing solution for complex engineering problems. | Cognitive Level 4 (Analysis) | EEE4000: Capstone Project 1 | EEE4209: Telecommunications Engineering | K4 | P1, P2, P6 |  |

**PO-c: Design/ development of solutions**Design solutions for complex engineering problems and design systems, components or processes that  
meet specified needs with appropriate consideration for public health and safety, cultural, societal, and  
environmental considerations. (K5).

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.c.1.C4** | Design solutions for components of an engineering problem considering public health and safety. | Cognitive Level 4 (Analyzing) | BAE1201: Basic Mechanical Engineering | EEE2211: Electrical Power Transmission & Distribution | K5 |  |  |
| **P.c.2.C4** | Develop process for complex engineering problems considering cultural and societal factors. | Cognitive Level 4 (Analyzing) | EEE4000: Capstone Project 1 | EEE4103: Microprocessor and Embedded System | K5 | P1, P3, P7 |  |
| **P.c.3.C4** | Develop solutions that meet specified needs with appropriate environmental considerations. | Cognitive Level 4 (Analyzing) | EEE4211: Measurement and Instrumentation | EEE4213: Power Stations and Substations | K5 | P1, P2, P6 |  |

**PO-d: Investigation**Conduct investigations of complex problems using research-based knowledge (K8) and research  
methods including design of experiments, analysis and interpretation of data, and synthesis of  
information to provide valid conclusions.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.d.1.C5** | Investigate the design of experiments for complex engineering problem through appropriate research. | Cognitive Level 5 (Evaluating) | EEE4103: Microprocessor and Embedded System | EEE3215: Principles of Communication Lab | K8 | P1, P3, P7 |  |
| **P.d.2.C4** | Analysis and Interpretation of collected data to provide valid conclusion acknowledging the limitations. | Cognitive Level 4 (Analyzing) | EEE2104: Electronic Devices Lab | EEE3102: Digital Logic and Circuits Lab | K8 |  |  |
| **P.d.3.C5** | Investigate solution of complex engineering problem by synthesis of information to provide valid conclusions. | Cognitive Level 5 (Evaluating) | EEE2208: Electrical Machines 2 Lab | EEE4102: Modern Control Systems Lab | K8 | P1, P4, P5 |  |

**PO-e: Modern Tool Usage**Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including  
prediction and modelling, to complex engineering problems, with an understanding of the limitations. (K6).

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.e.1.C3** | Select engineering tools and Apply appropriate techniques to solve complex engineering problems considering the limitations. | Cognitive Level 3 (Applying) | EEE4217: VLSI Circuit Design Lab | EEE2210: Analog Electronics Lab | K6 | P1, P4, P5 |  |
| **P.e.2.P4** | Use tools for prediction and modeling of complex engineering problems considering the practice in electrical and electronic engineering discipline. | Psychomotor Level 4 (Articulation) | EEE4217: VLSI Circuit Design Lab | BAE2101: Computer Aided Design and Drafting | P1, P4, P5 |  |  |
| **P.e.3.P5** | Create relevant resources for complex engineering problems using modern engineering tools. | Psychomotor Level 5 (Naturalization) | EEE3101: Digital Signal Processing | EEE4217: VLSI Circuit Design Lab | P1, P3, P7 |  |  |

**PO-f: The Engineer and Society**Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural  
issues and the consequent responsibilities relevant to professional engineering practice and solutions to  
complex engineering problems. (K7)

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.f.1.A3** | Accepts and Recognize the role of engineering in society, health, safety, legal and culture. | Affective Level 3 (Valuing) | EEE4208: Electrical Services Design Lab | BAE1201: Basic Mechanical Engineering |  |  |  |
| **P.f.2.C5** | Design solution for complex engineering problem in accordance with professional practices | Cognitive Level 5 (Evaluating) | EEE2215: Engineering Ethics and Environmental Protection | EEE2106: Electrical Machines 1 Lab | K7 | P1, P3, P7 |  |

**PO-g: Environment and Sustainability**Understand and evaluate the sustainability and impact of professional engineering work in the solution of  
complex engineering problems in societal and environmental contexts. (K7)

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.g.1.C5** | Evaluate sustainability of complex engineering problems considering society and environment. | Cognitive Level 5 (Evaluating) | EEE4213: Power Stations and Substations | BAE1201: Basic Mechanical Engineering | K7 | P1, P2, P6 |  |
| **P.g.2.C5** | Analyze the impact of professional engineering solutions to society and environment. | Cognitive Level 5 (Evaluating) | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project 1 | K7 |  |  |

**PO-h: Ethics**Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering  
practice. (K7)

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.h.1.C3** | Apply professional codes of ethics and standards considering public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability. | Cognitive Level 3 (Applying) | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project 1 | K7 |  |  |
| **P.h.2.A4** | Demonstrates individual responsibilities based on norms of engineering practice. | Affective Level 4 (Organization) | EEE4001: Internship/ Seminar/ Workshop | EEE4000: Capstone Project 1 |  |  |  |

**PO-i: Individual Work and Teamwork**Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary  
settings.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.i.1.A2** | Function as effective team member in multi disciplinary problems. | Affective Level 2 (Responding) | EEE1204: Electrical Circuits 1 (DC) Lab | EEE2102: Electrical Circuits 2 (AC) Lab |  |  |  |
| **P.i.2.A5** | Demonstrate individual skills as a leader in solving multi-disciplinary problems. | Affective Level 5 (Characterization) | EEE4102: Modern Control Systems Lab | EEE3110: Engineering Shop |  |  |  |

**PO-j: Communication**Communicate effectively on complex engineering activities with the engineering community and with  
society at large, such as being able to comprehend and write effective reports and design documentation,  
make effective presentations, and give and receive clear instructions.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.j.1.A2** | Optimize engineering solution by giving and responding to clear instructions. (Communicate effectively by giving and responding to clear instructions to produce engineering solutions.) | Affective Level 2 (Responding) | EEE4000: Capstone Project 1 | EEE4211: Measurement and Instrumentation Lab | A1, A3, A5 |  |  |
| **P.j.2.P3** | Produce written engineering reports by applying principle based approaches and design documentation on complex engineering activities for different stakeholders. | Psychomotor Level 3 (Precision) | EEE4000: Capstone Project 1 | EEE4209: Telecommunications Engineering Lab | A1, A4 |  |  |
| **P.j.3.A2** | Make and deliver effective presentation based on complex engineering activities. | Affective Level 4 (Organizing) | EEE4000: Capstone Project 1 | EEE3110: Engineering Shop | A1, A2 |  |  |

**PO-k: Project Management and Finance**Demonstrate knowledge and understanding of engineering management principles and economic decisionmaking and apply these to one’s own work, as a member and leader in a team, to manage projects and in  
multidisciplinary environments.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.k.1.P4** | Apply engineering management principles and economic decision making to solve engineering projects as a team. | Psychomotor Level 4 (Articulation) | EEE3106: Industrial Electronics and Drives Lab | EEE4000: Capstone Project |  |  |  |
| **P.k.2.P4** | Manage multi-disciplinary components of a project as a member/leader. | Psychomotor Level 4 (Articulation) | EEE3110: Engineering Shop | EEE4000: Capstone Project |  |  |  |
| **P.k.3.A5** | Demonstrate competency in completing individual engineering project based on relevant management principles and economic models. | Affective Level 5 (Characterization) | EEE4213: Power Stations and Substations | EEE4000: Capstone Project 1 |  |  |  |

**PO-l: Lifelong learning**Recognize the need for, and have the preparation and ability to engage in independent and life-long  
learning in the broadest context of technological change.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.l.1.A1** | Investigate and gather information on a given engineering issue. | Affective Level 1 (Receiving) | EEE4209: Telecommunications Engineering | EEE4000: Capstone Project 1 |  |  |  |
| **P.l.2.A4** | Seek and use resources in solving engineering problems. | Affective Level 4 (Organization) | EEE4211: Measurement and Instrumentation Lab | EEE4000: Capstone Project 1 |  |  |  |
| **P.l.3.A5** | Recognizing the need for continuing education and participation in professional societies and meetings. | Affective Level 5 (Characterization) | EEE4000: Capstone Project 1 | EEE4001: Internship/ Seminar/ Workshop |  |  |  |

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|  | **AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)**  Faculty of Engineering  Department of EEE and CoE  Undergraduate Program |  |

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| **COURSE PLAN SPRING 2020-2021 SEMESTER** |

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| --- | --- | --- |
| **I.** Course Core and Title  **EEE 4103 : Microprocessor and Embedded Systems**  **II.** Credit  **3 credit hours (3 hours of lab per week)**  **III.** Nature  **Core Course for EEE/CoE**  **IV.** Prerequisite  **EEE 3101: Digital Electronics,**  **CSC 2207: Programming Language 2** |  | **V. Mission of Faculty of Engineering**: To develop engineers with highest level of commitment toward the betterment of the society by applying science and technology.  To nurture young leaders with perspectives and ethics.  To create and disseminate state of the art knowledge and technical skills with problem solving attitude for a sustainable society.  **VI. Vision of Faculty of Engineering:** The Faculty of Engineering will endeavor to nurture young engineers for innovation and creativity dedicated to problem solving and lifelong learning for research, entrepreneurship, and professionalism with respective communities. |

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| **VII - Course Description:** |

This is a core course of Electrical and Electronic Engineering & Computer Engineering program.

The goal of this course is to:

* Introduction to microprocessor and microcontroller, understanding their basic differences and applications. Introduction to embedded systems and their applications. Understanding principles of operation of microcontrollers, including assembly language programming as well as internal architecture of processors and microcontroller. Learning about hardware-software interfacing and different interfacing techniques.
* Introduction to the commonly used modules of a microcontroller.
* Introduction to serial communication and different protocols. Emphasis will be given on RS-232 communication, understanding the principle of RS-232 communication and its implementation. Introduction to SPI and I2C protocols.
* Introduction to ADC conversion, principle of operation and implementing an ADC converter using Arduino. Understanding the basics of pulse-width modulation (PWM), duty cycle and observing the effect of PWM through a stepper motor.
* Introduction to Embedded systems, a brief overview of the system and internal architecture, state of the art technology.

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| **VIII – Course Outcomes (CO) Matrix:** |

By the end of this course, students should be able to –

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| **COs** | **Details** | **Level of Domain** | | | **K** | **P** | **A** | **Delivery methods**  **and activities** | **Assessed Program Outcomes**  **(PO)#** | **Assessment** |
| C | P | A |
| CO1 | Select engineering tools and Apply appropriate techniques to solve complex engineering problems considering the limitations | 3 |  |  | K6 | P1,  P4,  P5 |  |  | P.e.1.C3 |  |
| CO2 | Apply engineering management principles and economic decision making to solve engineering projects as a team. |  | 4 |  |  |  |  |  | P.k.1.P4 |  |
| **CO3** | **Develop process for**  **complex engineering**  **problems considering**  **cultural and societal**  **factors.** | **4** |  |  | **K5** | **P1,**  **P3,**  **P7** |  |  | **P.c.2.C4** | **Proposal form** |
| **CO4** | **Investigate the**  **design of**  **experiments for**  **complex engineering**  **problem through**  **appropriate**  **research.** | **5** |  |  | **K8** | **P1,**  **P3,**  **P7** |  |  | **P.d.1.C5** | **Project report** |
| *Level of Domain (C: Cognitive; P: Psychomotor; A: Affective)*  *K:* *Knowledge Profile; P: Range of Complex Engineering Problem Solving; A: Range of Complex Engineering Activities*  *\* Culminating CO for PO attainment*  # *For details please check the appendix A* | | | | | | | | | | |

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| **IX – Topics to be Covered\*:** |

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| **Time Frame** | **CO** | **Topics** | **Teaching Activities** | **Assessment** | **Evidence** |
| **Week 1** |  | Mission & Vision of AIUB, Dept. of EEE; OBE Assessment, Objective of Microprocessor and Embedded System Course.  Introduction to Microprocessor 8086. Familiarization with Emu8086 software and study of 8086 instructions to learn Assembly language programming. | The teacher should divide the groups accordingly. Students should be instructed to follow the lab report writing guidelines. Brief theoretical description, teaching circuit implementation, use of different tools, programming languages and related software simulation | Practical implementation of each lab-work | Nil |
| **Week 2** |  | Familiarization with microcontroller, study of blink test using delay function and implementation of a traffic control system using microcontrollers.(using tinkercad) | Students should be instructed to follow the lab procedures. Brief theoretical description, teaching circuit implementation , use of different tools, programming languages and related  software simulation | Lab reports for each lab-work |
| **Week 3** |  | Familiarization with microcontroller, study of blink test using delay function and implementation of a traffic control system using microcontrollers.(using Proteus) |
| **Week 4** |  | Designing of temperature controlling system using microcontroller (in proteus simulation). |
| **Week 5** |  | Interfacing the Arduino with an external sensor to establish communication using the RS- 232 protocol along-with Designing to implement an obstacle detection system |
| **Week 6** |  | Lab-quiz and viva | | Written lab-test, project proposal form submission |
| **Week 7** | **MID-TERM EXAM WEEK** | | | | |
| **Week 8** |  | Implementation of motor control system using Arduino Digital input, outputs and PWM | Students should be instructed to follow the lab procedures. Brief theoretical description, teaching circuit implementation , use of different tools, programming languages and related software simulation | Practical implementation of each lab-work | Nil |
| **Week 9** |  | Implementation of a weather forecast system | Lab reports for each lab-work |
| **Week 10** |  | Construction of a 7 segment display using LEDs along-with Timing the LEDs properly to flash the alphabetic letters |
| **Week 11** |  | Introduction to Raspberry Pi and Implementation of a traffic control system with raspberry Pi. |
| **Week 12** |  | From previous experiments, students will learn project designing and create their own experiment based on simulation mainly as open ended lab experiment. | Submission of report on individual based experiment. |
| **Week 13** |  | Project report Submission  Demonstration of hardware or simulation based project implementation and related viva | |  | Lab Report 10, simulation file submission, Project report submission,  Viva |
| **Week 14** | **FINAL-TERM EXAM WEEK** | | | | |

\* The faculty reserves the right to change, amend, add or delete any of the contents.

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| **X – Course Requirement:** |

At least **80% class attendance** is necessary to sit for the exam. If there is any assignment given to the students, they have to submit it before the deadline decided by the course teacher.

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| **XI – Evaluation Grading System:** |

The evaluation system will be strictly followed as par the AIUB grading policy. The following grading system will be strictly followed in this class.

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| **Marking system For Lab Classes (Midterm)** | |
| Attendance | 10% |
| Lab Report | 30% |
| Survey to develop process for complex engineering problems considering cultural and societal  factors. | 5% |
| Proposal form of project  Gantt chart | 10%  5% |
| Viva | 10% |
| Midterm Written Lab Quiz | 30% |
| **Total** | 100% |
| **Final Grade/ Grand Total** | |
| Midterm: | 40% |
| Final Term: | 60% |

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| **Letter** | **Grade Point** | **Numerical %** |
| A+ | 4.00 | 90-100 |
| A | 3.75 | 85-<90 |
| B+ | 3.50 | 80-<85 |
| B | 3.25 | 75-<80 |
| C+ | 3.00 | 70-<75 |
| C | 2.75 | 65-<70 |
| D+ | 2.50 | 60-<65 |
| D | 2.25 | 50-<60 |
| F | 0.00 | <50(Failed) |

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| **Marking system For Lab Classes (Final-term)** | |
| Attendance | 10% |
| Simulation files | 10% |
| Lab report | 30% |
| Open ended lab | 10% |
| Viva | 10% |
| Project report | 25% |
| Literature review for investigating the  design of experiments for complex engineering problem through  appropriate research. | 5% |
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| **Final Grade/ Grand Total** | |
| Midterm: | 40% |
| Final Term: | 60% |

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| **XII – COs and POs Assessment** |

**COs Assessment Tools for Mid-Term**

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| **Assessment Tools** | **CO1 Marks** | **CO2 Marks** | **CO3 Marks** | **CO4 Marks** | **Marks for Grading** |
| Attendance | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | 10 |
| Viva | 10 |
| Lab Report | 30 |
| Lab Quiz | 30 |
| Proposal form  Gantt chart | 10  5 |
| Survey to develop process for complex engineering problems considering cultural and societal factors. | Not counted for Assessment | Not counted for Assessment | Counted for OBE Assessment | Not counted for Assessment | 5 |
| **Total** |  | | | | **100** |

**COs Assessment Tools for Final-Term**

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| --- | --- | --- | --- | --- | --- |
| **Assessment Tools** | **CO1 Marks** | **CO2 Marks** | **CO3 Marks** | **CO4 Marks** | **Marks for Grading** |
| Attendance | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | 10 |
| Viva | 10 |
| Lab Report | 30 |
| Open ended lab | 10 |
| Simulation files | 10 |
| Project report | 25 |
| Literature review for investigating the design of experiments for complex engineering problem through appropriate research. | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | Counted for OBE Assessment | 5 |
| **Total** |  | | | | **100** |

**XIII – Teaching Method**

Formal lectures will provide the theoretical base for the subject as well as covering its practical application. A set of lecture notes, tutorial examples, lab manuals with subsequent discussion and explanation, together with suggested reading will support and direct the students in their own personal study.

Maximum topics will be covered from the textbooks, lab manuals. For the rest of the topics, reference books will be followed. Some Class notes will be uploaded on the web. White board will be used for most of the time.

For some cases, multimedia projector will be used for the convenience of the students.

Students must study up to the last lectures before coming to the class and it is suggested that they should go through the relevant chapter before coming to the class. Just being present in the class is not enough- students must participate in classroom discussions and experimental implementations.

Few assignments will be given to the students based on that class to test their class performance. Students must write lab reports and submit that during next week’s lab experiments.

**XIV – Textbook/ References**

**Textbooks:**

1. Jeremy Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry
2. Ytha Yu, Charles Marut-Assembly Language Programming Organization of the IBM PC (1992)
3. Barry B. Brey, “The Intel Microprocessors”, Fourth Edition, Prentice-Hall of India, ISBN 81-203-2158-8.
4. The ATMega328P datasheet

**References:**

1. Douglas V. Hall, “Microprocessors and Interfacing – Programming and Hardware”, Second Edition, TATA McGRAW-HILL, ISBN 0-07-463639-1.
2. Albert Paul Malvino, Jerald A. Brown, “Digital Computer Electronics”, Third Edition, Tata McGraw-Hill Publishing Company Ltd.
3. William Buchanan and Austin Wilson, “Advanced PC Architecture”.
4. Michael J. Debenham, “Microprocessors: Principles and Applications”.
5. N Senthil Kumar, M Saravanan and S Jeevananthan, “Microprocessors and Microcontrollers”.
6. Walter A. Triebel and Avtar Singh, “The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications”, Fourth Edition.
7. (2015) MIT Open Courseware [Online]. Available: <http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-823-computer-system-architecture-fall-2005/lecture-notes/> [Cited: August 30, 2015]
8. [John Uffenbeck](http://www.bestwebbuys.com/John_Uffenbeck-author.html?isrc=b-compare-author),"The 8086/8088 Family: Designing, Programming and Interfacing”, Second Edition, Prentice Hall, ISBN: 0132467526.
9. Microprocessor and Microcomputer-based System Design – by Mohammad Rafiquzzaman.
10. Digital Logic and Computer Design – by M. Morris Mano

**XV - List of Faculties Conducting Theory**

1. Mr. Ali Noor
2. Ms. Nadia Nowshin
3. Dr. Nadia Anam
4. Dr. Ferdous Jahan Shaun
5. Dr. Mohammad Shidujaman
6. Mr. Sujan Howlader
7. Ms. Tahseen Asma Meem (co-ordinator)

**XVI – Verification:**

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| --- | --- | --- |
| Prepared by:  ………………………………...  Ms. Tahseen Asma Meem  (Course Co-ordinator)  Date: …………………………. | Checked and certified by:  ..........................................................  Nafiz Ahmed Chisty  Head (UG), Department of EEE, Faculty of Engineering  Date: ............................................... | Approved by:  ..........................................................  Prof. Dr. A B M Siddique Hossain  Dean, Faculty of Engineering  Date: ............................................... |
|  | Moderated by:  …………………….  Date: …………………………. | Moderated by:  ……………………….  Date: …………………………. |

# Appendix A

*Table 1: Knowledge Profile*

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| **Indicator** | **Attribute** |
| **K1** | A systematic, theory-based understanding of the natural sciences applicable to the discipline |
| **K2** | Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline |
| **K3** | A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline |
| **K4** | Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline |
| **K5** | Knowledge that supports engineering design in a practice area |
| **K6** | Knowledge of engineering practice (technology) in the practice areas in the engineering discipline |
| **K7** | Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer’s professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability |
| **K8** | Engagement with selected knowledge in the research literature of the discipline |

*Table 2: Range of Complex Engineering Problem Solving***Complex Engineering Problems** have characteristic P1 and some or all of P2 to P7

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| **Indicator** | **Title** | **Description** |
| **P1** | Depth of knowledge required | Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach |
| **P2** | Range of conflicting requirements | Involve wide-ranging or conflicting technical, engineering and other issues |
| **P3** | Depth of analysis required | Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models |
| **P4** | Familiarity of issues | Involve infrequently encountered issues |
| **P5** | Extent of applicable codes | Are outside problems encompassed by standards and codes of practice for professional engineering |
| **P6** | Extent of stakeholder involvement andconflicting requirements | Involve diverse groups of stakeholders with widely varying needs |
| **P7** | Interdependence | Are high level problems including many component parts or sub problems |

*Table 3: Range of Complex Engineering Activities***Complex activities** means (engineering) activities or projects that have some or all of the following  
characteristics

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| **Indicator** | **Title** | **Description** |
| **A1** | Range of resources | Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies) |
| **A2** | Level of interaction | Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues |
| **A3** | Innovation | Involve creative use of engineering principles and research-based knowledge in novel ways |
| **A4** | Consequences for society and the environment | Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation |
| **A5** | Familiarity | Can extend beyond previous experiences by applying principles-based approaches |

**PO-a: Engineering Knowledge**Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering  
specialization as specified in K1 to K4 respectively to the solution of complex engineering problems.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.a.1.C3** | Apply information and concepts in *natural science* with the familiarity of issues. | Cognitive Level 3 (Applying) | EEE1203: Electrical Circuits – 1 (DC) | EEE3213: Electrical Properties of Material | K1 |  |  |
| **P.a.2.C3** | Apply information and concepts of *mathematics* with the familiarity of issues. | Cognitive Level 3 (Applying) | EEE2209: Analog Electronics | EEE2213: Signals and Linear Systems | K2 |  |  |
| **P.a.3.C3** | Apply information and concepts in *engineering fundamentals* to solve complex engineering problems with a range of conflicting requirements. | Cognitive Level 3 (Applying) | EEE2105: Electrical Machines 1 | EEE3101: Digital Logic and Circuits | K3 | P1, P2, P6 |  |
| **P.a.4.C3** | Apply information and concepts in *specialized engineering sciences* with the in-depth of analysis of a complex engineering problem. | Cognitive Level 3 (Applying) | EEE3105: Industrial Electronics and Drives | EEE4101: Modern Control Systems | K4 | P1, P3, P7 |  |

**PO-b: Problem Analysis**Identify, formulate, research literature and analyze complex engineering problems reaching substantiated  
conclusions using first principles of mathematics, natural sciences and engineering sciences. (K1 to K4).

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.b.1.C2** | Identify first principles of natural sciences and engineering sciences in practical applications. | Cognitive Level 2 (Understanding) | EEE2101: Electrical Circuits 2 (AC) | EEE2103: Electronic Devices | K1 |  |  |
| **P.b.2.C4** | Formulate solutions, procedures, and methods using first principles of mathematics for engineering sciences. | Cognitive Level 4 (Analyzing) | EEE3101: Digital Signal Processing | EEE3107: Electromagnetics Fields and Waves | K2 |  |  |
| **P.b.3.C5** | Analyze solutions for complex engineering problem reaching substantiated conclusion. | Cognitive Level 5 (Evaluating) | EEE3211: Power Systems Analysis | EEE2207: Electrical Machines 2 | K3 | P1, P3, P7 |  |
| **P.b.4.C4** | Research literature and analyze the validity and accuracy of existing solution for complex engineering problems. | Cognitive Level 4 (Analysis) | EEE4000: Capstone Project 1 | EEE4209: Telecommunications Engineering | K4 | P1, P2, P6 |  |

**PO-c: Design/ development of solutions**Design solutions for complex engineering problems and design systems, components or processes that  
meet specified needs with appropriate consideration for public health and safety, cultural, societal, and  
environmental considerations. (K5).

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.c.1.C4** | Design solutions for components of an engineering problem considering public health and safety. | Cognitive Level 4 (Analyzing) | BAE1201: Basic Mechanical Engineering | EEE2211: Electrical Power Transmission & Distribution | K5 |  |  |
| **P.c.2.C4** | Develop process for complex engineering problems considering cultural and societal factors. | Cognitive Level 4 (Analyzing) | EEE4000: Capstone Project 1 | EEE4103: Microprocessor and Embedded System | K5 | P1, P3, P7 |  |
| **P.c.3.C4** | Develop solutions that meet specified needs with appropriate environmental considerations. | Cognitive Level 4 (Analyzing) | EEE4211: Measurement and Instrumentation | EEE4213: Power Stations and Substations | K5 | P1, P2, P6 |  |

**PO-d: Investigation**Conduct investigations of complex problems using research-based knowledge (K8) and research  
methods including design of experiments, analysis and interpretation of data, and synthesis of  
information to provide valid conclusions.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.d.1.C5** | Investigate the design of experiments for complex engineering problem through appropriate research. | Cognitive Level 5 (Evaluating) | EEE4103: Microprocessor and Embedded System | EEE3215: Principles of Communication Lab | K8 | P1, P3, P7 |  |
| **P.d.2.C4** | Analysis and Interpretation of collected data to provide valid conclusion acknowledging the limitations. | Cognitive Level 4 (Analyzing) | EEE2104: Electronic Devices Lab | EEE3102: Digital Logic and Circuits Lab | K8 |  |  |
| **P.d.3.C5** | Investigate solution of complex engineering problem by synthesis of information to provide valid conclusions. | Cognitive Level 5 (Evaluating) | EEE2208: Electrical Machines 2 Lab | EEE4102: Modern Control Systems Lab | K8 | P1, P4, P5 |  |

**PO-e: Modern Tool Usage**Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including  
prediction and modelling, to complex engineering problems, with an understanding of the limitations. (K6).

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.e.1.C3** | Select engineering tools and Apply appropriate techniques to solve complex engineering problems considering the limitations. | Cognitive Level 3 (Applying) | EEE4217: VLSI Circuit Design Lab | EEE2210: Analog Electronics Lab | K6 | P1, P4, P5 |  |
| **P.e.2.P4** | Use tools for prediction and modeling of complex engineering problems considering the practice in electrical and electronic engineering discipline. | Psychomotor Level 4 (Articulation) | EEE4217: VLSI Circuit Design Lab | BAE2101: Computer Aided Design and Drafting | P1, P4, P5 |  |  |
| **P.e.3.P5** | Create relevant resources for complex engineering problems using modern engineering tools. | Psychomotor Level 5 (Naturalization) | EEE3101: Digital Signal Processing | EEE4217: VLSI Circuit Design Lab | P1, P3, P7 |  |  |

**PO-f: The Engineer and Society**Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural  
issues and the consequent responsibilities relevant to professional engineering practice and solutions to  
complex engineering problems. (K7)

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.f.1.A3** | Accepts and Recognize the role of engineering in society, health, safety, legal and culture. | Affective Level 3 (Valuing) | EEE4208: Electrical Services Design Lab | BAE1201: Basic Mechanical Engineering |  |  |  |
| **P.f.2.C5** | Design solution for complex engineering problem in accordance with professional practices | Cognitive Level 5 (Evaluating) | EEE2215: Engineering Ethics and Environmental Protection | EEE2106: Electrical Machines 1 Lab | K7 | P1, P3, P7 |  |

**PO-g: Environment and Sustainability**Understand and evaluate the sustainability and impact of professional engineering work in the solution of  
complex engineering problems in societal and environmental contexts. (K7)

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.g.1.C5** | Evaluate sustainability of complex engineering problems considering society and environment. | Cognitive Level 5 (Evaluating) | EEE4213: Power Stations and Substations | BAE1201: Basic Mechanical Engineering | K7 | P1, P2, P6 |  |
| **P.g.2.C5** | Analyze the impact of professional engineering solutions to society and environment. | Cognitive Level 5 (Evaluating) | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project 1 | K7 |  |  |

**PO-h: Ethics**Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering  
practice. (K7)

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.h.1.C3** | Apply professional codes of ethics and standards considering public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability. | Cognitive Level 3 (Applying) | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project 1 | K7 |  |  |
| **P.h.2.A4** | Demonstrates individual responsibilities based on norms of engineering practice. | Affective Level 4 (Organization) | EEE4001: Internship/ Seminar/ Workshop | EEE4000: Capstone Project 1 |  |  |  |

**PO-i: Individual Work and Teamwork**Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary  
settings.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.i.1.A2** | Function as effective team member in multi disciplinary problems. | Affective Level 2 (Responding) | EEE1204: Electrical Circuits 1 (DC) Lab | EEE2102: Electrical Circuits 2 (AC) Lab |  |  |  |
| **P.i.2.A5** | Demonstrate individual skills as a leader in solving multi-disciplinary problems. | Affective Level 5 (Characterization) | EEE4102: Modern Control Systems Lab | EEE3110: Engineering Shop |  |  |  |

**PO-j: Communication**Communicate effectively on complex engineering activities with the engineering community and with  
society at large, such as being able to comprehend and write effective reports and design documentation,  
make effective presentations, and give and receive clear instructions.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.j.1.A2** | Optimize engineering solution by giving and responding to clear instructions. (Communicate effectively by giving and responding to clear instructions to produce engineering solutions.) | Affective Level 2 (Responding) | EEE4000: Capstone Project 1 | EEE4211: Measurement and Instrumentation Lab | A1, A3, A5 |  |  |
| **P.j.2.P3** | Produce written engineering reports by applying principle based approaches and design documentation on complex engineering activities for different stakeholders. | Psychomotor Level 3 (Precision) | EEE4000: Capstone Project 1 | EEE4209: Telecommunications Engineering Lab | A1, A4 |  |  |
| **P.j.3.A2** | Make and deliver effective presentation based on complex engineering activities. | Affective Level 4 (Organizing) | EEE4000: Capstone Project 1 | EEE3110: Engineering Shop | A1, A2 |  |  |

**PO-k: Project Management and Finance**Demonstrate knowledge and understanding of engineering management principles and economic decisionmaking and apply these to one’s own work, as a member and leader in a team, to manage projects and in  
multidisciplinary environments.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.k.1.P4** | Apply engineering management principles and economic decision making to solve engineering projects as a team. | Psychomotor Level 4 (Articulation) | EEE3106: Industrial Electronics and Drives Lab | EEE4000: Capstone Project |  |  |  |
| **P.k.2.P4** | Manage multi-disciplinary components of a project as a member/leader. | Psychomotor Level 4 (Articulation) | EEE3110: Engineering Shop | EEE4000: Capstone Project |  |  |  |
| **P.k.3.A5** | Demonstrate competency in completing individual engineering project based on relevant management principles and economic models. | Affective Level 5 (Characterization) | EEE4213: Power Stations and Substations | EEE4000: Capstone Project 1 |  |  |  |

**PO-l: Lifelong learning**Recognize the need for, and have the preparation and ability to engage in independent and life-long  
learning in the broadest context of technological change.

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| **Indicators ID** | **Indicators Definition** | **Domain** | **Course 1** | **Course 2** | **K** | **P** | **A** |
| **P.l.1.A1** | Investigate and gather information on a given engineering issue. | Affective Level 1 (Receiving) | EEE4209: Telecommunications Engineering | EEE4000: Capstone Project 1 |  |  |  |
| **P.l.2.A4** | Seek and use resources in solving engineering problems. | Affective Level 4 (Organization) | EEE4211: Measurement and Instrumentation Lab | EEE4000: Capstone Project 1 |  |  |  |
| **P.l.3.A5** | Recognizing the need for continuing education and participation in professional societies and meetings. | Affective Level 5 (Characterization) | EEE4000: Capstone Project 1 | EEE4001: Internship/ Seminar/ Workshop |  |  |  |