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

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| **PART A** |

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| 1. Course No/Course Code | EEE 4103 |
| 1. Course Title | Microprocessor and Embedded System |
| 1. Course Type | Core Course |
| 1. Year/Level/Semester/Term | Fourth-year (9th Semester) |
| 1. Academic Session | Summer 2021-22 |
| 1. Course Teachers/Instructors | Prof. Dr. Engr. Muhibul Haque Bhuyan, Mr. Ali Noor ,Dr. Md. Jahid Hasan, Dr. Mohammad Shidujaman, Mr. Sujan Howlader, Mr. Nirjhor Rouf, Ms. Tahmida Islam, Ms. Tahseen Asma Meem (co-ordinator) |
| 1. Pre-requisite (If any) | EEE 3101: Digital Electronics, CSC 2207: Programming Language 2 |
| 1. Credit Value | 3 credit hours |
| 1. Contact Hours | 2 hours of theory per week and 3 hours of lab per week |
| 1. Total Marks | 100 |
| 1. Mission of the EEE Department | * Educate young leaders for academia, industry, entrepreneurship, and public and private organization through theory and practical knowledge to solve engineering problems individually and in teams. * Create knowledge through innovative research and collaboration with multiple disciplines and societies. * Serve the communities at national, regional, and global levels with ethical and professional responsibilities. |
| 1. Vision of the EEE Department | To become a front runner in preparing Electrical and Electronics Engineering graduates to be nationally and globally competitive and thereby contribute value to the knowledge-based economy and welfare of the people of the world. |
| 1. Rationale of the Course (Course Description) | This is a core course of the Electrical and Electronic Engineering & Computer Engineering program that presents the fundamental principles of microprocessors and embedded system that is commonly used in engineering research and science applications. The course aims to enhance the skill of the students in solving complex engineering problems related to systems implementations based on embedded systems as well. |
| 1. Course Objectives | The course is designed to provide students with:   * Introduction to microprocessors and microcontrollers 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 the internal architecture of processors and microcontrollers Learning about hardware-software interfacing and different interfacing techniques. * The basic knowledge of studying datasheets of popular processors * Introduction to the commonly used modules of a microcontroller: interrupt, timers, serial communication interface, PWM. * Processor unit designing and control logic designing for micro-operations based on arithmetic and logical instructions |

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| **15. Course Outcomes (CO)/Course Learning Outcomes (CLOs):** |

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

(Theory):

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| **COs/CLOs** | **Details** | **K** | **P** | **A** | **Assessed Program Outcome Indicator** | **BNQF Indicator** | **Assessment Techniques** |
| 1 | Apply information and  concepts in specialized  engineering sciences with  the in-depth of analysis of  a complex engineering  problem. | K4 | P1,  P3,  P7 |  | P.a.4.C.3 | N/A | Term Exams |

(Laboratory):

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| **COs/CLOs** | **Details** | **K** | **P** | **A** | **Assessed Program Outcome Indicator** | **BNQF Indicator** | **Assessment Techniques** |
| **1** | **Investigate the design of experiments for complex**  **engineering problem through appropriate**  **research** | **K8** | **P1,**  **P3,**  **P7** |  | **P.d.1.C.5** | **N/A** | **Project Report** |
| 2 | Analysis and Interpretation of collected data to provide a valid conclusion acknowledging the  limitations | K8 |  |  | P.d.2.C4 | N/A | OEL |
| 3 | Develop a process for complex engineering problems considering  cultural and societal factors. | K8 | P1,  P3,  P7 |  | P.c.2.C6 | N/A | Project Proposal Form |

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| **16. Mapping with Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs)** |

(Theory):

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| **CLOs** | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** | **PLO 11** | **PLO 12** |
| **1** | X |  |  |  |  |  |  |  |  |  |  |  |

(Laboratory):

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| **CLOs** | **PLO 1** | **PLO 2** | **PLO 3** | **PLO 4** | **PLO 5** | **PLO 6** | **PLO 7** | **PLO 8** | **PLO 9** | **PLO 10** | **PLO 11** | **PLO 12** |
| **1** |  |  |  | X |  |  |  |  |  |  |  |  |
| **2** |  |  |  | X |  |  |  |  |  |  |  |  |
| **3** |  |  | X |  |  |  |  |  |  |  |  |  |

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| **PART B** |

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| **17. Course plan for theory classes:** |

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

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| **Time Frame (Week)** | **Topics** | **Teaching Learning Strategy** | **Assessment Strategy** | **Corresponding COs /CLOs** | **Evidence** |
| **Week 1** | Mission & Vision of AIUB, Dept. of EEE; OBE Assessment, Objective of Microprocessor and Embedded System Course.  Comparison between microprocessors and microcontrollers, the contrast of Harvard architecture and von Neumann architecture, (introduction, components, classification of) embedded systems and popular boards and groups of embedded systems, Applications, and real-life examples of embedded systems. | Lecture Tutorial | **\*Calculation-based question:**  **test/project/**  **mid-term exam**  **\*Theoretical-based question:**  **test/**  **mid-term exam** |  | **Quiz/Assignment/Term Exam** |
| **Week 2** | The architecture of a modern microcontroller (Arduino), Learning about the Arduino launchpad, Learning about the ATMega IC chip (Pin configuration, Internal architecture), introduction to Timers, implementation of a simple program using Timer, Architecture of the basic Timer circuit (Block diagram, Information flow, and logic flow, The timer registers), 16-bit timer | Lecture Tutorial |  |
| **Week 3** | Introduction to debouncing, Necessity of debouncing. 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 the 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 | Lecture Tutorial |  | **Quiz/**  **Assignment/Term Exam** |
| **Week 4** | Oscillator/clock of a microprocessor and the power saving modes, Clock generator in Intel processors, Different available oscillators in a microcontroller (Clock generation, Information flow, and logic flow in the clock circuit), Features, Active modes, Power saving modes (Low power mode, sleep mode, etc.) | Lecture Tutorial |  |
| **Week 5** | 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 | Lecture Tutorial |  | **Quiz/**  **Assignment/Term Exam** |
| **Week 6** | Revision class | Lecture Tutorial |  |
| **Week 7** | **MID-TERM EXAM WEEK** | | | | |
| **Week 8** | Introduction to serial interfaces in a microprocessor, Different bus interfaces in Intel microprocessors, an RS-232 communication protocol for serial communication, Synchronous and Asynchronous communication, Different serial interfaces in microcontrollers (UART, USART, I2C, SPI), Comparison between different interfaces (UART and USART ) | Lecture Tutorial | **\*Calculation-based question:**  **test/**  **final exam**  **\*Theoretical-based question:**  **test/**  **final exam** |  | **Quiz/**  **Assignment/Term Exam** |
| **Week 9** | The theory of PWM, Application of PWM, Implementation of PWM using microcontroller, Architecture of the module, Generation of the PWM signal, Calculations and examples, Learning to drive a DC motor with PWM | Lecture Tutorial |  |
| **Week 10** | Processor Bus Organization, Brief Discussion on Scratchpad Memory, Design of Arithmetic Unit, Design of Logic Unit (Revision of K-Map) | Lecture Tutorial |  | **Quiz/**  **Assignment/Term Exam** |
| **Week 11** | Design of the combined ALU, Processor Unit, and Status Registers. Design of Shifter.  Design of Processor unit with control variables, Micro operations for the processor | Lecture Tutorial |  |
| **Week 12** | Flowchart, State diagram, and Micro-programmed Control Unit Design for addition/subtraction of signed numbers | Lecture Tutorial |  | **Quiz/**  **Assignment/Term Exam** |
| **Week 13** | Flowchart, State diagram, and Micro-programmed Control Unit Design for calculating the number of 1’s & 0’s in a register, Develop processor & control logic for arithmetic & logic instructions | Lecture Tutorial |  |
| **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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| **17. Course plan for laboratory classes:** |

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| **Time Frame (Week)** | **Topics** | **Teaching Learning Strategy** | **Assessment Strategy** | **Corresponding COs /CLOs** | **Evidence** |
| **Week 1** | Familiarization with a microcontroller, the study of blink test and implementation of a traffic control system using microcontrollers. | Lecture Tutorial | **\*Design based Project, Simulations, Performance Tests and Viva** |  |  |
| **Week 2** | Introduction to STM32 (system configuration and implementation of light controlling system) | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 3** | Implementation of traffic runway lights using timer functions. | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 4** | Learning basic concepts of debouncing, Interfacing the Arduino with a push switch, and Implementation of the traffic control system using debouncing. | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 5** | Implementation and analysis of Interrupts (Timer interrupt and Hardware interrupt) study of comparison of the efficiency of the 2 interrupts. | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 6** | Midterm Laboratory Exam week | Lecture Tutorial |  | Lab report of the previous experiment Lab-quiz/viva/lab performance (individual/group-wise) |
| **Week 7** | **MID-TERM EXAM WEEK** | | | | |
| **Week 8** | Interfacing the Arduino with an external sensor to establish communication using the RS-232 protocol with implementing an obstacle detection system | Lecture Tutorial | **\*Design based Project, Simulations, Performance Tests and Viva** |  |  |
| **Week 9** | Using the ADC modules in Arduino for the Implementation of a weather forecast system | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 10** | Implementation of a motor control system using Arduino Digital input, outputs, and PWM | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 11** | Open-Ended Laboratory (OEL) experiment | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 12** | Introduction to Raspberry Pi (system configuration and synchronizing the use of sensors) | Lecture Tutorial |  | Lab report of the previous experiment |
| **Week 13** | Final term Laboratory Exam week | Lecture Tutorial |  | Lab report of the previous experiment, project Presentation, demonstration /viva |
| **Week 14** | **FINAL-TERM EXAM WEEK** | | | | |

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| **PART C** |

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| **18. Assessment and Evaluation** |

1. **Assessment Strategy:**

**COs/CLOs Assessment Tools for Theory (Mid-Term and Final term)**

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| **Assessment Tools** | | **CO/CLO 1 Marks** | **Marks for Grading** |
| Attendance | | Not counted for Assessment | 10 |
| Class performance | | Not counted for Assessment | 10 |
| Quiz | Count Best one out of 2 | Not counted for Assessment | 20 |
| Assignment 1 | | Not counted for Assessment | 10 |
| Assignment 2 | | Not counted for Assessment | 10 |
| Mid-Term / Final term | | 40(Not counted for Assessment) | 40 |
| **Total** | |  | **100** |

**COs/CLOs Assessment System for Mid-Term Laboratory**

|  |  |  |
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| **Assessment Tools** | **CO/CLO 3 Marks** | **Marks for Grading** |
| Attendance | Not counted for Assessment | 10 |
| Lab report | Not counted for Assessment | 30 |
| Lab quiz | Not counted for Assessment | 20 |
| Lab Performance | Not counted for Assessment | 10 |
| Viva | Not counted for Assessment | 10 |
| Proposal form of a project (Gantt chart + Survey to develop a process for complex engineering problems considering cultural and societal  factors) | 5 (Not counted for Assessment) | 10+5+5=20 |
| **Total** |  | **100** |

**COs/CLOs Assessment System for Final Term Laboratory**

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| --- | --- | --- | --- |
| **Assessment Tools** | **CO/CLO 1 Marks** | **CO/CLO 2 Marks** | **Marks for Grading** |
| Attendance | Not counted for Assessment | Not counted for Assessment | 10 |
| Lab report | Not counted for Assessment | Not counted for Assessment | 30 |
| Project demonstration +viva | Not counted for Assessment | Not counted for Assessment | 10 |
| Project presentation | Not counted for Assessment | Not counted for Assessment | 10 |
| Open-Ended Laboratory (OEL) | Not counted for Assessment | 10 (Not counted for Assessment) | 10 |
| Rest of the Project report | Not counted for Assessment | Not counted for Assessment | 25 |
| Literature review for investigating the  design of experiments for complex engineering problems through  appropriate research. | 5 | Not counted for Assessment | 5 |
| **Total** |  |  | **100** |

1. **Table of Specification (TOS)**

**Mid-Term Exam**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  | | | | | **Level of Bloom’s Taxonomy** | | | | | | | | | | | | | | | | | |  |
| **Topics** | **CO No.** | **No. of Days** | **No. of Items** | **No. of COs** | **Remember** | | | **Understand** | | | **Apply** | | | **Analyze** | | | **Evaluate** | | | **Create** | | | **POI** |
| **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** |
| **Timers** | **CO1** | **1** | **1** |  |  |  |  |  |  |  | **1** | **PS** | **10** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Interrupt and debouncing (program +flowchart)** | **CO1** | **3** | **3** |  |  |  |  |  |  |  | **2** | **PS** | **5** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
|  |  |  |  |  |  |  | **2** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **3** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
| **Oscillator Setup** | **CO1** | **3** | **2** |  |  |  |  |  |  |  | **3** | **PS** | **5** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
|  |  |  |  |  |  |  | **4** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
| **Assembly language (program+flowchart)** | **CO1** | **3** | **3** |  |  |  |  |  |  |  | **4** | **PS** | **5** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
|  |  |  |  |  |  |  | **5** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **5** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
| **Total** |  | **7** | **9** |  |  |  |  |  |  |  |  |  | **50** |  |  |  |  |  |  |  |  |  |  |

**Final Exam**

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|  | | | | | **Level of Bloom’s Taxonomy** | | | | | | | | | | | | | | | | | |  |
| **Topics** | **CO No.** | **No. of Days** | **No. of Items** | **No. of COs** | **Remember** | | | **Understand** | | | **Apply** | | | **Analyze** | | | **Evaluate** | | | **Create** | | | **POI** |
| **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** | **Item No.** | **Test Type** | **Marks** |
| **Serial communication** | **CO1** | **1** | **1** |  |  |  |  |  |  |  | **1** | **PS** | **5** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
| **PWM** | **CO1** | **2** | **1** |  |  |  |  |  |  |  | **1** | **PS** | **5** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
| **Processor logic design** | **CO1** | **1** | **3** |  |  |  |  |  |  |  | **2** | **PS** | **10** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
|  |  |  |  |  |  |  | **3** | **PS** | **10** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **4** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
| **Control Logic design** | **CO1** | **2** | **3** |  |  |  |  |  |  |  | **4** | **PS** | **5** |  |  |  |  |  |  |  |  |  | **P.a.4.C3** |
|  |  |  |  |  |  |  | **5** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **5** | **PS** | **5** |  |  |  |  |  |  |  |  |  |
| **Total** |  | **6** | **8** |  |  |  |  |  |  |  |  |  | **50** |  |  |  |  |  |  |  |  |  |  |

***Test Type Legend****:* ***AS:*** *Assignment;* ***BQ****: Broad question;* ***SQ****: Short question;* ***D****: Derivation;* ***ES:*** *Essay;* ***EX:*** *Exercise;* ***GE:*** *Group Exercise;* ***ID:*** *Identification;* ***MC****: Multiple Choice;* ***MT****: Matching Type;* ***OB:*** *Observation;* ***PS****: Problem Solving;* ***SA****: Short Answer;* ***TF****: True or False;* ***VV:*** *Viva Voce;* ***Other please specify****:*

1. **Marks Distribution:**

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

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| **Assessment Type** | **Marking system For Theory Classes (Midterm and Final term)** | |
| Continuous | Attendance | 10% |
| Continuous | Assignment 1 | 10% |
| Continuous | Quiz | 20% |
| Continuous | Assignment 2 | 20% |
| Summative | Midterm/Final Exam | 40% |
|  | **Total** | 100% |
|  | **Final Grade/ Grand Total** | |
| Grand Total | Midterm: | 40% |
|  | Final Term: | 60% |

1. **Grading Policy**

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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) |

1. **Makeup Procedure:**

Students who fail to maintain the requirements and deadlines needed to contact faculty with reasoning. Continuous assessments will be taken in agreement with the student and faculty. For the make-up of the Summative assessment students need to apply for the SET – B exam according to the AIUB policy.

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| **PART D** |

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| **19. Learning Materials** |

Formal lectures will provide the theoretical base for the subject as well as cover 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 textbook. 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 lecture 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.

1. **Recommended Readings (Textbook);**
2. Jeremy Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry
3. Ytha Yu, Charles Marut-Assembly Language Programming Organization of the IBM PC (1992)
4. Barry B. Brey, “The Intel Microprocessors”, Fourth Edition, Prentice-Hall of India, ISBN 81-203-2158-8.
5. Ytha Yu, “Assembly Language Programming and Organization IBM Pc”
6. The ATMega328P datasheet
7. The STM32 F401RE datasheet
8. Morris Mano, “Microprocessors and Microcomputer based system design”
9. **Supplementary Readings (Reference Book);**
10. Douglas V. Hall, “Microprocessors and Interfacing – Programming and Hardware”, Second Edition, TATA McGRAW-HILL, ISBN 0-07-463639-1.
11. N Senthil Kumar, M Saravanan and S Jeevananthan, “Microprocessors and Microcontrollers”.

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| **PART E** |

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| Verification: **EEE 4103: Microprocessor and embedded system** | | |
| 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: …………………………. |

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| **Appendix A** |

**Table 1: Knowledge Profile** (according to BAETE Manual 2nd Edition)

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| 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** (according to BAETE Manual 2nd Edition)

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| **Attribute** | **Complex Engineering Problems** have characteristic P1 and some or all of P2 to P7: |
| Depth of knowledge required | P1: 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 |
| Range of conflicting requirements | P2: Involve wide-ranging or conflicting technical, engineering and other issues |
| Depth of analysis required | P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models |
| Familiarity of issues | P4: Involve infrequently encountered issues |
| Extent of applicable codes | P5: Are outside problems encompassed by standards and codes of practice for professional engineering |
| Extent of stakeholder  involvement and conflicting requirements | P6: Involve diverse groups of stakeholders with widely varying  needs |
| Interdependence | P7: Are high level problems including many component parts or sub-problems |

**Table 3: Range of Complex Engineering Activities** (according to BAETE Manual 2nd Edition)

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

### **Table 4: Learning Outcome Domains and Level Descriptors (as per BNQF)**

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| **Learning Outcome Domains** |
| **Fundamental Skills (FS):**  FS.1: demonstrate knowledge and critical understanding of the well-established principles of his/her field of study, and of the way in which those principles have developed;  FS.2: apply underlying concepts and principles outside the context in which they were first studied, including, where appropriate, the application of those principles in an employment context;  FS.3: apply knowledge and skills in addressing issues/solving problems with minimal supervision;  FS.4: evaluate critically the appropriateness of different approaches to solving problems in his/her field of study;  FS.5: support supervision of junior staff via a mentor or a leader/manager; and  FS6: display advanced digital literacy which is adequate to perform complex tasks and bring about solutions. |
| **Social Skills (SS):**  SS.1: communicate and interact effectively and clearly, ideas, information, problems and solutions as a team to peers, experts and non-experts in Bangla and English;  SS.2: express her/himself fluently and spontaneously in English and Bangla;  SS.3: use language flexibly and effectively for social, academic and professional purposes;  SS.4: produce clear, well structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices in advanced proficiency level of Bangla and English;  SS.5: demonstrate the ability to incorporate entrepreneurial skills in planning daily activities; and  SS.6: display advanced civic literacy and knowledge, exercising civic rights and obligations at all levels as well as participating in changes for the improvement of Bangladesh society. |
| **Thinking Skills (TS):**  TS.1: exercise very substantial degree of autonomy and often significant responsibility in making judgments/ decisions towards the management of self, others and for the allocation of substantial resources; and  TS.2: demonstrate professional knowledge and practical skills in both technical and management to lead a team in inexperienced environment. |
| **Personal Skills (PS):**  PS.1: engage in self-direction and self-enterprise skills;  PS.2: demonstrate social, professional, environmental and ethical practice/ values;  PS.3: show-case global knowledge and competencies to fulfil employment, entrepreneurial and lifelong learning skills; and  PS.4: contribute significantly to the society. |

Detail Program Outcomes

## **PO-a/PLO 1: 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.a.1.C3** | N/A | Apply information and concepts in *natural science* with the familiarity of issues. | Cognitive Level 3 (Applying) | 0.1 | EEE1203: Electrical Circuits – 1 (DC) | EEE3213: Electrical Properties of Material | K1 |  |  | Assignment |
| **P.a.2.C3** | N/A | Apply information and concepts of *mathematics* with the familiarity of issues. | Cognitive Level 3 (Applying) | 0.1 | EEE2209: Analog Electronics | EEE2213: Signals and Linear Systems | K2 |  |  | Assignment |
| **P.a.3.C3** | **FS.1** | Apply information and concepts in *engineering fundamentals* to solve complex engineering problems with a range of conflicting requirements. | Cognitive Level 3 (Applying) | 0.4 | EEE2105: Electrical Machines 1 | EEE3101: Digital Logic and Circuits | K3 | P1, P2, P6 |  | Assignment |
| **P.a.4.C3** | N/A | Apply information and concepts in *specialized engineering sciences* with the in-depth of analysis of a complex engineering problem. | Cognitive Level 3 (Applying) | 0.4 | EEE3105: Industrial Electronics and Drives | EEE4101: Modern Control Systems | K4 | P1, P3, P7 |  | Assignment |

## **PO-b/PLO 2: 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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| **P.b.1.C4** | N/A | Identify first principles of natural sciences and engineering sciences in practical applications. | Cognitive Level 4  (Analyze) | 0.1 | EEE2101: Electrical Circuits 2 (AC) | EEE2103: Electronic Devices | K1 |  |  | Assignment |
| **P.b.2.C4** | N/A | Formulate solutions, procedures, and methods using first principles of mathematics for engineering sciences. | Cognitive Level 4 (Analyzing) | 0.1 | EEE3101: Digital Signal Processing | EEE3107: Electromagnetics Fields and Waves | K2 |  |  | Assignment |
| **P.b.3.C4** | FS.3 | Analyze solutions for complex engineering problem reaching substantiated conclusion. | Cognitive Level 4 (Analyze) | 0.4 | EEE3211: Power Systems Analysis | EEE2207: Electrical Machines 2 | K3 | P1, P3, P7 |  | Assignment |
| **P.b.4.C4** | N/A | Research literature and analyze the validity and accuracy of existing solution for complex engineering problems. | Cognitive Level 4 (Analysis) | 0.4 | EEE2208: Electrical Machines 2 Lab | EEE4209: Telecommunications Engineering | K4 | P1, P2, P6 |  | Case Study |

## **PO-c/ PLO 3: 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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| **P.c.1.C4** | N/A | Design solutions for components of an engineering problem considering public health and safety. | Cognitive Level 4 (Analyzing) | 0.2 | BAE1201: Basic Mechanical Engineering | EEE2211: Electrical Power Transmission & Distribution | K5 |  |  | Assignment |
| **P.c.2.C6** | N/A | Develop process for complex engineering problems considering cultural and societal factors. | Cognitive Level 6 (Create) | 0.4 | EEE4000: Capstone Project | EEE2102: Electrical Circuits 2 (AC) Lab | K5 | P1, P3, P7 |  | Report |
| **P.c.3.C5** | N/A | Evaluate solutions that meet specified needs with appropriate environmental considerations. | Cognitive Level 5 (Evaluate) | 0.4 | EEE4211: Measurement and Instrumentation | EEE4213: Power Stations and Substations | K5 | P1, P2, P6 |  | Assignment |

## **PO-d/ PLO 4: 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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| **P.d.1.C5** | N/A | Investigate the design of experiments for complex engineering problem through appropriate research. | Cognitive Level 5 (Evaluating) | 0.4 | EEE4103: Microprocessor and Embedded System | EEE3215: Principles of Communication Lab | K8 | P1, P3, P7 |  | OEL lab/Project/Assignment |
| **P.d.2.C4** | N/A | Analysis and Interpretation of collected data to provide valid conclusion acknowledging the limitations. | Cognitive Level 4 (Analyzing) | 0.2 | EEE2104: Electronic Devices Lab | EEE3102: Digital Logic and Circuits Lab | K8 |  |  | OEL |
| **P.d.3.C5** | FS.2 | Investigate solution of complex engineering problem by synthesis of information to provide valid conclusions. | Cognitive Level 5 (Evaluating) | 0.4 | EEE2106: Electrical Machines 1 Lab | EEE4102: Modern Control Systems Lab | K8 | P1, P4, P5 |  | Project/OEL |

## **PO-e/PLO 5: 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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| **P.e.1.C6** | N/A | Select engineering tools and Apply appropriate techniques to solve complex engineering problems considering the limitations. | Cognitive Level 6  (Create) | 0.4 | BAE2101: Computer Aided Design and Drafting | EEE2210: Analog Electronics Lab | K6 | P1, P4, P5 |  | OEL/project |
| **P.e.2.P4** | N/A | Use tools for prediction and modeling of complex engineering problems considering the practice in electrical and electronic engineering discipline. | Psychomotor Level 4  (Articulation) | 0.3 | EEE4217: VLSI Circuit Design Lab | EEE4208: Electrical Services Design Lab |  | P1, P4, P5 |  | OEL/project |
| **P.e.3.P5** | FS.6 | Create relevant resources for complex engineering problems using modern engineering tools. | Psychomotor Level 5  (Naturalization) | 0.3 | EEE3101: Digital Signal Processing | EEE4217: VLSI Circuit Design Lab |  | P1, P3, P7 |  | OEL/project |

## **PO-f/ PLO 6: 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.f.1.A3** | PS.4 | Accepts and Recognize the role of  engineering in society, health, safety, legal and culture. | Affective Level 3  (Valuing) | 0.3 | EEE4208: Electrical Services Design Lab | BAE1201: Basic Mechanical Engineering |  |  |  | Project/Assignment |
| **P.f.2.C6** | FS.4 | Design solution for complex engineering problem in accordance with professional practices | Cognitive Level 6 (Create) | 0.7 | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project | K7 | P1, P3, P7 |  | Assignment/Report |

## **PO-g/PLO 7: 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.g.1.C5** | N/A | Evaluate sustainability of complex engineering problems considering society and environment. | Cognitive Level 5  (Evaluating) | 1.0 | EEE4213: Power Stations and Substations | EEE4000: Capstone Project | K7 | P1, P2, P6 |  | Report |

## **PO-h/ PLO 8: Ethics**

Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (K7)

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| **P.h.1.C3** | PS.2 | 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) | 0.3 | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project | K7 |  |  | Presentation/Report |
| **P.h.2.A4** | SS.6 | Demonstrates individual responsibilities based on norms of engineering practice. | Affective Level 4 (Organization) | 0.7 | EEE4001: Internship/ Seminar/ Workshop | EEE4000: Capstone Project |  |  |  | Report/Book |

## **PO-i/ PLO 9: 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.i.1.A3** | N/A | Function as effective team member in multi-disciplinary problems. | Affective Level 3 (Valuing) | 0.5 | EEE4000: Capstone Project | EEE4001: Internship/ Seminar/ Workshop |  |  |  | Peer Review Survey with rubrics and supervisor rubrics. |
| **P.i.2.A5** | FS.5 | Demonstrate individual skills as a leader in solving multi-disciplinary problems. | Affective Level 5 (Characterization) | 0.5 | EEE4102: Modern Control Systems Lab | EEE3110: Engineering Shop |  |  |  | OEL/Project |

## **PO-j/ PLO 10: 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.j.1.A2** | SS.1 | 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) | 0.4 | EEE4000: Capstone Project | EEE4211: Measurement and Instrumentation Lab |  |  | A1, A3, A5 | Viva/Presentation |
| **P.j.2.P3** | SS.4 | Produce written engineering reports by applying principle-based approaches and design documentation on complex engineering activities for different stakeholders. | Psychomotor Level 3  (Precision) | 0.25 | EEE4000: Capstone Project | EEE4209: Telecommunications Engineering Lab |  |  | A1, A4 | Report |
| **P.j.3.A4** | SS.2 | Make and deliver effective presentation based on complex engineering activities. | Affective Level 4 (Organizing) | 0.25 | BAS 1204: Bangladesh Studies | EEE3110: Engineering Shop |  |  | A1,  A2 | Presentation |
| **P.j.4.P5** | SS.3 | use language flexibly and effectively for social, academic and professional purposes | Psychomotor Level 5 (Naturalization) | 0.1 | EEE2215: Engineering Ethics and Environmental Protection | EEE4000: Capstone Project |  |  |  | Presentation/Report |

## **PO-k/ PLO 11: Project Management and Finance**

Demonstrate knowledge and understanding of engineering management principles and economic decision-making 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.k.1.P4** | TS.1 | Apply engineering management principles and economic decision making to solve engineering projects as a team. | Psychomotor Level 4 (Articulation) | 0.3 | EEE3106: Industrial Electronics and Drives Lab | EEE4000: Capstone Project |  |  |  | Project Report |
| **P.k.2.P4** | TS.2 | Manage multi-disciplinary components of a project as a member/leader. | Psychomotor Level 4 (Articulation) | 0.3 | EEE3110: Engineering Shop | EEE4000: Capstone Project |  |  |  | Project Report |
| **P.k.3.A5** | SS.5 | Demonstrate competency in completing individual engineering project based on relevant management principles and economic models. | Affective Level 5 (Characterization) | 0.4 | EEE4213: Power Stations and Substations | EEE4000: Capstone Project |  |  |  | Project Report |

## **PO-l/ PLO 12: 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** | **BNQF Indicator** | **Indicators Definition** | **Domain** | **W** | **Course 1** | **Course 2** | **K** | **P** | **A** | **Assessment Technique(s)** |
| **P.l.1.A1** | N/A | Investigate and gather information on a given engineering issue beyond classroom learning. | Affective Level 1 (Receiving) | 0.3 | EEE4209: Telecommunications Engineering | EEE4000: Capstone Project |  |  |  | Assignment/Report |
| **P.l.2.P5** | PS.1 | Seek and use resources in solving engineering problems. | Psychomotor Level 5 (Naturalization) | 0.4 | EEE4211: Measurement and Instrumentation Lab | EEE4000: Capstone Project |  |  |  | Report |
| **P.l.3.A5** | PS.3 | Recognizing the need for continuing education and participation in professional societies and meetings. | Affective Level 5 (Characterization) | 0.3 | EEE4000:  Capstone Project | EEE4001: Internship/ Seminar/ Workshop |  |  |  | **Report** |