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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 3101: Digital Logic and Circuits**  **II.** Credit  **3 credit hours (3 hours of theory per week)**  **III.** Nature  **Core Course for EEE**  **IV.** Prerequisite  **EEE 2103: Electronic Devices** |  | **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 core course of Electrical and Electronic Engineering & Computer Engineering program that presents basic tools for the design of digital circuits. It serves as a building block in many disciplines that utilize data of digital nature like digital control, data communication, digital computers etc.

This course is designed to:

Manipulate Boolean algebraic structures, Implement the Boolean Functions using NAND and NOR gates, Simplify the Boolean expressions using Karnaugh Map, Analyze and design various combinational logic circuits, Study of Storage Elements: Introduction to the behavior and structure of latches, flip-flops, and registers, Understand the importance of state diagram representation of sequential circuits, Study Sequential Circuits: Analyze and design clocked sequential circuits, Perform Timing Analysis: Introduction to timing analysis of combinational and sequential circuits. Special characteristics of Digital logic families and their comparative discussion. Definition and Problem solving on Fan out, Noise Margin, Propagation Delay, Power Dissipation, Duty Cycle and Speed Power Product. Diode Logic Gates. Basic Diode Transistor Logic Gates: RTL, DTL, Modified DTL and HTL with operational detail.

MOS and CMOS Logic with operational detail. Basic memory units and operations. Memory system: RAM Family. Memory System: ROM Family. Memory System: Flash Memory, Magnetic storage, USB Flash Drive, SSD hard drive. DSP basics: Sample and Hold circuits. Digital to Analog Conversion with application. Analog to Digital Conversion with application. Operation and Mathematical operation of 555 integrated timer circuit: Monostable, Astable multi-vibrator. Introduction to Programmable Logic Devices (PLDs): Advantages & disadvantages over discrete logic gates, Implementation of digital circuits using PLDs (using PAL and PLA).

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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** | Remember characteristics of various logic gates, techniques of simplification of expressions using Boolean algebra/ k-map, techniques of drawing logic gate circuits (both gate and transistor level), and special characteristics of logic families. | 1 |  |  |  |  |  |  | N/A |  |
| CO2 | Understand the applications of Boolean algebra simplification and apply appropriate techniques to design digital logic circuits (Combinational Logic Circuits like, adder, 2’s complement, magnitude comparator, encoder/ decoder, multiplexer/ demultiplexer) at gate level and transistor level (using RTL, DTL, TTL, CMOS), negative temperature co-efficient for MOSFET | 2 |  |  |  |  |  |  | N/A | 10+10  Quiz 3, Q4 |
| CO3 | Formulate solutions of a complex engineering problem with conflicting requirements by applying information, concepts and procedures in engineering fundamentals of digital logic and circuits at gate and transistor level. | **3** |  |  | **3** | **P1 P2**  **P6** |  |  | **P.a.3.C3** | **In Class**  **Assignment** |
| CO4 | Remember Logic Gate Diagrams, Truth-Table & Timing Diagrams for Latches & Flip-Flops, techniques of drawing timing diagrams of sequential logic circuits, concept of memory and memory devices, sampling, filtering and quantization. | 1 |  |  |  |  |  |  | N/A | 10  Final Q2 |
| CO5 | Understand applications of Flip-flops, methods of conversion of digital signals to analog signals and vice-versa and timer operation. | 2 |  |  |  |  |  |  | N/A |  |
| *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** | CO1 | Mission & Vision of AIUB, Dept. of EEE, Digital Logic Design meaning and objectives of this course  Binary Logic, Logic gates and their truth table  Boolean algebra, Simplification of logic function using Boolean Algebra, Implementing circuit from Boolean expressions  De-Morgan’s law  Universal gates and Implementation of Basic Combinational Logic Circuits using Universal Gates only | Lecture Tutorial | **\*Calculation-based question:**  **test/project/**  **mid-term exam**  **\*Theoretical-based question:**  **test/project/**  **mid-term exam** | **Quiz** |
| **Week 2** | CO1,  CO2 | Simplifying Boolean Expression using algebraic manipulation  Boolean expression in Sum of Product (SOP) and Product of Sum (POS) form, Canonical forms  Standardization of SOP/POS expressions and conversions between them  Simplifying Boolean Expressions using K – map | Lecture Tutorial |
| **Week 3** | CO1 | \*Adder: Half adder, Full adder, 2’s complement  \*Magnitude Comparators  \*Decoders, Encoders, Priority Encoders, Cascading of Decoders, Encoders | Lecture Tutorial | **Quiz** |
| **Week 4** | CO2 | \*Multiplexers, De-Multiplexer Boolean Function implementation using Multiplexers, Cascading of Multiplexers, De-Multiplexers | Lecture Tutorial |
| **Week 5** | CO1 | \*Introduction to Integrated Circuit (IC).  \*Special Characteristics of digital logic families  \*Diode Logic gates Basics of semiconductor memory  \* Logic Gates: using RTL, Solutions of RTL Logic family mathematical problems | Lecture Tutorial | **Quiz/**  **Assignment/Term Exam** |
| **Week 6** | CO1,  CO2 | \*Logic Gates: using DTL and Modified DTL.  \*Problem solving on Fan of DTL gate. and Modified DTL gate  \*Logic Gates: using HTL  \*MOS and CMOS logic with operation detail.  \*Negative temperature co-efficient  \*Design CMOS logic circuits from equation | Lecture Tutorial |
| **Week 7** | **MID-TERM EXAM WEEK** | | | | |
| **Week 8** | CO4 | \*Sequential Logic Circuit,  \*Different types of Flip – flop (S-R, J-K, D and T), Timing Diagram | Lecture Tutorial | **\*Calculation-based question:**  **test/project/**  **final exam**  **\*Theoretical-based question:**  **test/project/**  **final exam** |  |
| **Week 9** | CO4 | \*Counters: Asynchronous (Cascading and Modulus Counter) and Synchronous (Cascading)  [ State Diagram, Table, Equation]  \*Designing Irregular Counters using State Diagram and State Equation | Lecture Tutorial |
| **Week 10** | CO5 | Binary Up-Down counter [ State Diagram, Table, Equation]  \*Shift registers: Basic Shift Register Functions, Different types of Shift Registers  \*Shift register Counters: Johnson counter, Ring counter | Lecture Tutorial | **Quiz** |
| **Week 11** | CO4 | \*Memory Systems: read, write operations  \*RAM family, ROM family  Flash memory programming, read & erase operation. Magnetic Storage: Hard Disk Drive (HDD), SSD R-L transient: Storage cycle; Related Problems. | Lecture Tutorial |
| **Week 12** | CO4,  CO5 | \*Operation of 555 integrated timer circuit: Monostable, Astablemultivibrator  \*Introduction to Programmable Logic Devices (PLDs): Advantages and disadvantages of PLDs over discreet logic gates.  \*Classification of PLDs | Lecture Tutorial | **In Class Assignment** |
| **Week 13** | CO3,  CO4,  CO5 | \*Designing of combinational logic circuits using different types of PLD (PAL, PLA)  \* Digital Signal Processing Basics, Sample and Hold Circuits  \*Different types of A/D Converter with application  \*Different types D/A converter with application.  **Special In-Class Assignment for assessing P.a.3.C3** | 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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| **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 Theory Classes (Midterm)** | |
| Attendance | 10% |
| Midterm: Assignment (Not OBE) | 10% |
| Quiz (10 mcq) (best 2 out of 3) | 40% |
| Midterm: MCQ 20%+ Written20% | 40% |
| **Total** | 100% |

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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 Theory Classes (Final term)** | |
| Attendance | 10% |
| Final term: OBE assessed assignment | 30% |
| Quiz (10 mcq) (best 1out of 2) | 10% |
| Midterm: MCQ 15%+ Written15% | 30% |
| Project presentation + Viva (max. 4 members) | 20% |
| **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**

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| **Assessment Tools** | | **CO1 Marks** | **CO2 Marks** | **Marks for Grading** |
| Attendance and Performance | | Not counted for Assessment | Not counted for Assessment | 10 |
| Assignment | | 15 | 15 | 30 |
| Quiz 1 [10 marks] | Count Best  2 out of 4 | 10 | 10 | 20 |
| Quiz 2 [10 marks] |
| Mid-Term Assessment  MCQ + Written |  | Not Assessed | Not Assessed | 40 |
| **Total** | | **25** | **25** | **100** |

**COs Assessment System for Final-Term**

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| **Assessment Tools** | | **CO3**  **Marks** | **CO4**  **Marks** | **CO5**  **Marks** | **Marks for Grading** |
| Attendance and Performance | | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | 10 |
| Special In-Class Activity for assessing **P.a.3.C3** in any week of final term. | | 30 | Not counted for Assessment | Not counted for Assessment | 30 |
| Quiz 1 [10 marks] | Count Best 2 out of 4 | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment | 20 |
| Quiz 2 [10 marks] | Not counted for Assessment | Not counted for Assessment | Not counted for Assessment |
| Final Term Assessment  Presentation + VIVA |  | Not counted for Assessment | 20 | 20 | 40 |
| **Total** | | **30** | **20** | **20** | **100** |

**Mid-Term**:

**CO1 Marks: 25**

**CO2 Marks: 25**

**Final Term**:

**CO3 Marks: 30**

**CO4 Marks: 20**

**CO5 Marks: 20 Total P.a.3.C3 Marks from midterm and final term**: **30**

**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 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.

**XIV – Textbook/ References**

**Textbooks:**

1. Thomas L. Floyd, “Digital Fundamentals” 9th edition, Prentice Hall.
2. M. Morris Mano, “Digital Logic & Computer Design” Prentice Hall.

**References:**

1. Ronald J. Tocci & Neal S. Widmer, “Digital Systems” 7th edition, Prentice Hall.
2. Digital design – Karim and Johnson
3. Brian Holdsworth and Clive Woods, “Digital Logic Design”-Fourth Edition.
4. Stephen Brown and Zvonko Vranesic, “Fundamentals of Digital Logic with VHDL Design with CD-ROM”
5. William J. Dally and R. Curtis Harting, “Digital Design: A Systems Approach”
6. Victor P. Nelson, H. Troy Nagle, Bill D. Carroll and David Irwin, “Digital Logic Circuit Analysis and Design”
7. John P. Hayes, “Introduction to Digital Logic Design”
8. Norman Balabanian and Bradley Carlson, “Digital Logic Design Principles”
9. Enoch O. Hwang, “Digital Logic and Microprocessor Design with VHDL”

[10] Joseph Cavanagh, “Digital Computer Arithmetic: Design and Implementation (Computer Science)”

**XV - List of Faculties Conducting Theory**

1. **Mr. Dr. Md. Abdur Rahman**
2. **Mr. Nafiz Ahmed Chisty**
3. **Mr. Asif Mahfuz**
4. **Mr. Kawshik Shikder**
5. **Mr. Sujan Howlader**
6. **Ms. Tahseen Asma Meem**
7. **Mr. Abir Ahmed**
8. **Mr. Md. Shahariar Parvez**

**XVI – Verification:**

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| Prepared by:  Mr. Sujan Howlader  Assistant Professor, EEE  Course Coordinator  Date: …………………………. | Checked and certified by:  Prof. Dr. M. A. Mannan  Director, 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** (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 researchbased 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 |

**Program Outcomes** (according to BAETE Manual 2nd Edition)

**PO (a): Engineering Knowledge**

Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in KP1 to KP4 respectively to the solution of complex engineering problems

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| **Indicators ID** | **Indicators Definition** | **Domain** | **KP** | **CP** | **CA** |
| **P.a.1.C3** | Apply information and concepts in *natural science* with the familiarity of issues. | Cognitive Level 3 (Applying) | K1 |  |  |
| **P.a.2.C3** | Apply information and concepts of *mathematics* to solve complex engineering problems with a range of conflicting requirements. | Cognitive Level 3 (Applying) | K2 | CP1, CP2 |  |
| **P.a.3.C3** | Apply information and concepts in  *engineering fundamentals* with the familiarity of issues. | Cognitive  Level 3 (Applying) | K3 |  |  |
| **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) | K4 | CP1, CP3 |  |

**PO (b): Problem Analysis**

Identify, formulate, research literature and analyse 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** | **KP** | **CP** | **CA** |
| **P.b.1.C4** | Identify and relate first principles of mathematics, natural sciences and engineering sciences to solve complex engineering problems. | Cognitive Level  4  (Analyzing) | K1, K2, K3 | CP1, CP6 |  |
| **P.b.2.C4** | Formulate solutions, procedures,  and methods to solve complex engineering problems | Cognitive Level  4 (Analyzing)) |  | CP1,  CP4 |  |
| **P.b.3.C4** | Analyze and solves complex engineering problems reaching substantiated conclusion | Cognitive Level  4 (Analyzing) | K4 | CP1, CP2 |  |
| **P.b.4.C5** | Research literature and Critically evaluates the validity and accuracy of existing solution methods using specialized engineering knowledge. | Cognitive Level  5 (Evaluating) | K4 |  |  |

**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** | **KP** | **CP** | **CA** |
| **P.c.1.C2** | Identify the different components or processes of complex engineering problems. | Cognitive Level 2 (Understanding) |  | CP1, CP7 |  |
| **P.c.2.C3** | Develop solution for different components of complex engineering problem. | Cognitive Level 3 (Applying) |  | CP1, CP7 |  |
| **P.c.3.C4** | Develop probable solutions that meet specified needs with appropriate consideration for public health and safety, culture, societal and environmental considerations. | Cognitive Level 4 (Analyzing) | K5 |  |  |

**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** | **KP** | **CP** | **CA** |
| **P.d.1.P3** | Design Experiment to test complex engineering problem for certain constrains through appropriate research. | Psychomotor Level 3 (Precision) | K8 | CP1, CP2 |  |
| **P.d.2.C4** | Analysis and Interpretation  of collected data to provide valid conclusion acknowledging the limitations. | Cognitive Level  4 (Analyzing) |  |  |  |
| **P.d.3.C6** | Develop and Synthesis of  complex engineering problems using substantial engineering knowledge | Cognitive Level  6 (Creating) |  | CP1,  CP4 |  |

**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** | **KP** | **CP** | **CA** |
| **P.e.1.C3** | Select and Apply appropriate techniques to solve complex engineering problems using modern engineering tools considering the limitations. | Cognitive Level  3 (Applying) |  | CP1, CP2 |  |
| **P.e.2.P4** | Use engineering tools for prediction and modeling of complex engineering problems considering the practice in electrical and electronic engineering discipline. | Psychomotor Level 4 (Articulation) |  | CP1, CP5 |  |
| **P.e.3.P5** | Create relevant resources for complex engineering problems using modern engineering tools. | Psychomotor Level 5 (Naturalization) | K6 | CP1, CP7 |  |

**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** | **KP** | **CP** | **CA** |
| **P.f.1.A3** | Accepts and Recognize the role of  engineering in society, health,  safety, legal and culture. | Affective Level  3 (Valuing) |  |  |  |
| **P.f.2.C5** | Design solution for complex engineering problem in accordance with professional practices | Cognitive Level  5 (Evaluating) | K7 | CP1, CP3 |  |

**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** | **KP** | **CP** | **CA** |
| **P.g.1.C5** | Evaluate sustainability of complex engineering problems considering society and environment. | Cognitive Level  5  (Evaluating) | K7 | CP1, CP2 |  |
| **P.g.2.C5** | Identify impact on society and environment for professional engineering solutions. | Cognitive Level  5 (Evaluating) | 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** | **KP** | **CP** | **CA** |
| **P.h.1.A5** | Demonstrates knowledge of ethical standards (i.e. Code of Ethics) | Affective Level 5 (Characterization) |  |  |  |
| **P.h.2.A4** | Demonstrates individual responsibilities based on norms of engineering practice. | Affective Level 4 (Organization) | K7 |  |  |

**PO (i): Individual and Team work**

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** | **KP** | **CP** | **CA** |
| **P.i.1.A2** | Function as effective team leader/member in multi- disciplinary problems. | Affective Level 2 (Responding) |  |  |  |
| **P.i.2.A2** | Displays good interpersonal skills as a member/leader. | Affective Level 2 (Responding) |  |  |  |
| **P.i.3.A5** | Demonstrate individual skills in solving multi-disciplinary problems. | Affective Level 5 (Characterization) |  |  |  |

**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** | **KP** | **CP** | **CA** |
| **P.j.1.A2** | Demonstrates an ability to effectively give and respond to clear instructions. | Affective Level  2 (Responding) |  |  | CA1, CA3 |
| **P.j.2.P3** | Produces written engineering  reports by applying principle based approaches and design documentation on complex engineering activities for different stake holders. | Psychomotor  Level 3 (Precision) |  |  | CA1,  CA5 |
| **P.j.3.A2** | Perform effective oral presentation on complex engineering activities. | Affective Level  2 (Responding) |  |  | CA2, CA4 |

**PO (k): 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** | **Indicators Definition** | **Domain** | **KP** | **CP** | **CA** |
| **P.k.1.P4** | Apply engineering management principles and economic decision making to solve engineering projects as a team. | Psychomotor Level  4 (Articulation) |  |  |  |
| **P.k.2.P4** | Manage multi-disciplinary  projects as a member/leader. | Psychomotor Level  4 (Articulation) |  |  |  |
| **P.k.3.A5** | Demonstrate competency in completing individual engineering project based on relevant management principles and economic models. | Affective Level 5 (Characterization) |  |  |  |

**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** | **KP** | **CP** | **CA** |
| **P.l.1.A1** | Investigate and gather information on a given engineering issue. | Affective Level 1 (Receiving) |  |  |  |
| **P.l.2.A4** | Seek and use resources in solving engineering problems. | Affective Level 4 (Organization) |  |  |  |
| **P.l.3.A5** | Recognizing the need for  continuing education and participation in professional societies and meetings. | Affective Level 5  (Characterization) |  |  |  |