Bangladesh University of Business and Technology (BUBT)
Faculty of Engineering& Applied Sciences (FEAS)
Department of Computer Science and Engineering (CSE)

THEORY COURSE OUTLINE

1	**Program**	B.Sc. Engg. in CSE
2	**Course Code**	CSE 425
3	**Course Title**	Internet of Things
4	**Course Type**	Core Course
5	**Academic Session**	Summer 2021
6	**Credit Hour**	3.0
7	**Intake**	39
8	**Section**	2
9	**Pre-requisites**	Microprocessor and Microcontroller
10	**Campus**	Permanent Campus
11	**Course Teacher**	**Name:** Md. Hasibur Rahman | **Designation**: Lecturer **Specialization**: Machine Learning, Internet of Things **Room No. 503/B3** | **Email:** hasibur@bubt.edu.bd | **Cell No.** 01751362424
12	**Class Schedule**	Monday: 11:30 to 13:00, 805 (B-2) Thursday: 8:30 to 10:00, 910 (B-2)
13	**Counselling Schedule**	Monday: 10:30 to 11:30, 503 (B-3) Tuesday: 10:30 to 11:30, 503 (B-3)
14	**Course Objectives**	This course will build up student's ability to understand fundamental concepts of Internet of Things, techniques and tools for integrating hardware and software components in IoT systems. This course will emphasize different tools and techniques used in IoT and how to apply them as a solution of real life problem.
15	**Course Synopsis**	Definition and characteristics of IoT, M2M, Evolution and Challenges in IoT, IoT Network Architecture and Design, The IoT World Forum (IoTWF) Standardized Architecture, Simplified IoT Architecture, The Core IoT Functional Stack, Sensor Actuator, Micro-Electro-Mechanical Systems (MEMS), Smart Objects, Sensing Network, WSN, WMSN, RFID, Connecting Smart Objects, Communication Criteria, IoT Access Protocol: IEEE 802.15.4 (WPAN), IEEE 802.15.4g and 802.15.4e (LR-WPAN), IEEE 1901.2a (NB-PLC), IEEE 802.11ah (WiFi-HaLow), LoRaWAN, NB-IoT and Other LTE Variations, IP as the IoT Network Layer, Optimizing IP for IoT, 6LoWPAN and Routing, Application Protocols for IoT, CoAP, MQTT, Cloud Computing, Fog Computing, Edge Computing, The Hierarchy of Edge, Fog, and Cloud, Security in IoT, Data and Analytics for IoT, Smart Grid, Home Automation, Industrial IoT (IIoT).

16	**Text Book**	1. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – David Hanes 2. Internet of Things (A Hands-on Approach) - Vijay Madisetti and Arshdeep Bahga
17	**Reference Book**	1. From Machine-to-Machine to the Internet of Things – Jan Holler
18	**Course Outcomes (COs)**	CO1: **Understand** the concept of Internet of Things. CO2: **Explain** IoT architecture, functional blocks and different protocols used in Internet of Things. CO3: **Apply** the knowledge of IoT network architecture, IoT protocols and security in different layer of Internet of Things CO4: **Analyze** and design an IoT system to solve a real life problem.
	Mapping of COs to POs	

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	√											
CO2	√											
CO3			√									
CO4		√										

CO No.	PO No.	Bloom's Domain / Level	Delivery Methods / Activities	Assessment Tools
CO1	PO1	Cognitive / Understanding	Class Lecture	Midterm
CO2	PO1	Cognitive / Understanding	Class Lecture	Midterm and Final
CO3	PO3	Cognitive / Applying	Class Lecture	Midterm and Final
CO4	PO2	Cognitive/ Analyzing	Class Lecture	Final

19	**Teaching Strategy**	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. Multimedia projector and a PC will be used for the convenience of the students to understand codes practically. Students must participate in classroom discussions for case studies, problems solving and project developments.
20	**Assessment and Marks Distribution:**	

Class Participation	:	10%
Assignment/Presentation	:	10%
Class Test	:	10%
Midterm Examination	:	30%
Final Examination	:	40%

21 Lecture Plan (Weekly Schedule)

Week	Lecture	Topics	Chapter	CO	Assessment
1	1	Introduction to IoT: Definition and Characteristic of IoT, M2M, M2M Block Diagram.	DH: CH 1 AB: CH3	**CO1**	**Mid-Term Exam (30)**
	2	IoT vs M2M, Evolution of IoT, Challenges in IoT.	DH: CH1 & CH 2		
2	3	IoT Network Architecture and Design: The oneM2M IoT architecture, The IoT World Forum (IoTWF) Standardized Architecture	DH: CH 2	**CO1 & CO2**	
	4	IoT Network Architecture and Design: Layer 1: Physical Devices and Controllers Layer, Layer 2: Connectivity Layer, Layer 3: Edge Computing Layer	DH: CH 2		
3	5	IoT Network Architecture and Design: Upper Layers: Layers 4–7, IT and OT Responsibilities in the IoT Reference Model, Additional IoT Reference Models	DH: CH 2 **Class Test 1**	**CO2**	
	6	A Simplified IoT Architecture.	DH: CH 2	**CO3**	
4	7	The Core IoT Functional Stack: Layer 1, Layer2, Layer 3	DH: CH 2	**CO2**	
	8	Things in IoT: Sensor and Transducer	DH: CH 3	**CO2 & CO3**	
5	9	Things in IoT: Actuator, Micro-Electro-Mechanical Systems (MEMS), Smart Objects Definition, Trend in Smart Objects	DH: CH 3		
	10	Sensing Network: WSN, WMSN, Behave, challenges, protocol, and application I	DH: CH 3		
6	11	Sensing Network: RFID, Behave, challenges, protocol, and application II	DH: CH 3		
	12	Connecting Smart Objects: Communications Criteria	DH: CH 4		
7	13	IoT Access: IEEE 802.15.4 (WPAN), ZigBee, ZigBee IP	DH: CH 4		
	14	IoT Access: IEEE 802.15.4g and 802.15.4e (LR-WPAN), IEEE 1901.2a, IEEE 802.11ah (WiFi-HaLow)	DH: CH 4		
8		**Mid-term Examination**			
9	15	IoT Access: LoRaWAN, NB-IoT and Other LTE Variations, LTE Cat 0	DH: CH 4	**CO2 & CO3**	**Final Exam (40)**
	16	IP as the IoT Network Layer: The Business Case for IP: The Key Advantages of Internet Protocol, Adoption or Adaptation of the Internet Protocol. The Need for Optimization: Constrained Nodes, Constrained Networks, IP Versions.	DH: CH 5		
10	17	Optimizing IP for IoT: 6LoWPAN and Routing in 6LoWPAN	DH: CH 5		
	18	Application Protocols for IoT: MQTT	DH: CH 6 **Class Test 2**		
11	19	Application Protocols for IoT: CoAP	DH: CH 6	**CO2, CO3, & CO4**	
	20	IoT Data Management and Compute Stack: Cloud Computing	Notes Provide by CT		
12	21	IoT Data Management and Compute Stack: Fog Computing			
	22	IoT Data Management and Compute Stack: Edge Computing, The Hierarchy of Edge, Fog, and Cloud			
13	23	Industrial IoT (IIoT)		**CO2**	
	24	Security in IoT	DH: CH 8	**CO2**	
14	25	Data and Analytics for IoT	DH: CH 7	**CO2**	
	26	Smart Grid, Home Automation	Notes Provided by CT	**CO2**	
15		**Final Examination Week**			

22 Overall CO Assessment Criteria

Assessment methods of COs are given below:

Assessment Area	CO				Assessment Area Mark
	CO1	**CO2**	**CO3**	**CO4**	
Class Participation					
Assignment/Presentation					
Class Test					
Midterm Exam	10	10	10		30
Final Exam		10	15	15	40
Total Mark	**10**	**20**	**25**	**15**	**70**

23 Rubrics

COs (Bloom's Level)	**Excellent (80%-100%)**	**Good (70%-79%)**	**Satisfactory (60%-69%)**	**Poor (40%-59%)**	**Unsatisfactory (0-39%)**	**Marks (70)**
CO1 (Understanding)	Answer is complete and sufficient detail provided to support issues related to the question. And also deals fully with the entire question.	Answer is brief with sufficient detail provided to support issues were introduced. And most of the basic details are included but some are missing.	Answer is brief with insufficient detail provided to support issues were introduced.	Answer is incomplete and excessive discussion of unrelated issues. And serious gaps in the basic details.	None of the relevant details were included or didn't answer.	
CO2 (Understanding)	Answer is complete and sufficient detail provided to support issues related to the question. And also deals fully with the entire question.	Answer is brief with sufficient detail provided to support issues were introduced. And most of the basic details are included but some are missing.	Answer is brief with insufficient detail provided to support issues were introduced.	Answer is incomplete and excessive discussion of unrelated issues. And serious gaps in the basic details.	None of the relevant details were included or didn't answer.	
CO3 (Applying)	The question is answered appropriately by applying the suggested method in the question.	The question is answered briefly by applying the suggested method in the question.	The question is answered correctly by applying the suggested method in the question but some	The question is answered incompletely by applying the suggested method in the question	No attempt to implement the suggested method.	

					steps are missing.	but some steps are correct.		
		CO4 (Analyzing)	A clear, complete, and properly ordered chain of analyzing steps (i.e. proper explanation of the procedure) is followed to answer the question.	The chain of analyzing steps is complete and correctly ordered but lack of expected explanation.	One or more intermediate analyzing steps are missing or unclear, but the correctness of the analysis is not compromised.	One or more intermediate analyzing steps are missing or unclear to answer the question.	The stated chain of analysis does not lead to the stated question.	

24 Grading Policy

The following chart will be followed for grading. This has been customized from the guideline provided by the School of Engineering and Computer Science.

A+	A	A-	B+	B	B-	C+	C	D	F
≥ 80	75-<80	70-<75	65-<70	60-<65	55-<60	50-<55	45-<50	40-<45	<40

25 Additional Course Policies

Assignments	There will be at least two assignments. Average marks of the assignments will be counted. No late homework will be accepted. ***Any kind of copy/manipulation in assignment will carry zero mark.*** Two or more copied assignments will carry zero mark in all assignments. **Zero tolerance will be shown in this regard.** Solutions to assignment problems will be provided through web and on hand.
Class Test	There will be at least three class tests (CT).Best two of three or best three of four CTs will be counted. Both of regular and surprise CTs can be conducted.
Exams	CT, Mid-term and final exam will be closed book, closed notes. Mobile phone is strictly prohibited in exam hall. Students are insisted to carry their own watch and synchronize time during exam hours.
Test Policy	If a student is absent from class test anyway and made no report to the class teacher personally beforehand, his/her score for that test will be zero. No make-up for the class test will be allowed as 2 of 3 or 3 of 4 CTs are being considered. No make-up for Mid-exam will be entertained without physical presence and recommendation of the guardian along with written permission of the department. Make-up of Mid-exam may be much harder than the regular one.

26 Additional Information

a. Academic Calendar Summer 2021: http://www.bubt.edu.bd/academics/academic-calendar.
b. Academic Policies: http://www.bubt.edu.bd/academics/academic-rules-a-regulations.
c. Grading & Evaluation: http://www.bubt.edu.bd/academics/academic-rules-a-regulations.
d. Proctorial Rules: http://www.bubt.edu.bd/administrator/proctors-office.

27 Bloom's Taxonomy for Teaching-Learning

Bloom's Taxonomy is a set of three hierarchical models used to classify educational learning objectives into levels of complexity and specificity. The three lists cover the learning objectives in Cognitive, Affective and Psychomotor domains. The Cognitive domain list has been the primary focus of most education and is frequently used to structure curriculum learning objectives, assessments and activities. The three domains and respective levels are illustrated below.

Cognitive [C] (Knowledge-based)	**Affective [A]** (Emotion-based)	**Psychomotor [P]** (Action-based)
1. Remembering	1. Receiving	1. Imitating
2. Understanding	2. Responding	2. Manipulating
3. Applying	3. Valuing	3. Précising
4. Analyzing	4. Organizing	4. Articulating
5. Evaluating	5. Characterizing	5. Naturalizing
6. Creating	--- --- ---	--- --- ---

28 **Descriptions of Cognitive Domain (Anderson and Krathwohl's Taxonomy 2001):**

The **cognitive domain** involves the development of our mental skills and the acquisition of knowledge.

Level	Category	Meaning	Keywords
C1	Remembering	Recognizing or recalling knowledge from memory. Remembering is when memory is used to produce or retrieve definitions, facts, or lists, or to recite previously learned information.	Define, describe, draw, find, identify, label, list, match, name, quote, recall, recite, tell, write
C2	Understanding	Constructing meaning from different types of functions be they written or graphic messages or activities like interpreting, exemplifying, classifying, summarizing, inferring, comparing, or explaining.	Classify, compare, exemplify, conclude, demonstrate, discuss, explain, identify, illustrate, interpret, paraphrase, predict, report
C3	Applying	Carrying out or using a procedure through executing, or implementing. Applying relates to or refers to situations where learned material is used through products like models, presentations, interviews or simulations.	Apply, change, choose, compute, dramatize, implement, interview, prepare, produce, role play, select, show, transfer, use
C4	Analyzing	Breaking materials or concepts into parts, determining how the parts relate to one another or how they interrelate, or how the parts relate to an overall structure or purpose. Mental actions included in this function are differentiating, organizing, and attributing, as well as being able to distinguish between the components or parts. When one is analyzing, he/she can illustrate this mental function by creating spreadsheets, surveys, charts, or diagrams, or graphic representations.	Analyze, characterize, classify, compare, contrast, debate, deconstruct, deduce, differentiate, discriminate, distinguish, examine, organize, outline, relate, research, separate, structure
C5	Evaluating	Making judgments based on criteria and standards through checking and critiquing. Critiques, recommendations, and reports are some of the products that can be created to demonstrate the processes of evaluation.	Appraise, argue, assess, choose, conclude, critique, decide, evaluate, judge, justify, predict, prioritize, prove, rank, rate, select, Monitor
C6	Creating	Putting elements together to form a coherent or functional whole ;reorganizing elements into a new pattern or structure through generating, planning, or producing. Creating requires users to put parts together in a new way, or synthesize parts into something new and different creating a new form or product. This process is the most difficult mental function.	Construct, design, develop, generate, hypothesize, invent, plan, produce, compose, create, make, perform, plan, produce

29 Graduate Attributes (Program Outcomes) for B.Sc. in Engineering Program based on Washington Accord

Program Outcomes (POs) are narrower statements that describe what students are expected to know and be able to do by the Time of graduation. These relate to the knowledge skills and attitudes that students acquire while progressing through the program. The students of the B.Sc. in EEE program are expected to achieve the following graduate attributes or program outcomes at the time of graduation.

PO1–Engineering knowledge (Cognitive): Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2–Problem analysis (Cognitive): Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

PO3–Design/development of solutions (Cognitive, Affective): Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

PO4–Investigation (Cognitive, Psychomotor): Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

PO5–Modern tool usage (Psychomotor, Cognitive): Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6–The engineer and society (Affective): Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

PO7–Environment and sustainability (Affective, Cognitive): Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

PO8–Ethics (Affective): Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice.

PO9–Individual work and teamwork (Psychomotor, Affective): Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

PO10–Communication (Psychomotor, Affective): Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

PO11–Project management and finance (Cognitive, Psychomotor): Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments.

PO12–Life-long learning (Affective, Psychomotor): Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

30 Social & Moral Capital

Our promises are based on the three cardinal principles:

(a) What we do believe (b) What we do practice, and (c) What we will promote

However, students are advised to undertake the following commitments for moral development.

1. To be punctual and attentive in class
2. To maintain inclusive learning environment
3. To ensure mutual respect
4. To be cooperative in group learning.
5. To be innovative and Creative
6. To follow dress code and wearing ID card
7. To be always proactive
8. Try to follow and review day to day class
9. To avoid conspiracy
10. To prioritize honesty & faith
11. To be motivated for asking question and encourage feedback
12. To develop attitude for speaking in English
13. Do not ignore to carry out any assignments or commitments
14. To be clean and decent in all levels.
15. To be sincere for class preparation
16. Do not forget to switch-off the cell phone in class
17. Do not forget to carry course pack and learning stuffs in class
18. To maintain loyalty and trust to the university
19. Must avoid unfair means and plagiarism in

			exam, reports and assignments **20.** Must maintain eco-friendly environment in the campus.

Prepared by: **Checked by:** **Approved by:**