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 477
3	**Course Title**	Neural Network and Fuzzy Systems
4	**Course Type**	Core Course
5	**Academic Session**	Fall 2021-22
6	**Credit Hour**	3.0
7	**Intake**	39
8	**Section**	2
9	**Pre-requisites**	**CSE 351 Artificial Intelligence and Expert Systems**
10	**Campus**	Permanent Campus
11	**Course Teacher**	**Name:** T. M. Amir – Ul – Haque Bhuiyan; **Designation**: Assistant Professor **Specialization**: Artificial Intelligence (Machine Learning, Data Mining, Deep Learning, Computer Vision) IoT, Blockchain **Room No. 314/B-1**; **Email:** amir@bubt.edu.bd; **Cell No**. 01732-802625
12	**Class Schedule**	See table below
13	**Counselling Schedule**	See table below
14	**Course Objectives**	This course introduces the fundamental concepts of fuzzy logic and neural network based artificial intelligent systems with a specific focus on understanding of different state of the art neural network models and fuzzy systems. Emphasize would be provided to the state-of-the-art tools and techniques of neural networks that are required to solve real life problems.
15	**Course Synopsis**	Overview of artificial neural networks, applications of neural network; Different neuro-models and neural network architecture which includes perceptron, multilayer perceptron, backpropagation network etc.; gradient descent, activation function, cost function; Overview of deep neural network, different deep neural network models: convolutional neural network, recurrent neural network, long short term memory, gated recurrent unit, deep belief network, generative adversarial network etc.; Overview of set theory, fuzzy systems, applications of fuzzy system, crisp sets to fuzzy sets; Operations on fuzzy sets, fuzzy relations, fuzzy composition, fuzzy numbers, representing fuzzy numbers, fuzzy arithmetic operation using interval, fuzzy linguistic description, fuzzy inference and composition;

Class Schedule

Class Day	Class Hours	Class Room
Monday	3:00 PM – 4:00 PM	B2-808
Thursday	8:30 AM - 9:30 AM	B2-808

Counselling Schedule

Day	Office Hours	Room
Tuesday	12:00 PM – 2.00 PM	314(B-1)
Thursday	12:00 PM – 2.00 PM	314 (B-1)

16	**Text Book**	1. Intelligent Control Systems Using Soft Computing Methodologies; Editor: Ali Zilouchian, Mo Jamshidi [AM] 2. Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville [GBC]
17	**Reference Book**	1. Fuzzy and Neural Approaches in Engineering by Lefteri H. Tsoukalas, Robert E.Uhrig, Lotfi A. Zadeh [LR] 2. Hands-On Machine Learning with Scikit-Learn and TensorFlow by Aurélien Géron
18	**Course Outcomes (COs)**	Upon completing this course students will be able to: CO1: Understand the fundamental concepts of fuzzy systems and neural networks CO2: Explain the working procedure of different neural networks and related concepts CO3: Explain different fuzzy concepts that are being used in contemporary literature CO4: Apply, Analyze and Evaluate different state-of-the-art neural networks and fuzzy systems to formulate for real world problems.
	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	Interaction in Class
CO2	PO1	Cognitive / Understanding	Class Lecture	Class Test , Assignment, Midterm and Final
CO3	PO1	Cognitive / Understanding	Class Lecture	Class Test , Assignment, Midterm and Final
CO4	PO2	Cognitive/ Evaluate*	Class Lecture	Presentation, Final

***Higher level in Blooms Taxonomy is considered.**

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.. Students must participate in classroom discussions for case studies, problems solving and project developments.

20 Assessment and Marks Distribution:

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

21 Lecture Plan (Weekly Schedule)

Week	Lecture #	Selected Topics	Chapter #	COs	Assessment
1	1	Artificial Neural Network: Introduction of Artificial Neural Network, Biological neural network, Model of a neuron		CO1	
	2	ANN Features, Problem Domain and Application of ANN, Advantages of ANN, Activation functions, Adaline, Linear Separable Problems		CO1	
2	3	Perceptron: Introduction, Structure, Linear Classification by perceptron, Perceptron Learning Algorithm, Limitations		CO2	
	4	Multi-layer Perceptron: Architecture, I/O Mapping, XOR Realization.		CO2	
3	5	Supervised, Unsupervised Learning, Feedforward vs Feedback Networks, Loss Functions		CO1	
	6	Backpropagation Algorithm: Introduction, motivation, mathematical expression of gradient descent, Deriving the mathematical expression, training for multilayer and single layer neural network	**CT-1**	CO1 CO2	**Mid Term Exam 30**
4	7	Backpropagation: training for multilayer and single layer neural network		CO2	
	8	Introduction to Fuzzy Logic		CO1	
5	9	Fuzzy Arithmetic, Fuzzy Relations		CO1	
	10	Possibility Theory, Fuzzy Inference		CO1	
6	11	Fuzzy Logic in Databases		CO5	
	12	Fuzzy Decision Trees		CO3	
7	13	Medical Applications		CO1	
	14	***Troubleshooting Case Study, Review class for Semester Mid Term***			
8	**Midterm Examination**				
9	15	Radial Basis function Network,		CO2	**Final Exam**

	16	Self-Organizing Maps		CO2	40
10	17	Convolutional neural network: Introduction, motivation, applications of CNN, Architecture, Convolution layer construction	**CT-2**	CO2	
	18	Different types of optimizers, State-of-the-arts CNN		CO4	
11	19	Hopfield Network		CO2	
	20	Intro to Recurrent Neural Network: motivation, Architecture, applications of RNN		CO2 ,CO 4	
12	21	Intro to Long Short-Term Memory, Back Propagation in LSTM		CO2	
	22	Problem Solving with LSTM		CO 4	
13	23	Introduction to GAN, Problem Solving with GAN		CO2	
	24	Fuzzy Clustering		CO3	
14	25	Information Retrieval with Fuzzy Logic		CO4	
	26	Final Exam Review Class			
15	**Final Exam**				

22 Overall CO Assessment Criteria

Assessment methods of COs are given below:

Assessment Area	**CO**				**Assessment Area Mark**
	CO 1	**CO 2**	**CO3**	**CO 4**	
Class Participation					
Assignment/ Class Test					
Presentation					
Midterm Exam	10	10	10		30
Final Exam		10	10	20	40
Total Mark	10	20	20	20	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.	10

		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.	20
		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 steps are missing.	The question is answered incompletely by applying the suggested method in the question but some steps are correct.	No attempt to implement the suggested method.	20
		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.	20

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 Fall2021-22: https://www.bubt.edu.bd/Home/page_details/Academic_Calender 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:**

T. M. Amir – Ul – Haque Bhuiyan