North East University Bangladesh
Telihaor, Sheikghat, Sylhet, Bangladesh

School of Natural Science and Engineering

Outcome-based Curriculum of
B.Sc.(Engg.) in Computer Science and Engineering

Part – A
General Information

Department of Computer Science and Engineering
North East University Bangladesh
Outcome-based Curriculum for B.Sc.(Engg.) in CSE program

1. Vision of the University

North East University Bangladesh will have a transformative impact on society through continual innovation in education, research, creativity, and leadership with a view to remaining as a center of excellence in higher education both nationally and internationally.

2. Mission of the University

To achieve the vision, NEUB is working on the following missions:

M1	Provide cutting-edge, career-oriented academic programs in a supportive and stimulating environment, for the intellectual and ethical growth of a diverse student community, sensitivity to students, and to the spirit of society.
M2	Prepare graduates with physical facilities that manifest critical, creative, and effective communication skills along with well-versed value judgments.
M3	Practicing good governance and a strong educational foundation in mastering tomorrow's challenges by considering social norms and values and a strong association between university and industry.

3. Vision of the Department

To be the nation's preeminent research and teaching program in the field of computer science and engineering to create competent professionals with high morals to meet the national and global needs.

4. Mission of the Department

CSE department is working on the following missions:

M1	Provide quality learning experiences through effective classroom practices, active learning styles of teaching, and opportunities for meaningful interactions between students and faculty.
M2	Provide students with high-quality state-of-the-art education that enables them to contribute to the economic and well-being of humanity, observing the highest standards of ethics and effectiveness in the exercise of the computing profession.
M3	Conduct cutting-edge research in areas of national need, with the collaboration of other disciplines as well.

5. Program Name

B.Sc.(Engg.) in Computer Science and Engineering

6. Graduate Attributes

Graduate attributes are descriptions of knowledge, skills, and attitudes, which a university community intends its graduates will develop through their study to equip them for their future education or employment. Students graduating from the department of CSE, NEUB should have gained the following attributes:

a) Intellectual skills in Science and Engineering
b) Practical and problem-solving skills
c) Design and development skills
d) Numeracy and analytical skills
e) Skills on modern tool usage
f) Intellectual skills on environment and sustainability
g) Interpersonal, teamwork and leadership skills
h) Communication skills
i) Self-management & personal development skills
j) Entrepreneurship and innovation skills
k) Commitment to community, country, and humanity
l) Lifelong learning skill

7. Program Educational Objectives (PEOs)

The Department of Computer Science and Engineering forms the foundation for professional and personal development of the graduates that are expected within few years after graduation. The program educational objectives are to guide students to:

PEO1	Make them familiar with all the theoretical and practical knowledge about Computer Science and Engineering and related fields
PEO2	Make them skilled in addressing issues/solving problems with minimal supervision
PEO3	Develop skills to address realistic problems by analyzing, designing and implementing computing system using state-of-the-art tools
PEO4	Demonstrate social, professional, and environmental practice/values to ensure sustainable development
PEO5	Demonstrate professionalism, ethics, and ability to work in inter and multidisciplinary teams and to adapt to the latest trends and technology
PEO6	Manage engineering projects, and communicate and interact effectively, ideas, information, problems and solutions as a team to peers, experts and non-experts
PEO7	Involve themselves toward lifelong learning and the pursuit of post-graduation or any other professional education

8. Program learning Outcomes (PLOs)

After completion of graduation from Computer Science and Engineering, the graduates will be able to:

PLO1	**Engineering Knowledge**: Apply knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PLO2	**Problem Analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PLO3	**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
PLO4	**Investigation**: Investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis, and interpretation of experimental data, and synthesis of information to derive valid conclusions
PLO5	**Modern Tool Usage**: 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
PLO6	**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 solution to complex engineering problems
PLO7	**Environment and Sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development
PLO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice
PLO9	**Individual and Team Work**: Work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings
PLO10	**Communication**: Communicate effectively, orally as well as in writing, 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
PLO11	**Project Management**: Demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment
PLO12	**Lifelong Learning**: Recognize the importance of and pursue lifelong learning in the broader context of innovation and technological developments

9. Mapping missions with PEOs

Missions	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6	PEO7
M1	x			x		x	x
M2	x	x	x		x		x
M3		x	x		x	x	

10. Mapping PLOs with the PEOs

PLOs	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6	PEO7
PLO1	x						
PLO2		x					
PLO3			x				
PLO4			x				
PLO5			x				
PLO6				x			
PLO7				x			
PLO8					x		
PLO9					x		
PLO10						x	
PLO11						x	
PLO12							x

11. Mapping Courses with PLOs

Course Code	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CSE-06131111	x	x	x	x								
CSE-06131113	x	x	x		x						x	x
CSE-06131114		x	x		x							x
CSE-06131115	x	x	x	x							x	x
CSE-06131116	x	x	x	x	x				x		x	x
MAT-05411101	x	x	x	x		x	x					x
SSW-03141101		x						x				x
CSE-06131211	x	x	x									
CSE-06131212	x	x	x									
CSE-06131213	x	x	x	x							x	x
CSE-06131214	x	x	x	x	x				x		x	x
MAT-05411203	x	x	x	x								
PHY-05331201	x	x	x							x		x
ENG-02321201									x	x	x	

Course Code	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
SSW-03141202						x	x	x		x		
CSE-06132111	x	x	x	x						x		x
CSE-06132112	x	x	x	x	x		x		x	x	x	x
CSE-06132113	x	x	x	x	x					x		x
CSE-06132114	x	x	x	x	x			x	x	x		
CSE-06132115	x	x	x	x							x	x
CSE-06132116	x	x	x	x	x				x		x	x
STA-05422101	x	x	x	x	x							
BUS-04112101		x		x		x	x	x		x	x	x
CSE-06132211	x	x	x	x					x	x	x	
CSE-06132212		x	x						x	x	x	
CSE-06132213	x	x	x			x						x
CSE-06132214	x	x	x		x				x	x	x	
CSE-06132215	x	x	x	x		x	x					x
CSE-06132217	x	x	x	x								
CSE-06132218	x	x	x	x	x			x	x	x		
CSE-06132220	x	x	x	x	x	x	x	x	x	x	x	x
MAT-05412205	x	x	x									x
CSE-06133111	x	x	x	x	x			x				
CSE-06133112	x	x	x	x	x					x		
CSE-06133113	x	x	x	x								x
CSE-06133114	x	x	x	x	x				x	x	x	
CSE-06133115	x	x	x	x		x						x
CSE-06133116	x	x	x	x	x				x	x	x	x
CSE-06133117	x		x	x							x	x
CSE-06133118	x	x	x	x	x				x		x	x
CSE-06133119	x	x	x	x	x							
CSE-06133211	x	x	x	x		x	x					x
CSE-06133212	x	x	x		x				x	x	x	
CSE-06133213	x	x		x	x							x
CSE-06133214	x	x	x	x	x			x	x	x		
CSE-06133215	x	x	x		x							
CSE-06133216	x		x		x		x		x	x	x	
CSE-06133218				x	x					x		x
CSE-06133230	x	x	x	x	x	x	x	x	x	x	x	x
ECO-03113201		x				x	x	x	x	x	x	x
CSE-06134111	x	x	x	x								
CSE-06134112	x	x	x	x	x			x	x	x		
CSE-06134113	x	x	x	x								x

Course Code	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CSE-06134114	x	x	x	x	x				x		x	x
GED-02234101							x	x		x		x
CSE-06134140	x	x	x				x		x	x		x
CSE-06134142		x		x	x	x		x	x	x	x	x
CSE-06134211	x	x	x	x		x						x
CSE-06134212	x	x	x		x				x	x	x	
CSE-06134213	x	x	x	x								x
CSE-06134214	x	x			x				x			
CSE-06134260	x									x		
CSE-06134250	x	x	x				x		x	x		x
CSE-06134252		x		x	x	x		x	x	x	x	x
CSE-06134011	x	x	x	x	x							
CSE-06134012	x	x	x	x	x							
CSE-06134013	x	x	x	x	x	x						
CSE-06134014	x	x	x	x	x							
CSE-06134015	x		x	x	x							
CSE-06134016			x	x	x							
CSE-06134017	x	x	x	x	x							x
CSE-06134018	x	x	x	x	x			x	x	x		
CSE-06134021	x	x	x	x	x	x	x	x				
CSE-06134022			x		x				x	x	x	x
CSE-06134023	x	x	x	x								
CSE-06134024			x	x	x		x	x	x	x	x	x
CSE-06134025	x	x	x	x								
CSE-06134026					x				x	x	x	x
CSE-06134027	x	x	x	x		x	x					x
CSE-06134028	x	x	x		x				x	x	x	
CSE-06134033	x	x	x	x	x	x						
CSE-06134034					x	x	x			x	x	x
CSE-06134035		x	x		x	x	x					x
CSE-06134036					x	x	x					x
CSE-06134037	x	x	x									x
CSE-06134038	x	x	x	x	x				x		x	x

Part – B
Curriculum Summary

1. Structure of the Curriculum

a. Duration of the Program: Years: 4 Semester: 8

A student will be given 4 (four) extra semesters in addition to 8 (eight) semesters to complete his/her degree. However, his/her admission will be terminated if his/her remaining credits cannot be acquired in the allowed timeframe with the maximum allowable credits per semester.

b. Admission Requirements:

1. To get admitted to the B.Sc.(Engg.) in CSE program, a student must be from the science background in both SSC and HSC or equivalent examination with a minimum GPA of 3.00 in each of these examination.
2. A candidate who passed O-level exam must have taken at least five subjects and in A-level exam at least two subjects. Among these seven subjects in two exams, the candidate must obtain B grade or GPA 4.00 in four subjects and minimum C grade or GPA 3.5 in rest of the three subjects.
3. However, children of freedom fighters will be eligible for admission if they have an aggregate GPA of 5.0 in SSC and HSC combined.

Admission forms are available for Tk 500/= (Five Hundred only) from North East University Bangladesh Admission center. A complete application includes: (i) filled out application form; (ii) four passport size photographs; (iii) photocopies of certificates and mark sheets; Photographs should be attested by first class gazette officers or principal/Head of the department of the last academic institution. Completed application form must be submitted to the office of the Registrar.

c. Minimum credits requirements for graduation:

Minimum credit hour requirement for the award of bachelor's degree in Computer Science and Engineering is 156 credit hours.

d. Total class week in a year/semester:

There will be two semesters: Spring Semester (Jan-Jun) and Summer Semester (Jul-Dec) in an academic year. The duration of each semester comprises of 14 weeks of classes and 4 weeks for examinations.

e. Minimum CGPA requirements for graduation:

The minimum CGPA requirement for obtaining a bachelor's degree in Computer Science and Engineering is 2.00. A student may take additional courses with the consent of his/her academic adviser (as assigned by the department) to raise CGPA, but he/she may take a maximum of 30 such additional credits (maximum 10 distinct courses) in computer science and engineering beyond respective credit-hour requirements for bachelor's degree during his/her entire period

of study. A student can also retake maximum of 4 courses to improve his/her results if the grade point in that course is below or equal to 3.00.

f. Maximum academic years of completion:

A student must complete his/her studies within a maximum period of six years for engineering degree.

g. Category of courses:

Type of Courses	Course Code	Course Title	Credits
Core Courses	CSE-06131111	Discrete Mathematics	3.0
	CSE-06131113	Structured Programming Language	3.0
	CSE-06131114	Structured Programming Language Lab	1.5
	CSE-06131115	Basic Electrical Engineering	3.0
	CSE-06131116	Basic Electrical Engineering Lab	1.5
	CSE-06131211	Data Structures and Algorithms	3.0
	CSE-06131212	Data Structures and Algorithms Lab	1.5
	CSE-06131213	Electronic Devices and Circuits	3.0
	CSE-06131214	Electronic Devices and Circuits Lab	1.5
	CSE-06132111	Object Oriented Programming Language	3.0
	CSE-06132112	Object Oriented Programming Language Lab	1.5
	CSE-06132113	Algorithm Design and Analysis	3.0
	CSE-06132114	Algorithm Design and Analysis Lab	1.5
	CSE-06132115	Digital Logic Design	3.0
	CSE-06132116	Digital Logic Design Lab	1.5
	CSE-06132211	Introduction to Database Systems	3.0
	CSE-06132212	Introduction to Database Systems Lab	1.5
	CSE-06132213	Operating System	3.0
	CSE-06132214	Operating System Lab	1.5
	CSE-06132215	Theory of Computation	3.0
	CSE-06132217	Numerical Analysis	3.0
	CSE-06132218	Numerical Analysis Lab	1.5
	CSE-06133111	Computer Networks	3.0
	CSE-06133112	Computer Networks Lab	1.5
	CSE-06133113	Software Engineering and Design Patterns	3.0
	CSE-06133114	Software Engineering and Design Patterns Lab	1.5
	CSE-06133115	Artificial Intelligence	3.0
	CSE-06133116	Artificial Intelligence Lab	1.5
	CSE-06133117	Microprocessor and Interfacing	3.0

Type of Courses	Course Code	Course Title	Credits
	CSE-06133118	Microprocessor and Interfacing Lab	1.5
	CSE-06133119	Data Communication	3.0
	CSE-06133211	Introduction to Computer Security	3.0
	CSE-06133212	Introduction to Computer Security Lab	1.5
	CSE-06133213	Machine Learning	3.0
	CSE-06133214	Machine Learning Lab	1.5
	CSE-06133215	Computer Architecture	3.0
	CSE-06133216	Web Technologies	1.5
	CSE-06133218	Technical Writing and Research Methodology	1.5
	CSE-06134111	Software Testing and Management	3.0
	CSE-06134112	Software Testing and Management Lab	1.5
	CSE-06134113	Digital Signal Processing	3.0
	CSE-06134114	Digital Signal Processing Lab	1.5
	CSE-06134211	Computer Graphics	3.0
	CSE-06134212	Computer Graphics Lab	1.5
	CSE-06134213	Compiler Construction	3.0
	CSE-06134214	Compiler Construction Lab	1.5
	CSE-06134260	Viva Voce	2.0
		Total	**107**
General Education	MAT-05411101	Calculus	3.0
	SSW-03141101	History of the Emergence of Bangladesh	3.0
	MAT-05411203	Linear Algebra	3.0
	PHY-05331201	Fundamentals of Physics	3.0
	ENG-02321201	Advanced Functional English	3.0
	SSW-03141202	Bangladesh Studies	3.0
	STA-05422101	Basic Probability and Statistics	3.0
	BUS-04112101	Principles of Accounting	3.0
	MAT-05412205	Complex Variables, Laplace Transform and Fourier Series	3.0
	ECO-03113203	Principles of Economics	3.0
	GED-02234101	Engineering Ethics and Cyber Law	3.0
		Total	**33.0**
Elective	CSE-061340**	Elective I	3.0
	CSE-061340**	Elective I Lab	1.5
	CSE-061340**	Elective II	3.0
	CSE-061340**	Elective II Lab	1.5
		Total	**9.0**

Type of Courses	Course Code	Course Title	Credits
Thesis/Project	CSE-06132220	Project Work I	1.5
	CSE-06133230	Project Work II	1.5
	CSE-061341**	Thesis / Project I	2.0
	CSE-061342**	Thesis / Project II	2.0
		Total	**7.0**

Elective Courses

Course Code	Course Title	Credits
CSE-06134011	Advanced Algorithm and Data Structure	3.0
CSE-06134012	Advanced Algorithm and Data Structure Lab	1.5
CSE-06134013	Advanced Database Systems	3.0
CSE-06134014	Advanced Database Systems Lab	1.5
CSE-06134015	Digital Image Processing	3.0
CSE-06134016	Digital Image Processing Lab	1.5
CSE-06134017	Computer Vision	3.0
CSE-06134018	Computer Vision Lab	1.5
CSE-06134021	Natural Language Processing	3.0
CSE-06134022	Natural Language Processing Lab	1.5
CSE-06134023	Deep Learning	3.0
CSE-06134023	Deep Learning Lab	1.5
CSE-06134025	Reinforcement Learning	3.0
CSE-06134026	Reinforcement Learning Lab	1.5
CSE-06134027	Bioinformatics	3.0
CSE-06134028	Bioinformatics Lab	1.5
CSE-06134033	Cloud Computing	3.0
CSE-06134034	Cloud Computing Lab	1.5
CSE-06134035	Distributed and Parallel Computing	3.0
CSE-06134036	Distributed and Parallel Computing Lab	1.5
CSE-06134037	Mobile and Wireless Communication	3.0
CSE-06134038	Mobile and Wireless Communication Lab	1.5
CSE-06134041	Contemporary Course on Computer Science and Engineering – I	3.0
CSE-06134042	Contemporary Course on Computer Science and Engineering – I Lab	1.5
CSE-06134043	Contemporary Course on Computer Science and Engineering – II	3.0
CSE-06134044	Contemporary Course on Computer Science and Engineering – II Lab	1.5

Course Code	Course Title	Credits
CSE-06134045	Contemporary Course on Computer Science and Engineering – III	3.0
CSE-06134046	Contemporary Course on Computer Science and Engineering – III Lab	1.5
	Total	**63.0**

2. Year-wise course distribution:

Total Credits Required for Graduation: **156**
No. of Years: **4**
No. of Semesters: **08**

First Year: *Semester I*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06131111	Discrete Mathematics	3 + 0	3.0	
CSE-06131113	Structured Programming Language	3 + 0	3.0	
CSE-06131114	Structured Programming Language Lab	0 + 3	1.5	
CSE-06131115	Basic Electrical Engineering	3 + 0	3.0	
CSE-06131116	Basic Electrical Engineering Lab	0 + 3	1.5	
MAT-05411101	Calculus	3 + 0	3.0	
SSW-03141101	History of the Emergence of Bangladesh	3 + 0	3.0	
	Total		**18.0**	

First Year: *Semester II*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06131211	Data Structures and Algorithms	3 + 0	3.0	CSE-06131113
CSE-06131212	Data Structures and Algorithms Lab	0 + 3	1.5	
CSE-06131213	Electronic Devices and Circuits	3 + 0	3.0	CSE-06131115
CSE-06131214	Electronic Devices and Circuits	0 + 3	1.5	
MAT-05411203	Linear Algebra	3 + 0	3.0	
PHY-05331201	Fundamentals of Physics	3 + 0	3.0	
ENG-02321201	Advanced Functional English	3 + 0	3.0	
SSW-03141202	Bangladesh Studies	3 + 0	3.0	
	Total		**21.0**	

Second Year: *Semester I*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06132111	Object Oriented Programming Language	3 + 0	3.0	CSE-06131113
CSE-06132112	Object Oriented Programming Language Lab	0 + 3	1.5	
CSE-06132113	Algorithm Design and Analysis	3 + 0	3.0	CSE-06131211
CSE-06132114	Algorithm Design and Analysis Lab	0 + 3	1.5	
CSE-06132115	Digital Logic Design	3 + 0	3.0	
CSE-06132116	Digital Logic Design Lab	0 + 3	1.5	
STA-05422101	Basic Probability and Statistics	3 + 0	3.0	
BUS-04112101	Principles of Accounting	3 + 0	3.0	
	Total		**19.5**	

Second Year: *Semester II*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06132211	Introduction to Database Systems	3 + 0	3.0	
CSE-06132212	Introduction to Database Systems Lab	0 + 3	1.5	
CSE-06132213	Operating System	3 + 0	3.0	
CSE-06132214	Operating System Lab	0 + 3	1.5	
CSE-06132215	Theory of Computation	3 + 0	3.0	
CSE-06132217	Numerical Analysis	3 + 0	3.0	MAT-05411203
CSE-06132218	Numerical Analysis Lab	0 + 3	1.5	
CSE-06132220	Project Work I	0 + 3	1.5	CSE-06131113
MAT-05412205	Complex Variables, Laplace Transform and Fourier Series	3 + 0	3.0	
	Total		**21.0**	

Third Year: *Semester I*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06133111	Computer Networks	3 + 0	3.0	
CSE-06133112	Computer Networks Lab	0 + 3	1.5	
CSE-06133113	Software Engineering and Design Patterns	3 + 0	3.0	

CSE-06133114	Software Engineering and Design Patterns Lab	0 + 3	1.5	
CSE-06133115	Artificial Intelligence	3 + 0	3.0	CSE-06131211
CSE-06133116	Artificial Intelligence Lab	0 + 3	1.5	
CSE-06133117	Microprocessor and Interfacing	3 + 0	3.0	
CSE-06133118	Microprocessor and Interfacing Lab	0 + 3	1.5	
CSE-06133119	Data Communication	3 + 0	3.0	
	Total		**21.0**	

Third Year: *Semester II*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06133211	Introduction to Computer Security	3 + 0	3.0	
CSE-06133212	Introduction to Computer Security Lab	0 + 3	1.5	
CSE-06133213	Machine Learning	3 + 0	3.0	STA-05422101
CSE-06133214	Machine Learning	0 + 3	1.5	
CSE-06133215	Computer Architecture	3 + 0	3.0	
CSE-06133216	Web Technologies	0 + 3	1.5	
CSE-06133218	Technical Writing and Research Methodology	0 + 3	1.5	
CSE-06133230	Project Work II	0 + 3	1.5	CSE-06132220
ECO-03113203	Principles of Economics	3 + 0	3.0	
	Total		**19.5**	

Fourth Year: *Semester I*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06134111	Software Testing and Management	3 + 0	3.0	
CSE-06134112	Software Testing and Management Lab	0 + 3	1.5	
CSE-06134113	Digital Signal Processing	3 + 0	3.0	MAT-05412205
CSE-06134114	Digital Signal Processing Lab	0 + 3	1.5	
GED-02234101	Engineering Ethics and Cyber Law	3 + 0	3.0	
CSE-061340**	Elective I	3 + 0	3.0	
CSE-061340**	Elective I Lab	0 + 3	1.5	
CSE-061341**	Thesis / Project I	0 + 4	2.0	
	Total		**18.5**	

CSE-06134140	Thesis I	0 + 4	2.0	
CSE-06134142	Project I	0 + 4	2.0	

Fourth Year: *Semester II*				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06134211	Computer Graphics	3 + 0	3.0	MAT-05411203
CSE-06134212	Computer Graphics Lab	0 + 3	1.5	
CSE-06134213	Compiler Construction	3 + 0	3.0	
CSE-06134214	Compiler Construction Lab	0 + 3	1.5	
CSE-061340**	Elective II	3 + 0	3.0	
CSE-061340**	Elective II Lab	0 + 3	1.5	
CSE-061342**	Thesis / Project II	0 + 4	2.0	
CSE-06134260	Viva Voce	0 + 4	2.0	
	Total		**17.5**	
CSE-06134250	Thesis II	0 + 4	2.0	
CSE-06134252	Project II	0 + 4	2.0	

Elective Courses				
Course Code	**Course Title**	**Hrs/Week T + L**	**Credits**	**Pre-requisite**
CSE-06134011	Advanced Algorithm and Data Structure	3 + 0	3.0	CSE-06132113
CSE-06134012	Advanced Algorithm and Data Structure Lab	0 + 3	1.5	
CSE-06134013	Advanced Database Systems	3 + 0	3.0	CSE-06132211
CSE-06134014	Advanced Database Systems Lab	0 + 3	1.5	
CSE-06134015	Digital Image Processing	3 + 0	3.0	
CSE-06134016	Digital Image Processing Lab	0 + 3	1.5	
CSE-06134017	Computer Vision	3 + 0	3.0	
CSE-06134018	Computer Vision Lab	0 + 3	1.5	
CSE-06134021	Natural Language Processing	3 + 0	3.0	
CSE-06134022	Natural Language Processing Lab	0 + 3	1.5	
CSE-06134023	Deep Learning	3 + 0	3.0	CSE-06133213
CSE-06134023	Deep Learning Lab	0 + 3	1.5	
CSE-06134025	Reinforcement Learning	3 + 0	3.0	CSE-06133115
CSE-06134026	Reinforcement Learning Lab	0 + 3	1.5	

CSE-06134027	Bioinformatics	3 + 0	3.0	
CSE-06134028	Bioinformatics Lab	0 + 3	1.5	
CSE-06134033	Cloud Computing	3 + 0	3.0	
CSE-06134034	Cloud Computing Lab	0 + 3	1.5	
CSE-06134035	Distributed and Parallel Computing	3 + 0	3.0	
CSE-06134036	Distributed and Parallel Computing Lab	0 + 3	1.5	
CSE-06134037	Mobile and Wireless Communication	3 + 0	3.0	
CSE-06134038	Mobile and Wireless Communication Lab	0 + 3	1.5	
CSE-06134041	Contemporary Course on Computer Science and Engineering – I	3 + 0	3.0	
CSE-06134042	Contemporary Course on Computer Science and Engineering – I Lab	0 + 3	1.5	
CSE-06134043	Contemporary Course on Computer Science and Engineering – II	3 + 0	3.0	
CSE-06134044	Contemporary Course on Computer Science and Engineering – II Lab	0 + 3	1.5	
CSE-06134045	Contemporary Course on Computer Science and Engineering – III	3 + 0	3.0	
CSE-06134046	Contemporary Course on Computer Science and Engineering – III Lab	0 + 3	1.5	

Part – C
Detailed Curriculum

1st Year / 1st Semester

Course Code: CSE-06131111 **Course Title**: Discrete Mathematics
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
Discrete mathematics serves as a foundation for many areas of computer science. For example, an ability to create and understand a proof is important in virtually every area of computer science, including algorithms, formal specification, verification, databases, and cryptography. Graph theory concepts are used in networks, operating systems, and compilers. Set theory concepts are used in software engineering and in databases. Counting theory and probability theory is used in intelligent systems, networking, and several computing applications.

Course Learning Outcomes (CLOs):
On successful completion of this course, students will be able to:

CLO1	Use of mathematical and logical notation to define and formally reason about mathematical concepts such as sets, relations, and functions, and discrete structures like trees and graphs
CLO2	Use basic counting techniques to solve combinatorial problems and explain basic number theoretic concepts
CLO3	Express mathematical properties formally via the formal language of propositional logic and predicate logic
CLO4	Determine which type of proof is best for a given problem and apply various proof techniques correctly in the construction of a sound argument

Course Content:

SL No	Contents	Hrs	CLOs
1	**Sets**: Venn diagrams; union, intersection, complement operations; cartesian product; power sets; cardinality of finite sets. **Relations**: Reflexivity, symmetry, transitivity; Equivalence relations, partial orders. **Functions**: Surjections, injections, bijections; Inverses; Composition.	4	1
2	**Basic Logic**: propositional logic; logical connectives; truth tables; normal forms (conjunctive and disjunctive); validity of well-formed formula; propositional inference rules (modus ponens and modus tollens); predicated logic; universal and existential quantification; limitations of propositional and predicate logic (e.g., expressiveness issues).	9	3

3	**Proof Techniques**: notions of implication, equivalence, converse, inverse, contrapositive, negation, and contradiction; the structure of mathematical proofs; direct proofs; disproving by counterexample; proof by contradiction; induction over natural numbers; structural induction; weak and strong induction; recursive mathematical definitions; well orderings.	14	4
4	**Basics of Counting**: counting arguments (set cardinality and counting, sum and product rule, inclusion-exclusion principle, arithmetic, and geometric progressions); the pigeonhole principle; permutations and combinations (basic definitions, pascal's identity, the binomial theorem); solving recurrence relations; basic modular arithmetic.	7	2
5	**Number Theory:** divisibility and modular arithmetic; prime numbers; greatest common divisors and least common multiples; congruences.	3	2
6	**Graphs and Trees**: trees (properties, traversal strategies); undirected graphs; directed graphs; weighted graphs; spanning trees/forests; graph isomorphism.	5	1

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3	3	3									
CLO3	3	3	3									
CLO4	3	3	3	3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, MS
CLO2	CL, T, OR	CT, A, V, SF
CLO3	CL, T, OR, GD	CT, Q, A, V, MS
CLO4	CL, T, OR, GD	CT, Q, A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)
(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen

Course Code: CSE-06131113 **Course Title**: Structured Programming Language
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course is to provide a fundamental idea about the foundation concepts of programming and software code organization.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Understand the basic terminologies used in computer programming
CLO2	Demonstrate the fundamental principles and characteristics of a structured programming language
CLO3	Apply programming skills concerning program design and implementation
CLO4	Evaluate real-life problems using programming terminologies
CLO5	Develop confidence and ability to learn different programming languages on their own

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction to computer programming:** Programming Concepts, Program Development Stages, Structured Programming Language	2	1, 2
2	**Number System:** binary, octal, decimal, and hexadecimal systems	4	1
3	**Basic programming Structures:** Data types and their memory allocation, Operators, Expressions, Bitwise operations, Basic Input/output	4	1, 3
4	**Control Structure:** Flow charts, if-else, Loop, Nested Loop, switch	9	1,3
5	**Arrays:** One-dimensional array, multi-dimensional array, Character array/string	6	1, 3
6	**Function:** Function definition, Function declaration, Function call, Recursion, call by value, call by reference	4	1, 3
7	**Pointer:** Different types of pointers, Pass pointer as arguments	3	1, 3
8	**Dynamic Memory Allocation:** Malloc, Calloc, Realloc	2	1, 3
9	**User defined data types:** Structures, Unions, Enumerations	4	1, 3
10	**File I/O:** Read write append from files	2	1, 3
11	Header file and Preprocessors, Error Handling	2	1, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3											
CLO3		3	3		1							
CLO4											2	
CLO5												2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, A, MS, SF
CLO2	CL, T, OR	CT, A, MS, SF
CLO3	CL, T, OR, PrbL	CT, A, SF
CLO4	CL, T, OR, PrbL	CT, A, V, SF
CLO5	CL, OR, PrbL	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Schaum's Outline of Programming with C by Byron S. Gottfried
2. Teach Yourself C by Herbert Schidlt
3. Programming in Ansi C by E Balagurusamy
4. C: The Complete Reference by Herbert Schildt
5. C Programming Language by Dennis M. Ritche

Course Code: CSE- 06131114 **Course Title**: Structured Programming Language Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course is designed to practically introduce the fundamental concepts of computer programming and develop basic programming skills in designing and implementation.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Discuss algorithms and solve problems using computers
CLO2	Analyze the fundamental principles, typical characteristics and mechanisms of a structured programming language practically
CLO3	Apply practical knowledge to develop basic programming skills with respect to program design and development
CLO4	Learn different programming languages on their own

Course Content:

SL No	Content	Hrs	CLOs
1	**Practice basic programming structures**: data types, operators and expressions; basic Input/output functions, data type conversion	6	2
2	**Control Structure:** practice problems on if-else, loop, nested loop, switch	9	2, 3
3	**Arrays:** practice problems on one dimensional array, multi-dimensional array, character array/ string	5	2, 3
4	**Function:** practice problems on Function, Parameter Passing Convention	5	2, 3
5	**Recursion:** practice problems on recursion	3	2, 3
6	**Pointer:** practice problems on different types of pointers, pass pointer as argument	3	2, 3
7	**Dynamic Memory Allocation:** dynamically allocate memory using malloc, malloc, realloc	3	2, 3
8	**User defined data types:** practice problems on structures, unions, enumerations	5	2, 3
9	**File I/O:** read, write, append in file	3	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3	3									
CLO2		3										
CLO3			3		2							
CLO4					1							2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	LD, LP, GD, PrbL	A, LE, V
CLO2		
CLO3	LD, LP, PrbL	PP, LE, V
CLO4	CL, OR, PrbL	PP, A, V

(CL = Class Lecture, LD = Lab Demonstration, LP = Lab Practice, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(A = Assignment, V = Viva-voce, LE = Lab Examination, PP = Programming Problems)

Recommended Readings:

1. Schaum's Outline of Programming with C by Byron S. Gottfried
2. Teach Yourself C by Herbert Schidlt
3. Programming in Ansi C by E Balagurusamy
4. C: The Complete Reference by Herbert Schildt
5. C Programming Language by Dennis M. Ritche

Course Code: CSE-06131115 **Course Title**: Basic Electrical Engineering
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

This introductory course in Electrical Engineering is designed to introduce students to the world of Electrical Engineering, introducing simple electrical DC and AC circuits as well as the technical skills to facilitate necessary knowledge to analyze simple to complex circuits.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Recognize and understand the fundamental concepts used in Electrical Engineering
CLO2	Analyze different simple to complex electrical circuits (Both AC and DC)
CLO3	Apply concepts learnt for circuit analysis to different practical circuits including mains and electronic circuits
CLO4	Evaluate the best option for certain circuit analyzing tools for certain circuits
CLO5	Design electrical circuits based on requirements

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction to electrical engineering**: Units of measurements, circuit theory, circuit elements, independent and dependent sources, Voltage, current, power, energy, and electrical signals.	4.5	1
2	**Basic laws and rules in electrical circuits**: Ohm's law, KCL, KVL, Series resistance and VDR, Parallel resistors and CDR, and Wye-Delta Transformation.	6	1,2,4

3	**Techniques and theorems for circuit analysis**: Nodal analysis along with supernode, Mesh analysis along with supermesh, Linearity property, Superposition theorem, Source Transformation theorem, Thevenin's theorem, Norton's theorem, Maximum Power transfer theorem, and Reciprocity theorem.	9	1,2,4
4	**Analysis of circuits with non-linear elements**: Inductors and capacitors, series parallel combination of inductors and capacitors, Natural and Step responses of RL and RC circuits, RLC circuits.	9	1,2,4
5	**AC circuit analysis**: Sinusoidal functions, instantaneous current, voltage, power, effective current and voltage, average power, phasors and complex quantities, impedance, admittance, real and reactive power, power factor, and Analysis of single phase AC circuits using techniques used to solve DC circuits.	9	1,2,3,4
6	**Practical circuits**: Different practical circuits involving LDR, Thermistor, etc and their uses, Example of mains electricity wiring.	4.5	3,5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2		3										
CLO3		2										2
CLO4		3		2								
CLO5			3								2	1

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, GD, BL	CT, Q, A, MS, SF
CLO2	CL, T, GD, PrbL, BL	CT, Q, A, MS, SF
CLO3	CL, T, GD, PrbL, BL	CT, Q, A, MS, SF
CLO4	CL, T, OR, PrbL	A, P, V, MS, SF
CLO5	T, OR, PrbL	A, P, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Fundamentals of Electric circuit by Charles K. Alexander and Mathew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Electric Circuits by James W. Nilsson and Susan A. Riedel
4. Electrical and Electronic Principles and Technology by John Bird
5. Fundamental of Electrical and Electronic Principles by Christopher R Robertson

Course Code: CSE-06131116 **Course Title**: Basic Electrical Engineering Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This introductory lab course in Electrical Engineering is designed to introduce students to tools and equipment used in Electrical Engineering. In this course students will perform experiments to verify practically the theories and concepts learned in CSE-06131115.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	To familiarize with the operation of different electrical instruments
CLO2	Experimentally verify different theories learnt in theory
CLO3	Understand the connection of basic electrical element like fan, bulb, calling bell etc.
CLO4	Design circuits for practical usage as part group project

Course Content:

SL No	Contents	Hrs	CLOs
1	Familiarization of electrical lab equipment	3	1
2	Verify the following theorems: KCL and KVL theorem, Superposition theorem, Thevenin's theorem, Norton's theorem, and Maximum power transfer theorem	15	2
3	RL and RC circuits	6	3
4	Study the frequency response of an RLC circuit and find its resonant frequency.	3	2
5	Basic electrical element like fan, bulb, calling bell etc. connection from 220v AC single phase supply.	6	3
6	Lab project design, implementation, and submission.	9	4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3				3							2
CLO2		2		2	3							
CLO3	2											3
CLO4		3	3						2		3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	LD, LP	Q, V
CLO2	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO3	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO4	OR, GD, PrbL, PrjL	Prj, RW, P, V

(LD = Lab Demonstration, LP = Lab Practice, LExp = Lab Experiment, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, Prj,= Projects)

Recommended Readings:

1. Fundamentals of Electric circuit by Charles K. Alexander and Mathew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L. Boylestad

Course Code: MAT-05411101 **Course Title**: Calculus
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 1st /1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

The Calculus course focuses on the most critical foundations for math applications in science, engineering, and commerce. The course emphasizes calculus's fundamental ideas and historical motivation while balancing theory and application, resulting in mastery of crucial threshold concepts in foundational mathematics.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Demonstrate knowledge of basic pre-calculus concepts and skills
CLO2	Analyze and calculate the extreme values of functions and limits
CLO3	Determine the trend of change of a function concerning different independent variables
CLO4	Differentiate the techniques for evaluating indefinite and definite integrals

Course Content:

SL No	Contents	Hrs	CLOs
1	**Differential calculus:** Limit, Continuity and differentiability, Differentiation of explicit and implicit function and parametric equations, Significance of derivatives, Differentials, Successive differentiation of various types of functions. Leibnitz's theorem. Rolle's theorem. Mean value theorems. Taylor's theorem in finite and infinite forms. Maclaurin's theorem in finite forms.	21	1, 2, 3, 4

	Langrange's form of remainders. Caunchy's form of remainder. Expansion of functions by differentiation and integration. Partial differentiation, Euler's theorem, Tangent, Normal, Subtangent and subnormal in Cartesian and polar coordinates.		
2	**Integral calculus:** Definitions of integration, integration by method of substitution, Integration by part, Standard integrals, Integration by the methods of successive reduction, Definite integrals, Its properties and use in summing series, Wallis's formulae, Imptoper integrals, Beta function and Gamma functions, Area under a plane curve in catresian and polar co-ordinates, Area of the region enclosed by two curves in Cartesian and polar co-ordinates.	21	1, 2, 3, 4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2	2	3										
CLO3	3	2	2									
CLO4	2	3										

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, A, V, P, MS, FS
CLO2	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, FS
CLO3	CL, T, OR, PrbL, BL	CT, Q, A, V, P, MS, FS
CLO4	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, FS

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Das and Mukherjee: Differential Calculus.
2. Das and Mukherjee: Integral Calculus.
3. Calculus - Haward Anton (9th ed)- Stephen Davis, Wiley (2012).
4. Differential and Integral Calculus (5th ed)- Matin Chakraborty, Dhaka Standard Publication (2015).
5. A Text Book on Integral Calculus (4th ed)- Mohammad, Bhattacharjee & Latif, Dhaka (2010).

Course Code: SSW-03141101 **Course Title**: History of the Emergence of Bangladesh
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 1st /1st **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:
Bangladesh has a wonderful history, and this course is aimed to assist undergrad students in becoming acquainted with the rich history of Bangladesh and, as a result, understanding the present state of Bangladesh in the context of the past. Taking this course will enhance students' comprehension of the complex interconnections of historical events and will offer students with a grasp of the historical origins of Bangladesh as an independent state, among other benefits.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Recognize the areas of exploitation and oppression during the Pakistan regime
CLO2	Understand the inner significance of the emergence of Bangladesh as a nation
CLO3	Value the importance of language movement
CLO4	Apply critical skills to analyze importance of Six Point Program was crucial for the Birth
CLO5	Develop an understanding regarding the role of 7th March speech

Course Content:

SL No	Contents	Hrs	CLOs
1	**Partition of Bengal in 1947 and Rise of Nationalism:** Indian Nationalism-Muslim Nationalism-Partition of India and Bengal. Historical background, events, significance and its impacts. Initial differences between East Bengal and West Pakistan;	4.5	1, 6
2	**Peasant Movement of Bengal in 1946-47:** East Pakistan State Acquisition and Tenancy Act of 1950. Impacts of this Act Social Structure. Consequences of the act.	4.5	2
3	**The Language Movement 1952:** Background of Language Movement, Events of Language Movement, Impact of Language Movement.	4.5	2
4	**Movement for Autonomy:** Emergence of Political Parties, United Front, election of the Provincial Assembly of East Bengal, United Front ministries, Rise and development of Awami League, United Front Election and its Aftermath.	4.5	3
5	**Six Point Program and Backgrounds:** Constitution of Pakistan, 1956, Military Takeover, 1958, The Basic Democracies Order, 1959, Constitution of Pakistan, 1962., Education movement, 1962, 14-Point programme of National Awami Party, Six Points Movement.	4.5	3
6	**Mass upsurge of 1969:** Agartala conspiracy case, 11 points of the student, Legal Framework Order, Reactions of LFO, Election Manifesto, Election Result Non-Cooperation Movement, 7th March 1971, Importance of 7th March speech.	3	4

7	**Emergence of Bangladesh: Liberation War of 1971:** Operation searchlight, Military crackdown, Teliapara Documents, War Strategies, War Sectors, Training of Freedom Fighters	4.5	5
8	**Role of Major Countries:** Role of USA, USSR and China to the Liberation War of Bangladesh.	4.5	3
9	**11 Sectors in Liberation War:** The important aspects of 11 sectors of liberation war of Bangladesh.	4.5	3
10	**Constitution of Independent Bangladesh:** History of Bangladesh's Constitutional Development, Salient Features of Bangladesh Constitution, Major Amendments.	3	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1								2				3
CLO2												3
CLO3								3				3
CLO4		2						3				3
CLO5								3				3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, BL	CT, Q, A, V, P, MS, SF
CLO2	CL, T, OR, GD, BL	CT, Q, A, V, P, MS, SF
CLO3	CL, T, OR, GD, BL	CT, Q, A, V, P, MS, SF
CLO4	CL, T, OR, GD, BL	CT, Q, A, V, P, MS, SF
CLO5	CL, T, OR, GD, BL	CT, Q, A, V, P, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. History of Bangladesh by Sirajul Islam (ed).
2. Lonely Planet Bangladesh by R. Plunkett, A. Newton, and B. Wagenhauser.
3. Cambridge O Level- Bangladesh Studies (History, Culture, Environment and Development).
4. Changing Society in India, Pakistan and Bangladesh by N. Karim.
5. Social History of Bangladesh by Kumruddin.

1st Year 2nd Semester

Course Code: CSE-06131211 **Course Title**: Data Structures and Algorithms
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st/2nd **Course Type**: Core Course
Prerequisites: CSE-06131113: Structured Programming Language

Rationale of the Course:
This course is designed to provide a clear understanding of the essential properties of the data structures and related algorithms, to use these structures as tools to assist algorithm design, and to extend exposure to searching, sorting and hashing techniques.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Familiar with common data structures and the fundamental algorithms for manipulating these structures
CLO2	Choose among alternative data structures to solve specific data-representation and algorithmic problems
CLO3	Understand the use of complexity analysis to determine which data structure is most efficient and appropriate for use in a particular application
CLO4	Develop the ability to determine the computational complexity for algorithms related to data structures

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction:** Introduction to data structures and algorithms, array representation in memory, array mapping function	3	1
2	**Algorithm analysis:** asymptotic notation	3	1, 3,4
3	**Searching:** Linear search, Binary search	3	1, 2
4	**Sorting:** Insertion sort, Bubble sort, Quick sort	3	1, 2
5	**Linked list:** Single linked list, doubly linked list	6	1, 2
6	**FIFO-LIFO:** Stack, Queue	3	1, 2
7	**Graph Theory:** Introduction, classification of graph, representation of graph, breadth first search, depth first search, shortest path	9	1, 2
8	**Tree:** Classification of trees, tree traversal, Binary search tree, AVL tree, Huffman's algorithm	9	1, 2
9	**Hashing:** Hashing tables	3	1, 2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2		3	1									
CLO3	2	3	1									
CLO4	2	3										

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, MS
CLO2	CL, T, OR, GD	CT, Q, MS, SF
CLO3	CL, T, OR, GD	CT, A, MS, SF
CLO4		

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)
(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.
2. Advanced Data Structures by Peter Brass.
3. Data Structures by Seymour Lipschutz (Schaum's Outlines Series).

Course Code: CSE-06131212 **Course Title**: Data Structures and Algorithms Lab
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course is designed to provide a practical understanding of the essential properties of the data structures and related algorithms, and the ability to use these structures as tools to assist algorithm design and implementation.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Understand and implement common data structures and the fundamental algorithms for manipulating these structures
CLO2	Choose and apply among alternative data structures to solve specific data-representation and algorithmic problems
CLO3	Understand the use of complexity analysis to determine which data structure is most efficient and appropriate for use in a particular application

Course Content:

SL No	Content	Hrs	CLOs
1	Operations on static array	3	1, 2
2	Operations on dynamic array	3	1, 2
3	Linear and Binary search	3	1, 2
4	Single linked list	3	1, 2
5	Doubly linked list	6	1, 2
6	Stack representation by array and linked list	6	1, 2
7	Queue and circular queue	6	1, 2

8	Graph representation, Breadth first search, Depth first search	6	1, 2
9	Tree traversal, Binary search tree	6	1, 2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3	1									
CLO2	2	3	1									
CLO3	2	3										

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	LD, GD, OR	A, LE, V
CLO2	LD, GD, PrbL	
CLO3	LD, GD, OR, PrbL	

(LD = Lab Demonstration, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(A = Assignment, V = Viva-voce, LE = Lab Examination)

Recommended Readings:

1. Data Structures by Seymour Lipschutz (Schaum's Outlines Series).
2. Introduction to Algorithms by Thomas H. Cormen , Charles E. Leiserson.
3. Advanced Data Structures by Peter Brass.

Course Code: CSE-06131213 **Course Title**: Electronic Devices and Circuits
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 2nd **Course Type**: Core Course
Prerequisites: CSE-06131115: Basic Electrical Engineering

Rationale of the Course:
This course is designed to introduce students with knowledge about the concepts, principles and working of basic electronic components and their application in different circuits.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Identify the basic electronic devices such as Diode, BJT, JFET, MOSFET, Op-amp, and other special electronic devices
CLO2	Recognize, understand, and explain the fundamental concepts used to solve electronic circuits involving Diode, BJT, JFET, MOSFET, Op-Amp, etc. including the construction, working and characteristics
CLO3	Analyze different simple to complex Electronic Circuits involving Diode, BJT, JFET, MOSFET, Op-Amp, etc.

CLO4	Apply concepts learnt from this course to understand the working of different practical electronic circuits
CLO5	Design electronic circuits based on practical requirements

Course Content:

SL No	Contents	Hrs	CLOs
1	**P-N junction:** Intrinsic and extrinsic semiconductors, operational principle of p-n junction diode, contact potential, current-voltage characteristics of a diode.	3	1
2	**Diode circuits:** Diode Equivalent Circuits, Diode load line analysis, clamping and clipping circuits, half wave and full wave rectifiers, rectifiers with filter capacitor, characteristics of a Zener diode, Zener diode regulators, LEDs.	9	1,2,3
3	**Bipolar Junction Transistor (BJT):** BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch.	9	1,2,3
4	**Field Effect Transistor (FET)**: Structure and physical operation of JFET and MOSFET, threshold voltage, Body effect, current-voltage characteristics of JFET and MOSFET, biasing discrete and integrated FET amplifier circuits, single-stage FET amplifiers, JFET and MOSFET as a switch.	7.5	1,23
5	**Operational amplifiers (Op-Amp):** Properties of ideal Op-Amps, non-inverting and inverting amplifiers, inverting integrators, differentiator, weighted summer and other applications of Op-Amp circuits.	7.5	1,23
6	**Other Electronic Devices and circuits**: Introduction to photodiode, Laser, Solar cell, Photo detector, etc., analysis of practical circuits.	3	1,2,3,4
7	**Oscillators**: Characteristics, applications, and design of oscillator using different topology.	4.5	4,5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3											
CLO3		3										
CLO4		3		2								2
CLO5			2								2	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	CT, Q, V
CLO2	CL, T, OR, GD	CT, Q, A, MS, SF
CLO3	CL, T, OR, PrbL, GD	CT, Q, A, V, MS, SF
CLO4	CL, T, OR, PrbL, GD	CT, A, V, P, SF
CLO5	CL, T, OR, PrbL, GD	A, V, P, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashelsky
2. Fundamentals of Electric Circuits by Alexander
3. Electronic Devices and Circuit by David A. Bell
4. Electrical and Electronic Principles and Technology by John Bird
5. Fundamental of Electrical and Electronic Principles by Christopher R Robertson

Course Code: CSE-06131214 **Course Title**: Electronic Devices and Circuits Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

This course is designed to familiarize the students with electronic components and tools including hand-held tools and software tools necessary to analyze electronic circuits.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Experimentally understand the usage of different electronic devices like BJT, JFET, MOSFET, and Op-amp
CLO2	Investigate and analyze the working of different practical electronic circuits
CLO3	Design electronic circuits for practical usage as part group project

Course Content:

SL No	Contents	Hrs	CLOs

1	Study of V-I Characteristics curve of P-N junction diode and simple diode circuits	6	1,2
2	Study of Half-Wave and Full-Wave Rectification circuits	3	1,2
3	Study of Clipping and clamping circuits	3	1
4	Study of MOSFET and BJT characteristics	6	1
5	Application of BJT and MOSFET including amplification and switching	9	2
6	Different operational amplifier circuits	6	2
7	Lab project design, implementation, and submission.	9	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3				3							3
CLO2	3			3								2
CLO3		3	3						3		2	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO2	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO3	OR, GD, PrbL, PrjL	Prj, RW, P, V

(LD = Lab Demonstration, LP = Lab Practice, LExp = Lab Experiment, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, Prj,= Projects)

Recommended Readings:

1. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashelsky
2. Fundamentals of Electric Circuits by Alexander

Course Code: MAT-05411203 **Course Title**: Linear Algebra
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 2nd **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:

The aim of this course is to familiarize students with the elementary concepts of linear algebra, generally restricting to examples that relate to n-dimensional real-number space. The course provides foundational and pre-requisite knowledge for other computer science

courses, including artificial intelligence, machine learning, computer graphics, quantum computing, and so on.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Construct, or give examples of, mathematical expressions that involve vectors, matrices, and linear systems of linear equations
CLO2	Solve systems of linear equations using multiple methods
CLO3	Determine if a set of vectors is a vector space, a subspace, or a basis for a vector space
CLO4	Describe fundamental concepts of linear maps, including isomorphisms, range and null-space, matrices, change of bases and projections
CLO5	Use visualization, spatial reasoning, as well as geometric properties and strategies to model, solve problems, and view solutions, especially in two- and three-dimensional real numbers, as well as conceptually extend these results to higher dimensions
CLO6	Compute eigenvalues and eigenvectors and determine if a matrix is diagonalizable

Course Content:

SL No	Contents	Hrs	CLOs
1	**Vectors, matrices, and their operations**: vectors and linear combination; length, angle, unit vector and dot product; matrix operations: addition, multiplication, transpose, determinants	6	1
2	**Linear systems**: solving linear systems: Gauss's method, reduced echelon form; elimination using matrices; inverse matrices; factorization	8	1, 2
3	**Vector space**: basic definitions; subspace; span, independence, basis, dimension	10	3, 5
4	**Maps between spaces**: isomorphism; homomorphism; computing linear maps; change of basis; orthogonality; projections	10	4, 5
5	**Diagonalization**: eigenvalues and eigenvectors; diagonalization of a square matrix; inner products, orthogonality, orthogonal diagonalization; Applications of diagonalization	8	5, 6

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3	3									
CLO2		3	3	3								
CLO3		3										

CLO4		3										
CLO5	3	3	3	3								
CLO6		3	3	3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, Q, V
CLO2	CL, T, OR, PrbL	CT, A, MS
CLO3	CL, T, OR	CT, Q, V, MS
CLO4	CL, T, OR, GD, PrbL	CT, Q, A, V, SF
CLO5	CL, T, OR, PrbL, BL	CT, Q, V, P, SF
CLO6	CL, T, OR, BL	CT, A, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Introduction to Linear Algebra – Gilbert Strang
2. Linear Algebra Done Right – Sheldon Axler
3. Linear Algebra - Jim Hefferon
4. Introduction to Applied Linear Algebra - Stephen Boyd, Lieven Vandenberghe

Course Code: PHY-05331201 **Course Title**: Fundamentals of Physics
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 2nd **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:

This introductory course in physics is designed to impart students with the knowledge of basic physics in different fields of physics including mechanics, waves, oscillation, optics, thermodynamics, and electromagnetism**.** The course will emphasize on the basic concepts, theories, and application to solve quantitative problems which can be applicable in a wide spectrum of engineering disciplines.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Recognize, understand, and explain the fundamental concepts of physics including mechanics, waves, oscillation, optics, thermodynamics, and electromagnetism
CLO2	Solve different quantitative problems in the field of physics including mechanics, waves, oscillation, optics, thermodynamics, and electromagnetism

CLO3	Develop communication skills by presenting different topic related to mechanics, waves, oscillation, optics, thermodynamics, and electromagnetism

Course Content:

SL No	Contents	Hrs	CLOs
1	**Mechanics**: Motion in two dimensions, projectile motion, Newton's laws of motion, conservation of momentum and energy, collisions; circular motion, rotational dynamics of rigid bodies, central forces and gravitation, Kepler's laws.	9	1,2,3
2	**Waves and Oscillations**: Introduction to waves, properties of waves, simple harmonic motion (shm), damped and forced vibrations, waves in elastic media, energy of bodies in shm, resonance, damping, standing waves, sound waves, Doppler effect.	9	1,2,3
3	**Optics**: Nature and propagation of light, interference of light, Young's experiment, Newton's ring. Fraunhofer and Fresnel diffraction, diffraction grating. Polarisation of light, optical activity, polarimetry.	6	1,2,3
4	**Thermodynamics**: Principles of thermometry, measurement of high and low temperature, zeroeth law of thermodynamics, kinetic theory of ideal gas, first and second laws of thermodynamics, entropy, black body radiation. Wein's law, Planck's law.	9	1,2,3
5	**Electromagnetism**: Different electrical units, Coulomb's law, electric field, electric potential and potential energy, capacitance, energy storage in an electric field. magnetic field and field strength, magnetic forces on a current, torque on a current loop, Hall effect. Faraday's Law of induction, Lenz's Law, time-varying magnetic field, inductance, energy in magnetic field. Maxwell's equations, EM energy, Poynting Vector, Scalar and vector potentials, the wave equations. Plane EM waves in non-conducting media, waves in conducting media, boundary conditions, reflection and refraction at boundaries of two non-conducting media, total internal reflections.	9	1,2,3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2		3	2									2
CLO3										3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	CT, Q, A, V, MS, SF
CLO2	CL, T, OR, GD, PrbL	CT, Q, A, V, MS, SF
CLO3	T, OR, GD	P, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. The Feynman Lectures on Physics
2. University Physics (Vol 1, 2, 3) by Openstax
3. Physics (Vol. I and Vol II) by Halliday, D. and Resnick, R.

Course Code: ENG-02321201 **Course Title**: Advanced Functional English
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 1st / 1st **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:

This course provides the students with a fundamental idea about academic learning of the four skills of English language by engaging them in listening, speaking, reading, and writing activities. This also includes grammar learning to use them in the four skills.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Achieve the accuracy of grammar to use in the four skills.
CLO2	Apply the listening skill to relate and analyse different ideas effectively.
CLO3	Distinguish between different sound systems and tones of English language world-wide.
CLO4	Apply fruitful presentation skills and operate with communicative competence for professional purposes.
CLO5	Design formal and academic writings, documentation, and reports, etc.
CLO6	Demonstrate the ability to acquire knowledge and interrelate with different compositions in research areas.

Course Content:

- Main verbs / auxiliary verbs
- Tense and its structure
- Modals and modal related patterns
- Causatives / Conditionals
- Parts of speech
- Degrees of Adjectives
- Prepositions and Prepositional Idioms
- Agreement of Verbs
- Sentences and Clauses
- Word Choice / Vocabulary, Antonym, Synonym, Homonym, Homophone, Homograph
- Wh-words / Punctuation
- Reading Comprehensions
- Paragraphs and Compositions

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1									2	3		
CLO2									2	3		
CLO3									2	3		
CLO4									3	3	3	
CLO5									3	3	3	
CLO6									3	3	3	

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, MS, SF
CLO2	CL, OR, GD	CT, A, V
CLO3		
CLO4	CL, OR, GD	A, RW, P, V
CLO5		
CLO6		

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)
(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Barron's TOEFL
2. Cliff's TOEFL
3. Murphy, Raymond. Intermediate English Grammar

4. Thomson & Martinet. A Practical English Grammar

Course Code: SSW-03141202 **Course Title**: Bangladesh Studies
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 2nd / 1st **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:
This course is designed to introduce students with the knowledge on historical, socio-economic and political background of Bangladesh in order to encourage critical thinking, knowledge development and problem-solving ideas for contemporary Bangladesh society and culture. Moreover, this course also provides general idea of contemporary issues and problems in Bangladesh.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Obtain the idea on every aspect our rich culture.
CLO2	Describe the nature and pattern of Bangladesh society.
CLO3	Explain and evaluate the socio-economic, political, administrative and constitutional features of Bangladesh.
CLO4	Provide overall knowledge about socio economic prospects and potentiality of our nation.
CLO5	Generalize our Govt. system and adapt various social problems in the broad social spectrum and oblige the laws to be a good citizen.

Course Content:

Sl. No.	Course Content	Hours	CLOs
1	**Social Background of Bangladesh Society:** Ecological Context; Religion, Education, Culture and Ethnicity; Ethnic Groups of Bangladesh	4.5	3, 4
2	**Economy of Bangladesh:** Rural Economy; Urban Economy; Informal Economy; Migration and Bangladesh Economy.	4.5	4
3	**Culture:** Pattern of Religious Beliefs and Rituals in Bangladesh; Pattern of Social Change; Modernization and Counter- modernization, types, material and non-material culture, cultural lag.	4.5	1
4	**NGO and Development:** NGO, Types, Reason of growth, positive and negative aspects, evolution, contribution in development.	4.5	3

5	**Population, Ethnicity and Health:** Population Composition; Population Change, Theoretical Approaches; Changing Pattern of Health and Morbidity.	4.5	3
6	**Social Inequality, Social Stratification and Poverty:** Nature of Social Inequality in Bangladesh; Occupational Structure of Bangladesh; Poverty Trends.	3	2
7	**Urbanization:** Trends of Urbanization in Bangladesh; Problems and Issues of Urbanization- Urban Poor, Crime; Urban Planning.	4.5	3
8	**Migration:** Meaning, types, theories of migration, factors affecting migration, pros and cons.	4.5	3
9	**Major organ of Government:** Executive, judiciary and legislature, their role, functions and limitations.	4.5	5
10	**Governance and Good Governance:** Meaning of governance and good governance, elements of good governance, barriers to ensure good governance in Bangladesh.	3	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1						3	3	1		1		
CLO2						2	3	1				
CLO3						2	3					
CLO4						3	3					
CLO5						2	3					

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1		
CLO2		
CLO3		
CLO4		
CLO5		

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Haque, Mahmudul., Bangladesh: History, Politics, Economy, Society and Culture Essays in Honor of Professor Alamgir Muhammad Serajuddin, 2016, The University Press Limited (UPL)
2. Society and social structure of Bangladesh, Richard, T. Schaefer., Sociology, 2010, McGraw Hill Publications, Chapter five. pp 103--110 p, Chapter three p 53.
3. Culture and diversity of Bangladesh: Schaefer and Giddens, Sociology: chapters of Culture p 55
4. History of Bangladesh: 1905-2005, chapter one p 1-25 and chapter four p 187.

2nd Year / 1st Semester

Course Code: CSE-06132111 **Course Title**: Object Oriented Programming Language
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: **Course Type**: Core Course
Prerequisites: CSE-06131113: Structured Programming Language

Rationale of the Course:
Object Oriented Programming (OOP) paradigm is an essential concept for modern software development. This course will introduce how to design and implement objects and its various properties in Java language.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Understand object-oriented design and the principles of object-oriented programming
CLO2	Design class and apply OOP principles for real world scenarios.
CLO3	Deduce object-oriented solutions for small problems, involving multiple objects.
CLO4	Identify how to integrate robustness, reusability, and portability into large-scale software development.
CLO5	Develop the communication skill by presenting topics on Object Oriented Programming.

Course Content:

SL No	Content	Hrs	CLOs
1	**OOP Introduction:** Philosophy of Object Oriented Programming (OOP), Advantages of OOP over structured programming; OOP Principles. Assignment Operators, Increment and Decrement Operators, Primitive Data Types, Common Escape Sequence, Logical Operator.	3	1,2
2	**Introduction to class and objects:** classes and objects, access specifiers, static and non-static members; constructor.	4.5	1,2,3
3	**Encapsulation:** package, class member, public, private, protected, default	3	1,2,3

4	**Inheritance:** single and multiple inheritance; Polymorphism: overloading, abstract classes, virtual functions and overriding; Error Handling: Exception Handling;	3	1,2,3
5	**Introduction to polymorphism,** Dynamic method building, Final Methods and Classes, Abstract Superclasses and Concrete Classes.	1.5	1,2,3
6	**Control Structure**: Introduction with the 'for' structure, the 'switch' structure, the 'do/while' structure, the 'break' and 'continue' structure.	3	1,2,3
7	**Methods:** Introduction, Program Module in Java, Math Class Methods, Method Definitions, Java API Packages, Automatic Variables, Recursion, Method Overloading, Method of the Applet Class.	3	1,2,3
8	**Arrays:** Introduction, Arrays, Declaring and Allocating Arrays, Passing Arrays to Methods, Sorting Arrays, Searching Arrays, Multiple-Subscripted Arrays.	3	1,2,3
9	**Object Oriented I/O:** Object Oriented I/O ; Handling, Files and Stream	3	4,5
10	**Exception Handling**: Try-Catch-Finally, Throw, Throws	3	4,5
11	**Threads:** Multi-threaded Programming, Abstract Data Types.	3	4,5
12	Java Generics Java API, Utility Classes,	3	4,5
13	String and Characters, Graphics, 2D Graphics, GUI, Swing, Events.	3	4,5
14	Socket Programming in Java	3	4,5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2	3	3	3									
CLO3	3	3	3									
CLO4	3	3		3								
CLO5										3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	A, V, CT, MS
CLO2	CL,T	A, V, CT, MS
CLO3	CL,T	A, V, CT, MS
CLO4	CL,T,OR,GD	A, Q, CT, SF
CLO5	CL,T,OR,GD	A, Q, CT, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Java: The Complete Reference, Book by Herbert Schildt
2. Introduction to Programming in Java**,** Robert Sedgewick & Kevin Wayne.
3. An Introduction to Object-Oriented Programming, Timothy Budd.
4. Java-How to Program by Deitel & Deitel.

Course Code: CSE-06132112 **Course Title**: Object Oriented Programming Language Lab

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: **Course Type**: Core Course

Prerequisites: CSE-06131114: Structured Programming Language Lab

Rationale of the Course:

Object Oriented Programming (OOP) paradigm is an essential concept for modern software development. This course will introduce how to design and implement objects and its various properties in Java language.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Design object-oriented solutions for small systems problems, involving multiple objects.
CLO2	Demonstrate good programming style and discuss the impact of style on developing and maintaining programs.
CLO3	Implement programming practices and write modular codes with the help of OOP concepts.
CLO4	Write code, test, document and prepare a professional looking package for specified systems / problems

Course Content:

SL No	Content	Hrs	CLOs

1	**Object-Oriented Programming**: Classes and objects, Constructors and destructors, Encapsulation of class members and methods, manipulating objects	6	1,2
2	**Concept of Inheritance, Interface and Polymorphism:** Direct and indirect inheritance, Private and protected members of inherited class, Constructors and destructors under inheritance, Polymorphism, Abstract base classes.	6	1,2
3	**Exceptions:** Error handling in program, Creating own exception.	6	1,2
4	**Handing Files:** Input/output streams, Processing files, Random access files.	3	2,3
5	**Thread Programming:** Introduction to threads, Using threads to solve multi-tasking problems, Thread synchronization	6	2,3
6	**Java Generics**	6	3,4
7	**Graphical User Interface (GUI):** Basic user interface design using Java swing.	3	3,4
8	**Client-Server programming:** Introduction to Socket programming, Server, Client, Web socket, Web framework.	6	3,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2	2	3									2
CLO2		3		3								
CLO3			3		2							
CLO4										3	3	

(3= High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	V, LE, PP
CLO2	CL,T	V,LE, PP
CLO3	CL,PrbL, GD	V, RW, PD
CLO4	CL,PrjL,OR,GD	V, RW, PD

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. Java: The Complete Reference, Book by Herbert Schildt
2. Introduction to Programming in Java**,** Robert Sedgewick & Kevin Wayne.
3. An Introduction to Object-Oriented Programming, Timothy Budd.
4. Java-How to Program by Deitel & Deitel.

Course Code: CSE-06132113 **Course Title**: Algorithm Design and Analysis
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 2nd / 1st **Course Type**: Core Course
Prerequisites: CSE-06131211: Data Structures and Algorithms

Rationale of the Course:
The course introduces the basics of computational complexity analysis and various algorithm design paradigms. The goal is to provide students with solid foundations to deal with a wide variety of computational problems, and to provide a thorough knowledge of the most common algorithms and data structures.

Course Learning Outcomes (CLOs):
On successful completion of this course, students will be able to:

CLO1	Describe common algorithmic design techniques such as brute force, divide and conquer, greedy, and dynamic programming
CLO2	Derive and solve recurrences describing the performance of divide-and-conquer algorithms
CLO3	Associate a variety of real-world problems in computer science to appropriate forms of graphs and trees and explain major graph algorithms and their analysis
CLO4	Demonstrate simple inductive proofs and proofs by contradiction and assess program correctness and invariants
CLO5	Determine upper-, lower-, and tight-bounds on asymptotic time and space complexity of algorithms
CLO6	Analyze a computational problem and determine appropriate data structure and algorithmic approach to solve it
CLO7	Design solutions to small scale programming challenges using common algorithm design techniques

Course Content:

SL No	Contents	Hrs	CLOs
1	**Fundamental**: algorithmic problem formulation; search space of a combinatorial problem; brute-force solution.	2	1
2	**Incremental algorithms and analysis**: bubble sort; insertion sort; worst-, best-, average-case analysis; asymptotic bounds analysis.	6	1, 5
3	**Divide and conquer algorithms and analysis**: merge sort; quick sort; maximum subarray problem; worst case linear time order	12	1, 2, 4, 5, 6, 7

	statistics; recurrence design; solving recurrences using substitution method, recursion tree method, master method.		
4	**Graph basics**: graph representation; graph traversal: breadth first search traversal, depth first search traversal; topological sorting; connected components.	5	3, 5
5	**Dynamic programming**: elements of dynamic programming; rod cutting; matrix chain multiplication; longest common subsequence.	7	1, 2, 4, 5, 6, 7
6	**Greedy algorithms**: greedy choice property; activity selection problem; minimum spanning tree: Kruskal's and prim's algorithm.	3	1, 2, 3, 4, 5, 6, 7
7	**Shortest Path Algorithms**: dynamic and greedy properties; single-source shortest path: Dijkstra's algorithm, Bellman-ford algorithm; all-pair shortest path: Floyd-Warshall's algorithm, Johnson's algorithm	3	3, 4, 5, 6
8	**Network flow**: maximum flow, max-flow-min-cut, residual network, augmenting path, Ford-Fulkerson's method.	2	3, 4, 5, 6
9	**NP Hard** and **NP complete** problems.	2	6

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3	3	3									
CLO3	3	3	3	3								2
CLO4	3	3	3									
CLO5	3	3										
CLO6	3	3	3	3	3							3
CLO7	3	3	3	3	3					3		3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	CT, Q, V
CLO2	CL, T, OR, PrbL	CT, Q, A, V, MS
CLO3	CL, T	CT, Q, A, V, MS
CLO4	CL, T, OR, GD, PrbL	CT, Q, A, V, SF
CLO5	CL, T, PrbL	CT, Q, A, V, MS, SF
CLO6	CL, T, OR, GD, PrbL	A, P, MS, SF
CLO7	T, OR, GD, PrbL	A, P, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Introduction to Algorithms – Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein
2. Algorithm Design – Jon Kleinberg, Eva Tardos
3. Algorithms – Jeff Erickson
4. Algorithms – Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani

Course Code: CSE-06132114 **Course Title**: Algorithm Design and Analysis Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 2nd / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
The course is designed for practical implementations of common data structures and algorithms taught in the corresponding theory course – CSE-231. Students will design and implement algorithms directly from pseudocodes, as well as from problem statements new to them.

Course Learning Outcomes (CLOs):
On successful completion of this course, students will be able to:

CLO1	Implement algorithms from a known/given pseudocode, utilizing appropriate data structures
CLO2	Design and/or implement algorithms directly from a given problem statement (without needing any pseudocode)
CLO3	Apply changes and modifications in the existing data structures and algorithms to reduce the time and space complexity of any problem
CLO4	Implement bug-free and efficient codes against all algorithms
CLO5	Perform teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations

Course Content:

SL No	Contents	Hrs	CLOs
1	**Basic incremental and recursive algorithms**: linear and binary search; bubble sort; insertion sort.	6	1, 3, 4
2	**Divide and conquer algorithms**: merge sort, quick sort, and one or more other algorithms from the divide and conquer paradigm chosen by the course instructor.	12	1, 2, 3, 4, 5
3	**Basic graph theory**: representing graph using adjacency matrix and adjacency list; graph traversal using BFS and DFS algorithms.	6	1, 3, 4

4	**Dynamic programming algorithms**: rod cutting, matrix chain multiplication, and one or more other algorithms from the dynamic programming paradigm chosen by the course instructor.	12	1, 2, 3, 4, 5
5	**Greedy algorithms**: activity selection, and one or more other algorithms from the greedy algorithm paradigm chosen by the course instructor.	3-6	1, 2, 3, 4, 5
6	**Other graph algorithms**: instruction can choose to implement graph algorithms from minimum spanning tree, shortest path finding, or maximum flow problems. This section is optional.	3-6	1, 2, 3, 4, 5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3		3							
CLO2	3	3	3	3	3							
CLO3	3	3	3	3	3							
CLO4	3	3	3	3								
CLO5								3	3	3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, GD, PrbL	A, LE, PP
CLO3	CL, T, GD, PrbL	A, PP
CLO4	CL, T, OR, PrbL	A, PP
CLO5	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Introduction to Algorithms – Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein
2. Algorithm Design – Jon Kleinberg, Eva Tardos
3. Algorithms – Jeff Erickson
4. Algorithms – Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani

Course Code: CSE-06132115	**Course Title**: Digital Logic Design
Credit Value: 3.0	**Credit Hours**: 3 hours/week
Year/Semester: 2nd / 1st	**Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

This course is designed to enable students with the knowledge of working principle of digital circuits most commonly used in computer design. The knowledge spans from basic number systems to complex sequential circuits.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Remember and understand fundamental concepts of number system and Boolean algebra and basic properties of Boolean algebra to simplify simple Boolean functions
CLO2	Understand and apply different logic minimization techniques to simplify combinational and sequential circuits
CLO3	Recognize, understand, and explain the uses of basic digital devices such as gates, encoders, decoders, multiplexers, demultiplexers, flip-flops, latches, registers, counters. etc.
CLO4	Analyze different simple to complex digital combinational and sequential circuits
CLO5	Apply concepts learnt from this course to understand the working of different practical digital circuits
CLO6	Design digital logic circuits based on practical requirements

Course Content:

SL No	Contents	Hrs	CLOs
1	**Boolean and Logic gates**: Boolean algebra, De Morgan's Theorems, logic gates and their truth tables, canonical forms, combinational logic circuits, minimization techniques.	9	1, 2
2	**Combinational Circuits**: Arithmetic and data handling logic circuits, adder, subtractor, comparator, decoders and encoders, multiplexers and de-multiplexers, combinational circuit design.	12	2, 3, 4, 5, 6
3	**Sequential Circuits**: Latches, flip-flops, race around problems.	3	3, 4
4	**Counters**: Asynchronous counters, synchronous counters and their applications.	6	3, 4
5	**Memory**: Registers and basic memory unit; Logic Design: Synchronous and asynchronous logic design.	6	3, 4
6	**Design of sequential circuit**: State diagram; State minimizations and assignments.	6	2, 4, 5, 6

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3		2									
CLO3	3											
CLO4		3										
CLO5		3		2								2

CLO6			2								2	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, A, V, MS
CLO2	CL, T, OR, PrbL	CT, Q, A, V, MS
CLO3	CL, T, OR, PrbL	CT, Q, A, V, MS, SF
CLO4	CL, T, OR, PrbL	CT, Q, A, V, MS, SF
CLO5	CL, T, OR, PrbL	CT, Q, A, V, SF
CLO6	T, OR, GD, PrbL	A, P, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Digital Design by M. Morris Mano and Michael D. Ciletti
2. Digital Logic and Computer Design by M. Morris Mano
3. Digital Systems: Principles and Applications by Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss
4. Logic and Computer Design Fundamentals by M. Morris Mano and Charles Kime

Course Code: CSE-06132116 **Course Title**: Digital Logic Design Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 2nd / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

This course is designed to familiarize the students with digital logic blocks and tools including hand-held tools and software tools necessary to analyze digital logic circuits.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Experimentally understand the usage of different combinational and sequential digital circuits
CLO2	Investigate and analyze the working of different practical digital circuits
CLO3	Design digital circuits for practical usage as part group project

Course Content:

SL No	Contents	Hrs	CLOs
1	Study of logic gates: AND, OR, NOT. NAND, NOR, XOR, XNOR	3	1

2	Construction of OR and AND gate by diode resistors and observe its characteristics	3	1
3	Verification of different kind of applications of Boolean algebra	3	1,2
4	Verification of characteristics of XOR and XNOR using basic logic gate	3	1
5	Implementation of logic circuits using combination of gates	3	1,2
6	Simplification of Boolean function by using K-map and implementation with logic circuit	3	1
7	Design of ABCD to 7 Segment Decoder	3	1,2
8	Implementation of 4-bit BCD adder	3	1,2
9	Study of Asynchronous & Synchronous Flip-Flops	3	1
10	Design and study of binary Counters and registers	6	1,2
11	Lab project design, implementation, and submission.	9	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3				3							3
CLO2	3			3								2
CLO3		3	3						3		2	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO2	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO3	OR, GD, PrbL, PrjL	Prj, RW, P, V

(LD = Lab Demonstration, LP = Lab Practice, LExp = Lab Experiment, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, Prj,= Projects)

Recommended Readings:

1. Digital Design by M. Morris Mano and Michael D. Ciletti
2. Digital Systems : Principles and Applications by Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss

Course Code: STA-05422101 **Course Title**: Basic Probability and Statistics
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 2nd / 1st **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:

Probability theory deals with modeling uncertainty, which is now used as one of the primary methods for designing new algorithms for data analysis in computer science. This course, therefore, form the foundation for many other fields including artificial intelligence, data science, machine learning, noise modelling and mitigation etc.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Collect, organize, group and display data in tables and in graphs, analyze for shape and skewness and interpret different measures of central tendency, location, dispersion, and shape characteristics
CLO2	Explain probability as a model for uncertainty and apply common ideas from probability such as joint, conditional, marginal probability, independence, expectation, variance, covariance
CLO3	Apply common probability distributions to solve problems as appropriate
CLO4	Understand basic principles of statistical inference, both Bayesian and frequentist

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction to statistics**: population and sample; simple descriptive statistics – mean, median, and mode; quantile, percentile, and quartile; variance and standard deviation; interquartile range.	3	1
2	**Simple data visualization**: scatter plot; line plot; bar chart; histogram plot; stem-and-leaf plot; box-and-whisker plot.	3	1
3	**Introduction to probability**: experiments, outcomes, sample space, and events; axioms of probability; computing probability of events; combinatorics – equally likely events, permutation, and combination; conditional probability; independence; Bayes rule.	6	2
4	**Random variables and expectation**: random variables and distribution of random variables; joint, conditional, and marginal probability of random variables; expectation, variance, covariance, and correlation.	6	2
5	**Discrete probability distributions**: discrete uniform distribution; Bernoulli distribution; geometric distribution; binomial distribution; multinomial distribution; Dirichlet distribution; Poisson distribution.	6	3

6	**Continuous probability distributions**: continuous uniform distribution; beta distribution; gamma distribution; exponential distribution.	6	3
7	**The Gaussian distribution**: standard normal distribution and its mean, variance; multidimensional normal distribution and its mean, covariance; marginal and conditional Gaussians; the central limit theorem.	6	3
8	**Inferring probability models from data**: maximum likelihood estimation (MLE) – sufficient statistics, computation of MLE; confidence intervals; hypothesis testing (e.g., chi-square test, p-test, etc.); Bayesian inference – prior, likelihood, and posterior distribution, methods for choosing priors.	6	4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3	2		3							
CLO2		3										
CLO3		3		3								
CLO4	3	3	3	3	3							

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	CT, MS, Prj
CLO2	CL, T, PrbL	CT, Q, A, V, MS
CLO3	CL, T, OR, GD, PrbL	CT, A, SF
CLO4	CL, T, OR, GD, PrbL	CT, A, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final, Prj = Projects)

Recommended Readings:

1. Probability and Statistics for Engineering and the Sciences – Jay L. Devore
2. Probability and Statistics for Computer Scientists – Michael Baron
3. Probability and Statistics: the science of uncertainty – Michael J. Evans, Jeffrey S. Rosenthal

Course Code: BUS-04112101 **Course Title**: Principles of Accounting
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: 2nd /1st **Course Type**: General Education Course
Prerequisites:

Rationale of the Course:

The course provides students with a basic concept of accounting at a breadth. It is designed to provide students with a sound understanding of financial and managerial accounting procedures and an appreciation of its role in the society. The purpose of this course is to familiarize students with basic accounting principles as applied to partnership, corporate, and manufacturing concerns, with emphasis on the structure of corporate financial reporting and statements.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO 1	Describe, explain, and integrate fundamental concepts underlying accounting, finance, management, marketing, and economics.
CLO 2	Use information to support business processes and practices, such as problem analysis and decision making.
CLO 3	Apply quantitative skills to help analyze and solve business problems and to take advantage of business opportunities.
CLO 4	Understand and explain the ethical and social responsibilities of accountants in ensuring the integrity of financial information.
CLO 5	Develop an understanding of internal control issues and the effects of the regulatory environment on financial reporting by applying communication skills.
CLO 6	Apply knowledge of generally accepted accounting principles (GAAP) and managerial accounting theories to business organizations.

Course Content:

SL No	Content	Hrs	CLOs
1	**Introducing Accounting in Business:** Introduction, Definition of accounting, Roles and functions, Images of accounting, Users of accounting information, History of accounting, The Buildings Blocks of Accounting & Conceptual Framework- Ethical Issues, GAAP, Assumptions, Principles, Constraints, Using the Building Blocks, Financial Statement, The Accounting Profession.	4.5	1,6
2	**The Recording Process of Transactions:** Introduction, Definition of Account, Debits and Credits, Double Entry Systems, Basic Accounting Equation, The Steps in Recording Process, Journal, Ledger: Posting, Chart of Accounts, Trial Balance: Steps, Limitations, Locating Errors, Balance Sheet.	4.5	2
3	**Adjusting the Accounts:** Introduction, Accounting Time Period, Recognition Revenues and Expenses, Accrual Vs Cash-basis Accounting, Basics of Adjusting Entries, Types of Adjusting Entries, Adjusted Journal, Adjusted Trial Balance, Financial Statements.	4.5	2
4	**Completion the Accounting Cycle:** Introduction, Worksheet, Steps in Preparing a Worksheet, Using a Worksheet, Closing the Books, Preparing Closing Entries, Posting Closing Entries, Preparing a Post-closing Trial Balance, Summary of the Accounting Cycle, Classified Balance Sheet.	4.5	3
5	**Accounting for Merchandising Operations:** Introduction, Merchandising Operation, Operating Cycles, Inventory Systems-	4.5	3

	Periodic Inventory Systems, Perpetual Inventory Systems: Perpetual versus Periodic Inventory Method, Multiple and Single-step Income Statement, Reporting and Analyzing Inventory, Inventory Cost Flow Method in Perpetual Inventory System.		
6	**Accounting Information Systems:** Introduction, Systems Principles - Control, Relevance, Compatibility, Flexibility, Cost-benefit, System Components - Source Documents, Input Devices, Processors, Storage, Output Devices.	3	4
7	**Reporting and Analyzing Cash and Internal Controls:** Introduction, Internal Control, Principles of Internal Control, Cash Controls, Use of a Bank, Bank Reconciliation Statement - Definition, Causes, Need for Reconciliation, Reporting Cash.	4.5	5
8	**Accounting for Receivables:** Introduction, Types of Receivables, Accounts Receivable: Recognizing Accounts Receivable, Valuing Accounts Receivable, Disposing of Accounts Receivable, Notes Receivable: Determining the Maturity Date, Computing Interest, Recognizing Notes Receivable, Valuing Notes Receivable, Disposing of Notes Receivable, Statement, Presentation and Analysis.	4.5	3
9	**Accounting for Current Liabilities:** Introduction, Accounting for Current Liabilities: Notes Payable, Sales Taxes Payable, Unearned Revenues, Current Maturities of Long-term Debt, Statement, Presentation and Analysis, Contingent Liabilities: Recording a Contingent Liability, Disclosure of Contingent Liabilities, Payroll Accounting: Determining the Payroll, Recording the Payroll, Employer Payroll Taxes, Filing and Remitting Payroll Taxes, Internal Control for Payroll.	3	3
10	**Interpretation of Financial Statements:** Introduction, Meaning of Financial Statements, Importance and Purposes of Financial Statements Interpretations, Purposes of Interpretation of Ratios, Calculation of Accounting Ratios – Profitability, Liquidity, Efficiency, Position, Analysis of Relations Between Financial Statements and Accounting Ratios.	4.5	5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3	2	2								2
CLO2		3	2	2								2
CLO3			3	2			2					2
CLO4		3	3	2			2					2
CLO5			1	2		3		2		3		2
CLO6			2	3			3	2				3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, A, MS
CLO2	CL, T	CT, A, MS

CLO3	CL, T	CT, A, MS
CLO4	CL, T	CT, P, Q, SF
CLO5	CL, T, OR	CT, P, Q, SF
CLO6	CL, T, OR, GD	CT, P, Q, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)
(CT = Class Test, Q = Quiz, A = Assignment, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Accounting Principles - Jerry J. Weygandt, Paul D. Kimmel, and Donald E. Kieso; John Wiley & Sons, 13/E, 2019.
2. Principles of Accounting - Belverd E. Needles, Marian Powers, and Susan V. Crosson; Cengage Learning, 12/E, 2018.
3. Principles of Accounting, Volume 1: Financial Accounting - Mitchell Franklin, Patty Graybeal, and Dixon Cooper; OpenStax, 1/E, 2019.
4. Accounting Principles: The Ultimate Beginner's Guide to Accounting - Gregory Becker; Independently published, 1/E, 2019.
5. Financial Accounting: Information for Decisions - John Wild; McGraw-Hill Education, 9/E, 2018.
6. Financial and Managerial Accounting - John Wild, Ken Shaw, and Barbara Chiappetta; McGraw-Hill Education, 7/E, 2017.

2nd Year / 2nd Semester

Course Code: CSE-06132211 **Course Title**: Introduction to Database Systems
Credit Value: 3.00 **Credit Hours**: 3 hours/week
Year/Semester: 2nd/2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
The course intends to introduce the fundamental concept of database management, emphasizing organization, maintaining, and efficiently retrieving data from the system by conveying the rational algebra and data model, schema normalization, query optimization, and transactions.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Evaluate the fundamental concepts and manage the applications of database systems
CLO2	Apply the basics of SQL to construct queries
CLO3	Analyze and design the ER model, and transfer the ER diagram to the relationship with a different entity
CLO4	Write SQL using an eminent relational database system (Oracle)
CLO5	Apply the knowledge of relational database concepts to execute algebra expressions for queries
CLO6	Improve the database design by normalization

CLO7	Reliable with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing

Course Content:

SL No	Contents	Hrs	CLOs
1	Introduction: Purpose of Database Systems, Data Abstraction, Data Models, Instances and Schemes, Data Independence, Data Definition Language, Data Manipulation Language, Database Manager, Database administrator, Database Users, Overall System Structure, Advantages and Disadvantage of a Database Systems. Data Mining and analysis, Database Architecture, History of Database Systems.	6	1
2	Relationship Entity-Model: Entities and Entity Sets, Relationships and Relationship Sets, Attributes, Composite and Multivalued Attributes, Mapping Constraints, Keys, Entity-Relationship Diagram, Reducing of E-R Diagram to Tables, Generalization, Attribute Inheritance, Aggregation, Alternative E-R Notatios, Design of an E-R Database Scheme.	12	3
3	Relational Model: Structure of Relational Database, Fundamental Relational Algebra Operations, The Tuple Relational Calculus, The Domain Relational Calculus, Modifying the Database.	6	5
4	Relational Commercial Language: SQL, Basic structure of SQL Queries, Query-by-Example, Quel., Nested Sub queries, Complex queries, Integrity Constraints, Authorization, Dynamic SQL, Recursive Queries. Relational Database Design: Pitfalls in Relational Database Design, Functional Dependency Theory, Normalization using Functional Dependencies, Normalization using Multivalued Dependencies, Normalization using join Dependencies, Database Design Process.	9	2, 4, 5, 6
5	File and System Structure: Overall System Structure, Physical Storage Media, File Organization, RAID, Organization of Records into Blocks, Sequential Files, Mapping Relational Data to Files, Data Dictionary Storage, Buffer Management.	6	7
6	Indexing and Hashing: Basic Concepts, Ordered Indices, B+ -Tree Index Files, B-Tree Index Files, Static and Dynamic Hash Function, Comparison of Indexing and Hashing, Index Definition in SQL, Multiple Key Access.	3	7

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3		3									
CLO2	3	3										
CLO3	3	3	3									
CLO4	3			2	2							
CLO5	3	3	3									
CLO6	2	3	3									
CLO7	2	2	2									

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, Q, A, MS
CLO2	CL, OR, PrbL	CT, A, V, MS
CLO3	CL, T, OR, GD, PrjL	CT, P, MS, SF
CLO4	CL, OR, PrbL	CT, Q, A, MS, SF
CLO5	CL, OR, PrbL	CT, A, V, MS
CLO6	CL, T, GD	CT, A, SF
CLO7	CL, T, GD	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Database System Concepts – Abraham Silberschratz, Henry K. Korth, S. Sudarshan, Sixth edition.
2. Fundamentals of Database Systems - Benjamin/Cummings, 1994.
3. Database Management Systems, McGraw Hill, 1996.

Course Code: CSE-06132212 **Course Title**: Introduction to Database Systems Lab
Credit Value: 1.50 **Credit Hours**: 3 hours per week
Year/Semester: 2nd/2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

The course introduces the practical applicability of database management systems, particularly learning to develop a conceptual design for implementing database schemas and user interfaces by gaining first-hand experience with a real-world database application in a team project.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Implementing the knowledge in a team-based project compliant with the commercial relational database system (Oracle)
CLO2	Evaluate the database design principles such as SQL and PL SQL
CLO3	Implement the knowledge of relational database theory to write relational algebra in a query form
CLO4	Demonstrate the ER diagram to design the database of a project

Course Content:

SL No	Contents	Hrs	CLOs

1	**Introduction:** What is database, MySQL , Oracle , SQL, Datatypes, SQL / PLSQL, Oracle Software Installation, User Type, Creating User , Granting.	6	1, 2, 4
2	**Basic Parts of Speech in SQL:** Creating Newspaper Table, Select Command (Where , order by), Creating View, Getting Text Information & Changing it, Concatenation, Cut & paste string (RPAD , LPAD , TRIM , LTRIM , RTRIM, LOWER, UPPER , INIT, LENGTH , SUBSTR , INSTR , SOUNDEX).	6	2
3	**Playing The Numbers:** Addition , Subtraction , Multiplication , Division, NVL , ABS , Floor , MOD , Power , SQRT , EXR , LN , LOG , ROUND, AVG , MAX , MIN , COUNT , SUM, Distinct, SUBQUERY FOR MAX, MIN.	9	1, 2, 3
4	**Grouping things together:** Group By , Having, Order By, Views Renaming Columns with Aliases.	6	1, 2, 3
5	**When one query depends upon another:** Union, Intersect , Minus, Not in , Not Exists. Changing Data : INSERT,UPDATE, MERGE, DELETE, ROLLBACK , AUTOCOMMIT , COMMIT, SAVEPOINTS, MULTI TABLE INSERT, DELETE, UPDATE, MERGE. Creating And Altering tables & views: Altering table, Dropping table, Creating view, Creating a table from a table.	6	1, 2
6	**By What Authority:** Creating User, Granting User, Password Management.	3	1
7	**An Introduction to PL/SQL:** Implement few problems using PL/SQL (eg Prime Number, Factorial, Calculating Area of Circle, etc).	6	2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1			1						3			
CLO2	2								3			
CLO3	1								3			
CLO4			3						3			

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD, PrjL, BL	V, P, Prj
CLO2	CL, T, OR, PrbL, BL	LE, SF
CLO3	CL, OR, GD, PrbL, PrjL	Q, V, LE, MS, SF
CLO4	CL, GD, PrjL	V, P, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(Q = Quiz, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final, LE = Lab Examination, Prj = Projects)

Recommended Readings:

1. Database System Concepts – Abraham Silberschratz, Henry K. Korth, S. Sudarshan, Sixth edition.
2. The Complete Reference JAVA2, Herbert Schildt.
3. Microsoft C# Professional Projects, Geetanjali Arora, B. Aiaswamy, Nitin Pandey.
4. The Complete Reference PHP 5.2 Steven Holzner.

Course Code: CSE-06132213 **Course Title**: Operating System
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 2nd / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
The course provides an overall comprehensive cognition of the modern Operating System, conserving its previous history and reviewing the hardware elements to operating system concepts, system architecture, process and threads, memory management, file system, apposite security aspects, multiprocessor system, virtualization and the cloud.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Classify, identify and analyze modern operating systems; concept for virtualization, cloud and multiple processor systems. Discuss and apply internal design principles of Operating Systems
CLO2	Elaborate on the process, threads, memory and file management
CLO3	Design and analyze practical applications such as deadlock detection and recovery and raid level for memory management
CLO4	Analyze the issues related to I/O, security, and distributed systems

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction:** Operating Systems Concept, Computer System Structures, Operating System Structures, Operating System operations, Protection and Security, Special-Purpose Systems.	3	1
2	**Fundamentals of OS:** OS services and components, multitasking, multiprogramming, time sharing, buffering, spooling.	9	1
3	**Process Management:** Process Concept, Process Scheduling, Process State, Process Management, Interprocess Communication, interaction between processes and OS, Communication in Client-Server Systems, Threading, Multithreading, Process Synchronization.	12	1, 2
4	**Concurrency control:** Concurrency and race conditions, mutual exclusion requirements, semaphores, monitors, classical IPC problem and solutions, Dead locks - characterization, detection, recovery, avoidance and prevention.	6	1, 3
5	**Memory Management:** Memory partitioning, Swapping, Paging, Segmentation, Virtual memory - Concepts, Overlays, Demand Paging, Performance of demand paging, Page replacement algorithm, Allocation algorithms.	6	1, 2

6	**Storage Management:** Principles of I/O hardware, Principles of I/O software, Secondary storage structure, Disk structure, Disk scheduling, Disk Management, Swap-space Management, Disk reliability, Stable storage implementation.	3	4
7	**File Concept:** File support, Access methods, Allocation methods, Directory systems, File Protection, Free Space management.	3	2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2		3										
CLO3	2	2	3									
CLO4	3											

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, FS
CLO2	CL, T, OR, BL	CT, A, V, MS, FS
CLO3	CL, T, PrbL	CT, A, V, FS
CLO4	CL, T, OR, BL	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Operating System Concepts – Silberschatz & Galvin Wiley 2000 (7th Edition).
2. Modern Operating Systems (4th ed) - Andrew S. Tanenbaum; Prentice Hall (2014).
3. Operating Systems - Achyut S. Godbole Tata Mc Graw Hill (2nd Edition).
4. "UNIX Shell Programming" – Kanetkar.

Course Code: CSE-06132214 **Course Title**: Operating System Lab
Credit Value: 1.50 **Credit Hours**: 3 hours per week
Year/Semester: 2nd / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

Identify the core elements of a computer operating system and the effects of interactions between them on scheduling, deadlocks, memory management, synchronization, system calls, and file systems rules with a project.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Evaluate major operating systems such as Windows and Linux
CLO2	Discuss and apply internal design principles of the Operating System

CLO3	Develop and design algorithms for process, thread and memory management in a project form
CLO4	Configure system software to enhance system capacity and security

Course Content:

SL No	Contents	Hrs	CLOs
1	**Thread programming:** Creating thread and thread synchronization.	12	3
2	**Process Programming:** The Process ID, Running a New Process, Terminating a Process, Waiting for Terminated Child Processes, Users and Groups, Sessions and Process Groups	9	2
3	**Concurrent Programming:** Using fork, exec for multi-task programs.	6	2
4	**File Operations:** File sharing across processes, System lock table, Permission and file locking, Mapping Files into Memory, Synchronized, Synchronous, and Asynchronous Operations, I/O Schedulers and I/O Performance.	9	3
5	**Communicating across processes:** Using different signals, Pipes, Message queue, Semaphore, Semaphore arithmetic and Shared memory.	6	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1											3	
CLO2										2	3	
CLO3							2				3	
CLO4									3			

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD, PrbL, PrjL	A, V, P, LE, MS
CLO2	CL, T, OR, GD, PrjL, BL	V, LE, SF
CLO3	CL, OR, GD,PrjL	P, Prj
CLO4	CL, T, OR, PrbL, BL	SF, LE

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final, LE = Lab Examination, Prj = Projects)

Recommended Readings:

1. Operating System Concepts – Silberschatz & Galvin Wiley 2000 (7th Edition).
2. Modern Operating Systems (4th ed) - Andrew S. Tanenbaum; Prentice Hall (2014).
3. Operating Systems - Achyut S. Godbole Tata Mc Graw Hill (2nd Edition).
4. "UNIX Shell Programming" – Kanetkar.

Course Code: CSE-06132215	**Course Title**: Theory of Computation
Credit Value: 3.00	**Credit Hours**: 3 hours per week

Year/Semester: 2nd /2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
The course is designed for the students to learn the formal mathematical models of computation to analyze the problem-solving skill and evaluate the efficiency of a machine applying the appropriate algorithms with some elementary methods that reflect real-world computers.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Analyze the key notions of computation, such as algorithm, computability, decidability, reducibility, and complexity through problem-solving
CLO2	Elaborate the models of computation, including formal languages, grammars and automata, and their correlations
CLO3	Analyze and design finite automata, pushdown automata, Turing machines, formal languages, and grammars
CLO4	Apply the theoretical concepts to the practice of program design with regular expressions, parsing, and complexity analysis
CLO5	Evaluate the computational problems regarding their computability and complexity and prove the basic results of the theory of computation

Course Content:

SL No	Contents	Hrs	CLOs
1	**Finite Automata:** Deterministic and nondeterministic finite automata and their equivalence. Equivalence with regular expressions. Closure properties. The pumping lemma and applications.	9	2, 3
2	**Context-free Grammars:** Definitions. Parse trees. The pumping lemma for CFLs and applications. Normal forms. General parsing. Sketch of equivalence with pushdown automata.	12	2, 3
3	**Turing Machines:** Designing simple TMs. Variations in the basic model (multi-tape, multi-head, non-determinism). Church-Turing thesis and evidence to support it through the study of other models.	12	2, 3, 5
4	**Undecidability:** The undecidability of the halting problem. Reductions to other problems. Reduction in general.	9	1, 5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2	3										1
CLO2	2		3	1								

CLO3	3	2	2									
CLO4	2	3		2								
CLO5	3	3	3	3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, PrbL	CT, Q, A, MS
CLO2	CL, T, BL	CT, A, V, MS
CLO3	CL, T, OR, PrbL	CT, A, V, MS, FS
CLO4	CL, T, OR, GD	CT, A, V, MS, FS
CLO5	CL, T, OR, GD, BL	CT, A, V, FS

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. An Introduction to Formal languages and Automata, Fifth Edition – Peter Linz.
2. Introduction to Languages and the Theory of Computation, 4th Edition - J. C. Martin, McGraw Hill Publications, 1997.
3. Introduction to the Theory of Computation, 3rd edition, Michael Sipser, Cengage Learning, 2012.
4. Introduction to Automata Theory, Languages, and Computation. Addison (3rd ed) - J. E. Hopcroft; R. Motwani; J. D. Ullman (2006).

Course Code: CSE-06132217 **Course Title**: Numerical Analysis

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 2nd / 2nd **Course Type**: Core Course

Prerequisites: MAT-05411203: Linear Algebra

Rationale of the Course:

Numerical analysis is the story of how functions, derivatives, integrals, and differential equations are handled as strings of numbers in the computer. Many of these problems are too large or too difficult to solve in a conventional manner, for which we resort to using the computer to do the hard work for us. This course is intended to introduce the student to the algorithms and techniques an engineer might employ in solving these difficult problems.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Analyze the sources of errors in mathematical operations on the computer and their effects on using numerical algorithms
CLO2	Perform numerical analysis to obtain approximate solutions for various mathematical operations and tasks, such as finding the solution of linear and nonlinear equations, root finding, optimization, interpolation, integration, and the solution of ordinary differential equations

CLO3	Analyze the behavior of various numerical methods and to be able to discuss their stability, their order of convergence and their conditions of application

Course Content:

SL No	Contents	Hrs	CLOs
1	**Approximation and round-off errors**: sources of approximations; different classification of errors; conditioning, stability, and accuracy; Taylor's series.	3	1
2	**Linear systems**: Gaussian elimination; pivoting; LU decomposition. **Linear least squares and QR**: regression and least squares; positive definite matrix and Cholesky factorization; condition number; orthogonality; Gram-Schmidt orthogonalization; QR factorization.	6	2, 3
3	**Eigenvalue problems**: computing eigenvalues and eigenvectors; properties of eigenvectors; computing singular value decomposition.	4	2, 3
4	**Root finding**: in single variable – bisection, fixed point iteration, Newton, secant, and hybrid methods.	4	2, 3
5	**Optimization**: optimization in one dimension; unconstrained optimization; nonlinear least squares; constrained optimization; iterative linear solvers – gradient descent, conjugate gradient.	8	2, 3
6	**Interpolation**: polynomial interpolation with monomial, Lagrange, and Newton's basis, piecewise polynomial interpolation, nearest-neighbor interpolation, barycentric interpolation.	6	2, 3
7	**Numerical integration**: Interpolatory quadrature; Newton-Cotes quadrature.	5	2, 3
8	**Ordinary Differential Equations**: theory of ODEs; time-stepping schemes – forward Euler, backward Euler, trapezoidal method, Runge-Kutta method.	6	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3			3								
CLO2	3	3	3	3								
CLO3	3	3		3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, Q, V, MS
CLO2	CL, T, OR, PrbL	CT, A, MS, SF
CLO3	CL, T, OR, PrbL	CT, A, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Numerical Analysis – R. L. Burden, J. D. Faires
2. Scientific Computing: An introductory survey – Michael T. Heath
3. Numerical Methods for Engineers – Steven C. Chapra, Raymond P. Canale

Course Code: CSE-06132218 **Course Title**: Numerical Analysis Lab

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: 2nd / 2nd **Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

The course is designed for practical implementations of common algorithms taught in the corresponding theory course – MAT-201. Students will design and implement algorithms directly from pseudocodes, as well as from problem statements new to them.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Implement algorithms from a known/given pseudocode for solving numerical analysis problem
CLO2	Design and/or implement algorithms directly from a given problem statement (without needing any pseudocode)
CLO3	Implement bug-free and efficient codes against all algorithms
CLO4	Perform teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations

Course Content:

SL No	Contents	Hrs	CLOs
1	**Linear systems**: Gaussian elimination; pivoting; LU decomposition. **Linear least squares and QR**: regression and least squares.	9	1, 2, 3, 4
2	**Eigenvalue problems**: computing eigenvalues and eigenvectors.	6	1, 2, 3, 4
3	**Root finding**: in single variable – bisection, fixed point iteration, Newton, secant, and hybrid methods.	9	1, 2, 3, 4
4	**Optimization**: optimization in one dimension; unconstrained optimization; nonlinear least squares; constrained optimization; iterative linear solvers – gradient descent, conjugate gradient.	9	1, 2, 3, 4
5	**Interpolation**: polynomial interpolation with monomial, Lagrange, and Newton's basis.	6	1, 2, 3, 4
6	**Numerical integration**: Interpolatory quadrature.	3	1, 2, 3, 4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3		3							
CLO2	3	3	3	3	3							
CLO3	3	3	3	3								
CLO4								3	3	3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, GD, PrbL	A, LE, PP
CLO3	CL, T, OR, PrbL	A, PP
CLO4	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Numerical Analysis – R. L. Burden, J. D. Faires
2. Scientific Computing: An introductory survey – Michael T. Heath
3. Numerical Methods for Engineers – Steven C. Chapra, Raymond P. Canale

Course Code: CSE-06132220 **Course Title**: Project Work I
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 2nd / 2nd **Course Type**: Core Course
Prerequisites: CSE-06131114: Structured Programming Language Lab

Rationale of the Course:
This project will give students a hands-on problem-solving experience by applying knowledge learned in C and Java language.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Apply programming knowledge to create visible products
CLO 2	Design logical platforms to divide a problem and solve it with scientific and technical knowledge
CLO 3	Present ideas and projects in front of audience

Course Content:

SL No	Content	Hrs	CLOs
1	Any project based on C/Java language including implementation of Data Structure. Or, Gaming project using the graphics.h library in C is preferable Or, Basic Robotics Project using Arduino. Or, Java Desktop application Or, Android application. Or, solving certain number of programming problem assigned by the course teacher.	36	1, 2
2	Presentation and Report Writing	6	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	3									2
CLO2	2		3	2	1							2
CLO3	1							3	2	3	2	3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD, PrbL, PrjL	PP, V
CLO2	CL, OR, GD, PrbL, PrjL	PD, RW, V
CLO3	CL, OR, GD, PrbL, PrjL	PD, RW, V

(CL = Class Lectures, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. No textbook is required for this course.

Course Code: MAT-05412205 **Course Title**: Complex Variables, Laplace Transform and Fourier Series

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 2nd / 2nd **Course Type**: General Education Course

Prerequisites: None

Rationale of the Course:

This course is designed to impart students with the knowledge of Complex variables, Laplace Transform, Fourier Series, Fourier Transform which are applicable in many fields of computer science like signal processing.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Recognize and define basic concepts of complex number system, complex variable, Laplace transform, Fourier series, Fourier Transform, etc.

CLO2	Recognize and identify the basic properties of complex number, Laplace transform, and Fourier transform.
CLO3	Interpret complex function, the integrals of complex functions and the technique of Laplace transform, and Fourier transform of some elementary function.
CLO4	Apply Laplace transform to Ordinary Differential Equation and Fourier as well as Inverse Fourier transform to make use of boundary value problems in Engineering fields.

Course Content:

SL No	Contents	Hrs	CLOs
1	**Complex Variable**: Complex number system, general functions of a complex variable limits and continuity of a function of complex variable and related theorems. Complex differential and the Cauchy, Riemann equations. Mapping by elementary functions. Line integral of a complex function. Cauchy's integral formula. Kiouville's theorem. Taylor's and Laurent's theorem. Singular points. Residue. Cauchy's residue theorem. Evaluation of residues. Contour integration. Conformal mapping.	15	1,2,3
2	**Fourier Series**: Real and Complex form of Fourier Series, Definition and expansion of a function of x in a Fourier Series, Physical application of Fourier Series.	6	1,2,3
3	**Fourier Transform**: Finite Fourier Transform, Fourier Integral, Inverse Fourier transform, Fourier transform and their uses in solving boundary value problems, Diffusion, wave, Laplace Equation.	10.5	1,2,3
4	**Laplace Transform**: Definition. Laplace transforms of some elementary functions. Sufficient conditions for existence of laplace transform. Inverse Laplace transforms. Laplace transforms of derivatives. The unit step function. Periodic function. Some special theorems on Laplace transforms. Partial fraction. Solutions of differential equations by Laplace transform. Evaluation of improper integrals, Application of Laplace Transform.	10.5	1,2,3,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2	3											2
CLO3		3										2
CLO4		3	2									2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, V, MS, SF

CLO2	CL, T, OR, GD	CT, Q, A, V, MS, SF
CLO3	CL, T, OR, GD, PrbL	CT, Q, A, V, MS, SF
CLO4	CL, T, OR, GD, PrbL	CT, Q, A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. An Introduction to Laplace Transforms and Fourier Series by Phil Dyke
2. Introduction to Complex analysis by KK Kodaira
3. Methods of Mathematical Physics by H Jaffreys and B Jaffreys
4. Laplace Transform by M.R. Spiegel
5. Laplace Transforms by M.L. Khanna

3rd Year / 1st Semester

Course Code: CSE-06133111 **Course Title**: Computer Networks
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 3rd / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course will introduce advanced computer science students to networking and internetworking. The goal is for students to learn not only what computer networks are and how they work today, but also why they are designed the way they are and how they are likely to evolve in the future.

Course Learning Outcomes (CLOs):
On successful completion of this course, students will be able to:

CLO1	Describe the current architecture of the Internet and the entities involved with the day to day running of the Internet
CLO2	Discuss and utilize client-server and P2P application-layer architectures and analyze application-layer protocols such as HTTP, DNS, SMTP, and DHCP
CLO3	Explain how different reliable and unreliable end-to-end transport protocols work
CLO4	Explain network addressing and apply IP addressing using CIDR and NAT and construct forwarding and routing tables
CLO5	Discuss link-layer standards and MAC protocols
CLO6	Explain and identify security and ethical issues in computer networking

Course Content:

SL No	Contents	Hrs	CLOs
1	**Computer Network Fundamental and the Internet**: History and current architecture of the Internet, the network edge, the network core, delay, loss, and throughput in Packet-Switched networks, Protocol layers and Service models, Client-server model, messages, segments, datagrams, frames.	4	1
2	**Application Layer**: Principles of Network applications, methods of process communication, transport services available to applications, application-layer protocols, World-Wide Web, HTTP, nonpersistent and persistent connections, cookies, web caching, FTP, SMTP and email, DNS services, peer-to-peer applications.	6	2
3	**Transport Layer**: Transport layer services, relationship between transport and network layers, multiplexing and demultiplexing, Connectionless vs. connection-oriented services, UDP, principles of reliable data transfer, TCP, error control, flow control, congestion control.	12	3
4	**Network Layer**: Forwarding and routing, network service models, routers, switching, IP protocol, IPv4, IPv6, routing algorithms, routing on the Internet, broadcast, and multicast routing.	9	4
5	**Link Layer**: Error detection and correction, multiple access protocols, link-layer addressing, Ethernet, link-layer switches.	6	5

6	**Network Security and Ethics**: Kinds of attacks, Cryptography, TCP Security: SSL, Network-layer Security: IPsec, VPN, Firewalls, Intrusion Detection System.	5	6

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3	3	2							
CLO2	3	2	3	3	1							
CLO3	3	3	3	3								
CLO4	3	3	3	2	3							
CLO5	3	2	2	1	1							
CLO6	3	3		3				3				

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, MS
CLO2	CL, T, OR, GD	CT, A, V, MS
CLO3	CL, T	CT, A, V, MS, SF
CLO4	CL, T, OR	CT, A, V, SF
CLO5	CL, T, OR	CT, A, V, SF
CLO6	CL, T, OR, GD	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)
(CT = Class Test, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Computer Networking: A Top-Down Approach – James F. Kurose and Keith W. Ross
2. Data Communications and Networking – Behrouz A. Forouzan
3. Computer networks – A. S. Tanenbaum

Course Code: CSE-06133112 **Course Title**: Computer Networks Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 3rd / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
The course is designed for analyzing practical networks and implementing common networking protocols based on concepts taught in the corresponding theory course.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Implement common networking functionality using a network programming language
CLO2	Manually implement a client-server protocol like HTTP
CLO3	Capture and analyze packets from different layers of the TCP/IP protocol suite

Course Content:

SL No	Contents	Hrs	CLOs
1	**Network programming language**: basics of a network programming language with its relevant networking features will be explored. Preferred choice for the language is Go or Rust. Alternative choices include – Python, C, Java.	15	1
2	**Programming application and transport layer**: HTTP protocol, socket programming.	15	2
3	**Packet analysis**: analyzing packets from different layers. Networks can be simulated using cisco packet tracer or NS2. Alternatively, the network can be a real network analyzed using Wireshirk.	12	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3	3	3							
CLO2	3	3	3	3	3							
CLO3	3	3		3	3					3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	Q, LE, PP
CLO2	CL, T, OR, PrjL, BL	A, V, P, PP, Prj
CLO3	CL, T, OR, GD, PrbL, PrjL, BL	A, V, P, LE, PP, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Computer Networking: A Top-Down Approach – James F. Kurose and Keith W. Ross

2. Data Communications and Networking – Behrouz A. Forouzan
3. Computer networks – A. S. Tanenbaum

Course Code: CSE-06133113 **Course Title**: Software Engineering and Design Patterns

Credit Value: 3.00 **Credit Hours**: 3 hours per week

Year/Semester: 3rd/1st **Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

This course introduces the essential concepts of both engineering and design patterns such as software processes, activities, and agile methodology required for constructing large software-intensive systems, including requirements analysis, specification, design, coding, debugging and testing, maintenance, and thorough documentation, as illustrated by examples and papers from current literature.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Apply software engineering principles through the Software development process, design, and analyze Software Requirements
CLO2	Analyze different software development models for various real-life organizational contexts
CLO3	Learn the skills and activities of an effective project manager and project management process, Cost estimation, risk analysis, project scheduling, and ethical values
CLO4	Apply the practical approaches to designing and maintaining large scale software for organizations

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction:** Overview of Software Industry, Introduction to Software Engineering, Software Development Process and Various Life Cycle Models. Requirement Analysis: Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification.	3	1
2	**Group Dynamics:** Working in Teams, Characteristics of Successful Team, Understanding Group Dynamics, Team Roles and Temperament, Democratic Team and Chief Programmer Team Approach. Introduction to Extreme Programming, Analysis Modeling: Steps of system analysis, Feasibility study, Economic and technical analysis, System specification, the elements of analysis model, Data modeling, Functional modeling and information flow, Behavioral modeling, Mechanics of structured analysis, Data Dictionary.	9	1, 3
3	**Software Design:** Design principles, Design Concepts, effective modular design, design heuristics, Data Design, Architectural Design process, Transformation mapping, Transaction mapping, interface design, human-computer interface design, procedural	12	2

	design. Software Testing: Testing fundamentals, test case design, white-box testing, black-box testing, testing GUIs, Unit testing, Integration testing, validation testing, system testing, debugging.		
4	**Maintenance:** Major maintenance activities, estimating maintenance cost and productivity.	3	4
5	**Technical Metrics for Software:** Software quality, Framework for technical metrics, metrics for analysis and design models, source code, testing and maintenance.	6	4
6	**Software Architecture:** Pipe and Filter, Object Oriented, Event-Based, Layered System, Data-centered repository, Process Control Architectures, Object Oriented Software Engineering: O-O concepts, O-O analysis, Domain analysis, O-O analysis process, Object-relational model.	3	2, 4
7	**O-O design:** System design process, object design process, O-O programming.	3	1
8	**O-O Testing:** Testing strategies, test case design. Service-Oriented Software Engineering: Introduction to SOA, SOAP, Analysis, design, validation, verification, implementation and maintenance of service-oriented software; ESB, Messaging Architecture, Software Tools for SOA. Software Project Management: Cost estimation, risk analysis, project scheduling.	3	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3										
CLO2		3	3				2					
CLO3	3							2		2		
CLO4			3							1		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, BL	CT, Q, A, MS, FS
CLO2	CL, T, BL	CT, A, MS, SF
CLO3	CL, T, OR, PrbL, GD, BL	CT, MS, SF
CLO4	CL, OR, GD, BL	CT, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Software Engineering, A practitioner's Approach, Second Edition- Roger S. Pressman.
2. Software Engineering Concepts - Richard Fairley.

3. Software Engineering Environments - Robert N. Charette.
4. Software Engineering - Ian Sommerville.

Course Code: CSE-06133114 **Course Title**: Software Engineering and Design Patterns Lab

Credit Value: 1.50 **Credit Hours**: 3 hours per week

Year/Semester: 3rd/1st **Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

Enabling significant teamwork and project-based experience, the course grasp students with hands-on training on fundamental design principles and how principles can be utilized to make more modular and scalable programs with various software engineering diagrams such as class diagrams, state diagrams, use-case diagrams to construct a high quality software, which is reliable finally, and reasonably easy to understand, modify and maintain.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Acquire skills that will enable the students to construct software of high quality
CLO2	Analyze requirements of real-life software
CLO3	Estimate timeline for fully functional software development

Course Content:

SL No	Contents	Hrs	CLOs
1	**Requirement Engineering:** Choose a company/institute/client for which software will be developed (make sure that they will provide required information whenever necessary). Follow the steps for eliciting requirements and generate use-case diagram. Also analyze the sufficiency of the requirement engineering outcome for steps to follow.	12	2
2	**Analysis model to Architectural and Component level design:** Generate Activity diagram, Data flow diagram (DFD), Class diagram, State diagram, Sequence diagram and follow other relevant steps for creating complete architectural and component level design of the target software.	12	1, 3
3	**User Interface design, Design evaluation, Testing strategies and Testing Tactics:** Perform the user interface design with the help of swimlane diagram. Carry out the design evaluation steps. Generate all test cases for complete checking of the software using black box, white box testing concept.	12	1, 3
4	**Software testing and debugging and Managing Software Projects:** Analyze the estimation and project schedule.	6	1, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3		3		2				3	2	3	
CLO2	2	3							2	3		
CLO3	2	1	3						2	2	2	

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL,OR, GD, PrjL	P, Prj
CLO2	CL, T, OR, GD, PrjL, BL	RW, Prj
CLO3	CL,GD, PrbL, PrjL	V, RW, P, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(V = Viva-voce, P = Presentation, RW = Report Writing, Prj = Projects)

Recommended Readings:

1. Head First Software Development, O'Relly.

Course Code: CSE-06133115 **Course Title**: Artificial Intelligence
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: **Course Type**: Core Course
Prerequisites: CSE-06131211: Data Structures and Algorithms

Rationale of the Course:
Artificial intelligence is the key to perceive real life complex environment and making intelligent decision. This course will help students to learn how to represent complex problem and solving them by implementing artificial intelligence algorithms in Python.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Compare AI with human intelligence and traditional information processing and discuss its strengths and limitations as well as its application to complex and human-centered problems.
CLO 2	Able to apply problem solving methods (informed, uninformed, local search, adversarial search, CSP and reinforcement learning) of single or multi agents to solve real life problems.
CLO 3	Apply learning and planning to improve machine intelligence.
CLO 4	Develop communication skills by presenting AI topics.

Course Content:

SL No	Content	Hrs	CLOs
1	**What is Artificial Intelligence:** The AI problems, The underlying assumption, What is an AI technique? Different types of environments and agents.	3	1, 2
2	**Problems, Problem spaces and classical Search:** Defining the problem as a state space search, Production system, Problem characteristics, Breadth First Search, Depth First Search, Uniform Cost Search, Iterative deepening search.	6	1, 2, 3
3	**Heuristics Search Techniques:** The idea of heuristic, A* search	3	2, 3
4	**Local Search:** Hill climbing, Simulated Annealing, Best First Search, Problem Reduction, Genetic Programming.	6	2, 3
5	**Game playing:** Overview, The Minimax Search Procedure, Adding Alpha-Beta cutoffs, Additional refinements, iterative Deepening.	4.5	2, 3
6	**Constraint satisfaction Problem (CSP)**: How to represent CSP problems Backtracking solution.	4.5	2, 3
7	**Knowledge representation:** Review of Propositional logic, first order Logic,	9	2, 3, 4
8	**Reasoning:** Bayesian Rule and its use in probabilistic reasoning;	3	2, 3, 4
9	**Reinforcement Learning:** Introduction to stochastic environment, Bellman equation, value iteration, policy iteration	3	3, 4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2			3	2								2
CLO3			2	3								
CLO4						2	2			3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	A, Q, CT, MS
CLO2	CL,T	A, Q, CT, MS
CLO3	CL,T, PrbL	A, V, CT, SF
CLO4	CL,T,OR,PrbL	A, V, CT, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Artificial Intelligence: A Modern Approach by Stuart Russel.
2. The Cambridge Handbook of Artificial Intelligence by Keith Frankish, William M. Ramsey.

Course Code: CSE-06133116 **Course Title**: Artificial Intelligence Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: **Course Type**: Core Course
Prerequisites: CSE-06132114: Algorithm Design and Analysis Lab

Rationale of the Course:
Hands on training on implementing various artificial intelligence algorithms in python and understanding and applying different algorithms for real world scenario.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Implementing major artificial intelligence concepts in python and experimenting with various simulated environments.
CLO 2	Analysis and evaluating programming skills in python.
CLO 3	Apply traditional algorithms in real world complex problems.
CLO 4	Design and analysis solution of a specific project and write report on different behavior on various scenarios.

Course Content:

SL No	Content	Hrs	CLOs
1	**What is Artificial Intelligence:** State space representation Searching: Python refresher	6	1, 2
2	**Classical Search:** Breadth first search, Depth First Search, Uniform cost search, Iterative deepening search.	6	1, 2
3	**Heuristic:** Calculate heuristic for various problems, A* search.	6	2, 3
4	**Local Search:** Hill climbing, simulated annealing, Genetic algorithm.	6	2, 3
5	**Probability:** Bayes theorem	3	2, 3
6	**Constraint satisfaction problem:** Solve Two+Two=Four, map coloring, Backtracking algorithm.	3	2, 3
7	**Games:** Minimax, Minimax with alpha-beta pruning.	6	3, 4
8	**Reinforcement Learning:** Bellman equation, value iteration, policy iteration.	6	3, 4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		2	3									2
CLO2			3	2								2

CLO3			2	3								
CLO4									3	3	3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, PrbL	V, LE, PP
CLO2	CL, PrbL	V,LE, PP
CLO3	CL,PrbL, OR,GD	V, RW, PD
CLO4	CL,PrjL,OR,GD	V, RW, PD

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. Artificial Intelligence: A Modern Approach by Stuart Russel.
2. The Cambridge Handbook of Artificial Intelligence by Keith Frankish, William M. Ramsey.

Course Code: CSE-06133117 **Course Title**: Microprocessor and Interfacing
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 3rd/1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

This course is designed to teach students the basic concepts of microprocessors, their working principle along with the techniques of interfacing those microprocessors with other components of computing system. This course will also introduce students to the world of embedded systems.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Interpret and explain how full microcomputer system works including the memory organization in a microcomputer system
CLO2	Interpret microprocessor‘s and microcontroller‘s internal architecture and their operation
CLO3	Interpret how low-level programming language such as assembly language works
CLO4	Understand and evaluate various types of interfacing devices with other peripheral devices

CLO5	Design microprocessor/microcontroller based projects from practical requirements

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction to Microprocessors:** Concept of microprocessor; Evolution of microprocessors, difference between microprocessor and microcontroller, classification of microprocessor.	4.5	1
2	**Microcomputer System**: Components of microcomputer system, communication between common components of microcomputer system, busses in microcomputer system.	3	1
3	**Simple As Possible (SAP) microprocessors**: Architecture, instruction set, programming, fetch cycle, execution cycle, microprogramming, register structure of SAP-1, SAP-2, and SAP-3 microprocessor.	6	1,2
4	**8086/8088 microprocessors**: Internal architecture, register structure, instruction set and format, programming in machine or assembly languages, interrupt structure, memory organization and segmentation, DMA, I/O operation, addressing, uses of flags, microprocessor interface ICs, peripheral interfacing, microprocessor based system design, coprocessor, multiprocessor system.	9	1,2,3
5	**Bus System**: Classification of busses, data transfer in a bus, common bus systems: ISA, EISA, PCI AGP, Memory Bus, SCSI and USB.	4.5	1,4
6	**Interfacing with analog world**: A/D conversion, digital ramp ADC, successive approximation ADC, flash ADC, integrating ADC, D/A converter, DAC specifications, DAC applications, Data acquisition, sample-and-hold circuits, Stepper Motor, Transducers, motors and other peripherals.	9	1,4
7	**Microcontroller**: Types of microcontrollers, components of microcontroller, internal architecture and instruction set of any common microcontroller, design of embedded system with microcontroller.	6	1,2,3,4,5

Note: This course can be taught either by focusing on any common type of microprocessor. In this curriculum Intel's X86 architecture is shown but if necessary the contents should be adapted for other architecture like ARM, RISC V, etc.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3			2								
CLO2	3											

CLO3	3											
CLO4	3		2									
CLO5			3								2	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD	CT, V, MS
CLO2	CL, T, OR, GD, BL	CT, Q, A, V, MS
CLO3	CL, T, OR, BL	CT, Q, V, MS, SF
CLO4	CL, T, OR, PrbL, BL	CT, A, V, SF
CLO5	OR, PrbL, PrjL, BL	A, P, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Digital Computer Electronics by Albert P. Malvino and Gerald A. Brown
2. Microprocessors and interfacing by Douglas V hall
3. Microprocessors, PC Hardware and interfacing by N. Mathivanan
4. Assembly Language Programming and Organization for the IBM PC by Ytha Yu and Charles Marut
5. The Intel Microprocessors by Barry B Brey
6. Microprocessors and Microcomputer- based system design by Mohamed Rafiquzzaman

Course Code: CSE-06133118 **Course Title**: Microprocessor and Interfacing Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 3rd/1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

This course introduces students to basics of programming microprocessors and interfacing of microprocessors along with introduction to embedded systems.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Understand how low-level languages are implemented and how a processor executes a program line by line.
CLO2	Understand and analyze functions of different peripheral devices interfaced with microprocessor.
CLO3	Program microprocessor/microcontroller.
CLO4	Analyze and understand the working of different practical embedded systems.
CLO5	Design microprocessor/microcontroller based system as part group project.

Course Content:

SL No	Contents	Hrs	CLOs
1	**Basics of Assembly Language**: Compilation, input, output, variables, basic instructions, memory model, data segment, stack segment, code segment, Input Output Instruction.	3	1
2	**Flow Control Instruction**: Conditional and unconditional jump instructions, If-then-else, case, for loop, while loop, repeat loop.	3	1
3	**Logic, Shift and Rotate Instructions**: AND, OR, XOR, complement, shift left, shift right, rotate left, rotate right, rotate carry left, rotate carry right, Binary, Hex Input Output.	6	1
4	**Stack and Procedure**: Push, Pushf, Pop, Popf. Multiplication and Division: Mul, IMul, Div, Idiv.	3	1
5	**Array and Addressing modes**: 1D Array, DUP operator, Addressing-mode, register indirect mode.	3	1
6	**String Instructions**: Moving string, load string, scan string, compare string. File Operations: File errors, opening and closing a file, reading a file, writing a file.	3	1
7	**Introduction to embedded Systems**: Programming and LED, Seven Segment display, LCD, Keyboard, Motor, Dot matrix interfacing with microcontroller like ATMEGA 328.	15	2,3,4
8	Lab project design, implementation, and submission.	9	5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3	3		3								
CLO3	3				2							
CLO4		3		3								
CLO5		3	3						3		3	3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, BL	CT, Q, V, RW, PP, LE
CLO2	LD, T, OR, BL	CT, Q, V, RW, LE
CLO3	LD, LExp, PrbL	CT, Q, V, RW, LE
CLO4	LD, LExp, PrbL, OR	CT, Q, V, RW, LE
CLO5	OR, GD, PrbL, PrjL	Prj, RW, P, V

(LD = Lab Demonstration, LExp = Lab Experiment, CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Assembly Language Programming and Organization for the IBM PC by Ytha Yu and Charles Marut
2. Microprocessors, PC Hardware and interfacing by N. Mathivanan

Course Code: CSE-06133119 **Course Title**: Data Communication
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 3rd / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course aims to provide a solid conceptual understanding of the fundamentals of data communications and computer networks.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Interpret the components, tools and techniques of communication systems
CLO2	Illustrate the TCP/IP and OSI Reference model and identify their differences in implementation within and across enterprises
CLO3	Explain how information can be sent via communication interfaces and links
CLO4	Determine the various modulation and error detection and correction techniques and their application in communication systems

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction:** Data communications, Networks, Internet, Protocols and Standards	3	1
2	**Network Models:** OSI Model, TCP/IP Protocol suite, Addressing	4	1,2
3	**Data and Signals:** Analog and Digital data, Analog and Digital Signals, Time and Frequency Domain, Transmission impairments, Data rate limits, Performance	6	1,3
4	**Digital Transmission:** Digital-to-Digital Conversion, Analog-to-Digital Conversion, Transmission Modes	4	1,3
5	**Analog Transmission:** Digital-to-Analog Conversion, Analog-to-Analog Conversion.	3	1,3
6	**Multiplexing and Spread Spectrum:** FDM, WDM, TDM, STDM, Digital Subscriber Line, FHSS, DSSS.	6	1,3,4
7	**Transmission Media:** Guided and Unguided Media	3	1,2
8	**Switching:** Circuit switching, Packet switching.	3	1,3
9	**Data Link Layer:** Error Detection and Correction, Data Link Control, Framing, Flow and Error Control.	6	1,4
10	**Multiple Access:** CSMA, CSMA/CD, CSMA/CA, FDMA, TDMA, CDMA.	4	1,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2		3		3								
CLO3		1	3	3								
CLO4		3			2							

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, A, MS
CLO2		
CLO3	CL, T, OR, PrbL	CT, Q, A, SF
CLO4		

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

5. Data Communication and Networking by Behrouz A Forouzan (4^{th} edition)
6. Data and Computer Communication by William Stallings
7. Data Communication & Networks by R L Brewster

3rd Year / 2nd Semester

Course Code: CSE-06133211 **Course Title**: Introduction to Computer Security
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 3rd / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
The fundamental course of computer security's primary goal is to introduce students to cryptography and computer security concepts, including physical security, operating system security, and network and web security.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Explain the basic concepts of security and its different properties
CLO2	Elaborate on the theoretical foundation of cryptography
CLO3	Explain the practical application of cryptography in different application domains
CLO4	Analyze and identify security vulnerabilities in practical systems
CLO5	Design different security solutions in practical systems
CLO6	Analyze the importance of human resources within an organization to maintain its security practices
CLO7	Evaluate the role of users to maintain personal security

Course Content:

SL No	Contents	Hrs	CLOs
1	**Basic terminology and security concepts:** Fundamental concepts, Access control models, Cryptographic concepts, Security principles	3	1, 2
2	**Classic Crypto Systems:** Substitution cipher, Vigenère cipher, Hill Cipher, One-time pads.	6	2
3	**Symmetric Encryption:** Advanced Encryption Standard (AES) **Public Key Encryption:** RSA and ElGamal crypto systems **Other crypto mechanisms:** Hash Function, Digital Signature	6	3
4	**Physical security:** Authentication technologies, Direct attacks, Physical Intrusion Detection.	4.5	4, 7
5	**Operating Systems Security:** Process, security, Memory and file system security, Application program security.	4.5	4
6	**Malware and forensic analysis:** Insider & Malware attacks, Computer viruses, Privacy-invasive software, Countermeasures, Malware forensic.	6	4, 5

7	**Network Security:** Network security concepts, Vulnerabilities in Link, Network, Transport and Application layers, Firewall, Tunnelling and Intrusion detection, Denial of Service attacks, Countermeasures.	6	4, 5
8	**Web security:** Attacks on clients, Attacks on servers, Countermeasures. **Blockchain and Bitcoin:** History of money, The need of decentralization, State machine replication, Concepts of transaction, block, blockchain and distributed consensus of Blockchain security, Blockchain applications.	6	6, 7

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2	3											
CLO3	3											
CLO4	3	2	2	2								
CLO5	3		2	2								
CLO6	3					2	1					
CLO7	3	1				2	1					

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, BL	CT, Q, A, V, MS, SF
CLO2	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO3	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO4	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO5	CL, T, OR, GD, PrbL, BL	CT, Q, A, P, V, MS, SF
CLO6	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO7	CL, T, OR, BL	CT, Q, A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Introduction to Computer Security by Michael T. Goodrich and Roberto Tamassia.
2. Introduction to Computer Security by Matt Bishop.

Course Code: CSE-06133212 **Course Title**: Introduction to Computer Security Lab
Credit Value: 1.50 **Credit Hours**: 3 hours per week
Year/Semester: 3rd / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
These students will participate in various hands-on lab exercises based on concepts learned in the theory course. The primary goal of this course is to give students hands-on experience working with multiple encryption algorithms, attacking systems using various vulnerabilities, and implementing security measures to mitigate these vulnerabilities.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Explain the practical knowledge of security and its different properties
CLO2	Demonstrate practical knowledge of different types of attacks in experimental systems
CLO3	Analyze and identify security vulnerabilities in practical systems
CLO4	Demonstrate knowledge about different tools that are used to secure different systems
CLO5	Design and implement different security solutions in practical systems
CLO6	Demonstrate their ability to work on teams to address a particular security problem and design a secure system
CLO7	Improve the skill in different measures for the protection of personal security

Course Content:

SL No	Contents	Hrs	CLOs
1	Attacking classic cipher systems	6	1, 2
2	Programming different cryptographic algorithms	9	2, 3, 4
3	Developing secure systems utilizing different cryptographic libraries	15	3, 4, 6
4	Exploiting network vulnerabilities, attacking and defending web applications	6	6, 7
5	Malware analysis.	6	5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3				2							
CLO2	3				2							
CLO3	3											
CLO4	3	2	2	2								
CLO5	3			2								
CLO6	3		2	2								
CLO7	3	2						2	2			

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL, BL	A, P, Prj
CLO2	CL, T, OR, GD, PrbL, BL	A, V, P, Prj
CLO3	CL, T, OR, GD, PrbL, BL	A, V, P, Prj
CLO4	CL, OR, GD, PrbL, BL	A, V, P, Prj
CLO5	CL, OR, GD, PrbL, BL	A, V, PP
CLO6	CL, OR, GD, PrbL, BL	A, V, P, Prj
CLO7	CL, OR, GD, PrbL, BL	A, V, PP, LE

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Introduction to Computer Security by Michae lT. Goodrich and Roberto Tamassia.
2. Computer Security: Principles and Practice by William Stallings Lawrie Brown, 4th Edition.
3. Introduction to Computer Security by Matt Bishop.

Course Code: CSE-06133213 **Course Title**: Machine Learning
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 3rd / 2nd **Course Type**: Core Course
Prerequisites: STA-05422101: Basic Probability and Statistics

Rationale of the Course:

This course on machine learning aims to provide students with an in-depth introduction to two main areas of machine learning: supervised and unsupervised learning. A major emphasis of this course is on optimizing learning objectives of different leaning algorithms and investigating these algorithms strengths and weaknesses under different conditions.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Develop an appreciation for what is involved in Learning models from data
CLO2	Identify the basic building blocks and general principles that allow one to design machine learning algorithms
CLO3	Develop an understanding of training a learning algorithm including over-fitting, noise, convergence and stopping criteria
CLO4	Connect ideas from computational learning theory to ensemble learning to produce strong learners from a set of weak learners and develop an understanding of unsupervised learning algorithms

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction to machine learning**: definition; different types – supervised, unsupervised, reinforcement learning; regression vs classification; parametric vs non-parametric models; discriminative vs generative models.	4.5	1
2	**Review on probability**: random variables; joint, conditional, and marginal probability; Bayes rule; discrete probability distributions – Bernoulli, geometric, binomial, multinomial, Dirichlet; continuous probability distributions – Gaussian, beta, gamma, exponential.	1.5	1
3	**Linear models for regression**: linear regression, linear models of regression in higher dimensional feature space; loss optimization and normal equation; probabilistic linear regression; maximum likelihood estimation for regression problems; maximum a posteriori approximation and regularization; techniques for measuring regression algorithms.	7.5	2, 3
4	**Simple classification models**: non-parametric classifier – k-nearest neighbor, perceptron; discriminative vs. generative classifiers - logistic regression, naïve Bayes; tree-based nonlinear classifier – decision tree.	6	2, 3
5	**Support vector machine**: detailed derivation of primal and dual formulation; slack variable and soft-margin support vector machine.	4.5	2, 3
6	**Artificial neural network**: network architecture; making inference using feed-forward algorithm; learning using the back-propagation algorithm; regularization in neural networks.	4.5	2, 3
7	**Computational learning theory**: probably approximately correct learning model; Vapnik-Chervonenkis dimension; strong and weak learners.	3	4
8	**Ensemble learning**: three pillars of an ensemble system – diversity, training ensemble members, and combining ensemble members; ensemble algorithms – bagging; boosting.	4.5	3, 4
9	**Clustering**: k-means, k-center, k-median clustering, and their optimization objectives; Gaussian mixture model for clustering; the expectation-maximization algorithm.	4.5	2, 3
10	**Dimension Reduction:** principal component analysis.	1.5	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3	3		3								
CLO3	3	3		3	3							3
CLO4	3	3			3							3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	Q, V
CLO2	CL, T, OR	CT, A, MS
CLO3	CL, T, OR, GD	CT, A, V, SF
CLO4	CL, T, OR, GD, BL	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Pattern Recognition and Machine Learning – Christopher M. Bishop
2. Machine Learning: A Probabilistic Perspective – Kevin P. Murphy
3. Learning from Data: A Short Course – Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin
4. Foundations of Machine Learning – Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar

Course Code: CSE-06133214 **Course Title**: Machine Learning Lab

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: 3rd / 2nd **Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

The course is designed for practical implementations of theories and algorithms taught in the corresponding theory course – CSE-06133213.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Implement algorithms from a known/given pseudocode or theory
CLO2	Implement bug-free and efficient codes against all algorithms
CLO3	Do teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations

Course Content:

SL No	Contents	Hrs	CLOs
1	**Projects based on known algorithms**: one or more mini projects based on theories and algorithms covered in the class can be chosen by the course instructor. Although shorter in length, these projects will cover many data analysis steps including data pre-processing, implementation of existing algorithms, tuning parameters, and improving algorithms based on different criteria, and so on.	15	1, 2

2	**Projects based on solving real-world problem**: one or more full projects based on addressing and solving real-world problems or in-class competition (Kaggle) can be chosen by the students or assigned by the course instructor.	27	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3		3							
CLO2	3	3	3	3								
CLO3								3	3	3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, PrbL	A, PP
CLO3	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Pattern Recognition and Machine Learning – Christopher M. Bishop
2. Machine Learning: A Probabilistic Perspective – Kevin P. Murphy
3. Learning from Data: A Short Course – Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin
4. Foundations of Machine Learning – Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar

Course Code: CSE-06133215 **Course Title**: Computer Architecture
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 3rd / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

Computer Architecture is the science and art of selecting and interconnecting hardware components to create computers that meet functional, performance and cost goals. In this course, students will learn contemporary state-of-the-art in computer hardware and how to program many core machines.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Understand the Computer System, Arithmetic and Logic Unit, Central Processing Unit and parallel organization

CLO2	Demonstrate computer architecture concepts related to design of modern processors, memories and I/Os
CLO3	Understand and apply the basic principles and techniques of parallel, concurrent, distributed and real-time programming
CLO4	Develop and design an instruction set architecture and subsystems of central processing unit
CLO5	Analyze the performance of commercially available computers

Course Content:

SL No	Content	Hrs	CLOs
1	**Fundamentals of Computer Organization and Architecture:** Fundamentals of computer Design, Processor Design	3	1
2	Computer Evolution and Performance, Processor Design	3	1, 2
3	**Computer Function and Interconnection:** overview of computer BUS standards, Multiprocessors: types of multiprocessors, performance, single bus multiprocessors, multiprocessors connected by network, clusters	3	1, 2
4	**Cache Memory:** Computer Memory System Overview, Cache Memory Principles, Elements of Cache Design, Pentium 4 Cache Organization, ARM Cache Organization;	3	1, 2
5	**Internal Memory:** Memory organization, ARM Cache Organization, cache, Error Correction, virtual memory, channels; Concepts of DMA and Interrupts, Advanced DRAM Organization;	3	1, 2
6	**External Memory:** Magnetic Disk, RAID, Solid State Drives, Optical Memory, Magnetic Tape;	3	1, 2
7	**Input/ Output:** External Devices, I/O Modules, Programmed I/O, Interrupt Driven I/O, Direct Memory Access, I/O Channels and Processors, Thunderbolt and Infini Band;	3	1, 2
8	**Operating System Support:** Operating System Overview, Scheduling, Memory Management, Pentium Memory Management, ARM Memory Management	3	1, 2
9	Number Systems, Computer Arithmetic, Machine Instruction Characteristics, Types of Operands, Types of Operations	3	1, 2
10	**Processor Structure and Function; Processor design:** Data-paths, single-cycle and multi-cycle implementations; Control Unit design – hardwired and microprogrammed; Hazards; Exceptions;	3	2, 4
11	Reduced Instruction Set Computers; RISC Processor, Pipeline: pipelined data-path and control, superscalar and dynamic pipelining;	3	2, 4
12	**Parallel Processing:** Instruction-Level Parallelism and Machine Parallelism, Instruction Issue Policy, Register Renaming, Machine Parallelism, Branch Prediction;	3	2, 3
13	**Superscalar Processors:** Superscalar Execution, Superscalar Implementation;	3	2, 3
14	**Parallel Organization:** Multiple Processor Organizations, Symmetric Multiprocessors, Cache Coherence and the MESI	3	2, 3

	Protocol, Multithreading and Chip Multiprocessors, Clusters, Non-uniform Memory Access, Vector Computation.		

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2	3	3										
CLO3		1	2		3							
CLO4			3									
CLO5	3											

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, MS, SF
CLO2	CL, OR, GD	LE, V
CLO3		
CLO4	CL, OR, GD	A, RW, P, V
CLO5		
CLO6		

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion)
(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Computer Architecture and Organization by John P.Hayes.
2. Computer Organization and Design: The hardware / software interface by David A.Patterson and John L.Hennessy.

Course Code: CSE-06133216 **Course Title**: Web Technologies
Credit Value: 1.50 **Credit Hours**: 3 hours per week
Year/Semester: 3rd/2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course is intended for the students to develop an ability to design and implement static and dynamic websites by acquiring novel and modern web technologies such as HTML, Javascript, AJAX, PHP, Tomcat Server, Servlets, JSP, and ASP.NET or relevant others.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Analyze a web page and identify its elements and attributes
CLO2	Develop web pages using HTML, Javascript, Cascading Style Sheet, AJAX, PHP, Servlets, and JSPs
CLO3	Connect to Database and get results
CLO4	Build dynamic web pages using JavaScript or other modern and novel technologies

CLO5	Parse XML files using Java (DOM and SAX parsers)

Course Content:

SL No	Contents	Hrs	CLOs
1	Getting started with the novel technology and its several attributes	12	1
2	Implementation and application of the attributes of the technology in a web service	6	1, 2
3	Database integration for the novel technology-based webs	6	3
4	Apply and utilize the technology in a complete web project form	18	2, 3, 4, 5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2		2		3				2	2		
CLO2					3				2	2	2	
CLO3					3				2			
CLO4					3				3	2	3	
CLO5									3		3	

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL, BL	Q, A, V, P
CLO2	CL, GD, PrjL	P, Prj
CLO3	CL, PrjL	Prj
CLO4	CL, OR, GD, PrjL, BL	P, Prj
CLO5	CL, OR, PrjL	Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning, BL = Blended Learning)

(Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, Prj = Projects)

Recommended Readings:

1. Achyut Godbole,Atul Kahate"Web Technologies:TCP/IP,Web/Java Programming, and Cloud Computing",Third Edition,McGraw Hill Education.
2. Deitel, Deitel, Goldberg, "Internet & World Wide Web How to Program", Third Edition, Pearson Education, 2006.
3. Raj Kamal, "Internet and Web Technologies", Tata McGraw-Hill.
4. Apposite online and offline resources instructed by the course teacher.

Course Code: CSE-06133218 **Course Title**: Technical Writing and Research Methodology

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: 3rd / 2nd **Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

This course is designed to expose students to tools necessary to interpret technical knowledge into writing by using latest technologies relevant to typesetting, visualization, and presentation.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Write reports, thesis, books, illustrating technical concepts relating to CSE
CLO2	Create creative visualization of technical data using latest tools
CLO3	Present technical findings in front of audiences

Course Content:

SL No	Contents	Hrs	CLOs
1	Issues of technical writing and effective oral presentation in Computer Science and Engineering.	3	1
2	Writing styles of definitions, propositions, theorems and proofs.	3	1
3	Preparation of reports, research papers, theses, and books: abstract, preface, contents, bibliography and index. Writing of book reviews and referee reports.	7.5	1
4	Writing tools: WYSIWYG tools, LATEX.	10.5	1
5	Presentation tools; Diagramming and visualization software.	9	3
6	Research methodologies.	6	1
7	Ways of improving presentation skills.	3	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1				2	1					3		3
CLO2					1					3		3
CLO3										3		3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, BL	A, RW
CLO2	CL, T, OR, BL	Q, A, RW, V
CLO3	GD, Prbl, PrjL, BL	Prj, P, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, MS = Mid Semester, SF = Semester Final, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Handbook for Technical Writing by James H. Shelton
2. How to Write Technical Reports: Understandable Structure, Good Design, Convincing Presentation by Heike Hering

Course Code: CSE-06133230 **Course Title**: Project Work II
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: **Course Type**: Core Course
Prerequisites: CSE-06132220: Project Work I

Rationale of the Course:
This course will give students to identify a real-world problem and demonstrate skills and knowledge achieved from the previous courses to solve the problem by applying web technologies.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Identify a real-life problem and solve by Apply latest state of the art web technologies
CLO 2	Analyze, design, build, and evaluate engineering/computing system/subsystem with given specifications and requirements
CLO 3	Develop communication skills by presenting and demonstrating the project in front of audience

Course Content:

SL No	Content	Hrs	CLOs
1	Front Design, Database design, and Back-end design following particular Agile methodology.	30	1, 2
2	Testing	6	2, 3
3	Presentation and Report Writing	6	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2	2	3									2
CLO2	2		3	2								2
CLO3	2								3	3	3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD, PrbL, PrjL	PP, V
CLO2	CL, OR, GD, PrbL, PrjL	PD, RW, V
CLO3	CL, OR, GD, PrbL, PrjL	PD, RW, V

(CL = Class Lectures, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. User Stories Applied by Mike Cohn

Course Code: ECO-03113203 **Course Title**: Principles of Economics
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: 3rd /2nd **Course Type**: General Education Course
Prerequisites: None

Rationale of the Course:

This course introduces students to economic ideas, theories, and analytical methods. It addresses microeconomics, which examines the market supply and demand model, evaluating the costs and advantages of various activities, as well as production and market structure at the business level. Microeconomic market failures and macroeconomic aims are discussed alongside macroeconomic issues including commodity interaction, labor markets, and national income. The student will be able to describe consumer and producer economic motivations, market processes, and macroeconomic trends, as well as the interdependence of economic processes and the basic elements of public economic policy.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO 1	Demonstrate knowledge and understanding of core economics concepts, tools and models and critically reflect social consequences of economic decision making.
CLO 2	Use a demand and supply model to calculate the elasticities of demand and supply, as well as comprehend production costs and market structures.

CLO 3	Use marginal utility theory to predict the effects of changes in prices and incomes and to explain the budget line.
CLO 4	Measure national income and rates of unemployment and inflation as well as identify the phases of the business cycle.
CLO 5	Demonstrate the concepts of money supply and money creation by the banking system and the role of the central bank.

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction**: Scope of economics, Microeconomics and macroeconomics, Economic problem and economic systems, economic questions –Social and Self-Interest, Opportunity cost and Trade-Off; Production Possibilities Frontier, Circular flow of income.	3	1
2	**Demand and Supply:** The Law of demand and supply, Factors affecting demand and supply, Demand and supply function, Market equilibrium, Changes in price and quantity. Elasticity of demand and supply, Price ceiling and price floor.	3	2
3	**Theory of Consumer Behaviour:** Concepts of utility, paradox of value, Diminishing marginal utility**,** Indifference curves, Consumer equilibrium – consumption possibilities and budget line.	6	3
4	**Theory of Firms:** Firm's goals and accounting profit, Technological efficiency and economic efficiency, Types of business organization, Pros and cons of different types of firms, Law of diminishing returns, Short-run and long-run cost, Economies and diseconomies of scale.	6	2
5	**Markets Structures:** Characteristics of different market structures, Perfect Competition, Monopoly, Oligopoly, Monopolistic competition.	3	2
6	**Introduction to Macroeconomics:** Definitions of macroeconomics, Macroeconomic performance, Objectives and instruments of macroeconomics, GDP, GNP, NI, Circular flow of income.	3	4
7	**Measuring National Income:** GNP-concept and measurement, GDP, GNP, NI And personal disposable income, Price indices, Aggregate demand and supply, macroeconomic equilibrium, Multiplier model of income and expenditure.	6	4
8	**Money Market and Monetary Policy:** Definition and functions and types of money, money creation through credit by commercial banks and financial institution, Functions of central bank, Demand for money, Money supply, Open market operations, Interest rate, Reserve ratio and Money multiplier.	6	5
9	**Inflation and Unemployment:** Definitions, measures of inflation, types of inflation, costs of inflation, consequences of price instability on markets, Demand pull and cost push, remedies, definitions, causes and types of unemployment, Measurement of unemployment. Natural rate of unemployment and full employment.	6	4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3										2
CLO2		3	2	2								2
CLO3		3	2	2		3	2					2
CLO4		3	2	2		3	2				3	2
CLO5			2	2		3		2		3	3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T	CT, A, Q, MF
CLO2	CL, T	CT, A, Q, MF
CLO3	CL, T, PrbL	CT, A, Q, MF
CLO4	CL, T, OR, PrbL	CT, P, SF
CLO5	CL, T, OR, GD	CT, P, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Microeconomics – Roger A. *Arnold;* Cengage Learning, 13/E, 2018.
2. Macroeconomics – Michael Parkin; Pearson, 13/E, 2018.
3. Microeconomics – Michael Parkin; Pearson, 13/E, 2018.
4. Principles of Microeconomics – N. Gregory Mankiw; Cengage Learning, 8/E, 2017.
5. Principles of Macroeconomics – Karl E. *Case*, Ray C. *Fair* and Sharon E. *Oster*; Pearson, 13/E, 2019.
6. Macroeconomics: Principles & Policy – William J. Baumol, Alan S. Blinder, and John L. Solow; Cengage Learning, 14/E, 2019.

4th Year / 1st Semester

Course Code: CSE-06134111 **Course Title**: Software Testing and Management
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st **Course Type**: Core Course
Prerequisites: None.

Rationale of the Course:
This course attempts to enlighten students on how software projects are tested and managed properly (planning, scheduling, resource allocation, execution, tracking and delivery), developing the basic skills and different software V & V plans and techniques in the current software industry.

Course Learning Outcomes (CLOs):
On successful completion of this course, students will be able to:

CLO1	Demonstrate the application of verification and validation tasks and their outcomes during the software life cycle
CLO2	Apply various verification and validation techniques, appropriate planning, and scoping to verification and validation effort based on the needs and characteristics of the system/software (safety, security, risk, etc.) being developed
CLO3	Improve the knowledge of the blueprint of the entire project from ideation to fruition
CLO4	Develop managerial skill-set such as cost estimation, risk management, configuration management, proper use of available resources etc

Course Content:

SL No	Contents	Hrs	CLOs
1	**Software verification and validation:** introducion, principles. **Software Testing:** Testing fundamentals, test case design, white-box testing, black-box testing, basis path testing, testing for specialized environments, testing GUIs. **Software testing strategies:** Unit testing, Integration testing, validation testing, system testing, debugging. Zips Concepts of software reliability and availability; Software repair, downtime, error and faults, specification and correction. Quality assurance; Quality measures; Different cost estimation models and their comparisons; Software maintenance;	14	1
2	**Software Verification and Validation methods** **Software Verification and Validation tools:** Tools for tracing, formal proof, and testing. **Software Verification and Validation plan:** Style, responsibility, medium, service information.	14	1
3	Planning and managing of software development projects. Software process models. ISO 9000, SEI's Capability Maturity Model, continuous process improvement. Planning, scheduling, tracking, cost estimation, risk management, configuration management.	14	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3		3									
CLO2	2		3									
CLO3	2		3	3								
CLO4	2	2	2	2								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, A, V, P, MS, FS
CLO2	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, FS
CLO3	CL, T, OR, PrbL, BL	CT, Q, A, V, P, MS, FS
CLO4	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, FS

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Software verification and validation for practitioners and managers, Second edition by Steve Rakitin.
2. Software Project Management for Dummies by Joseph Phillips and Teresa Luckey.
3. Introduction to Software Project Management by Book by Adolfo Villafiorita.

Course Code: CSE-06134112 **Course Title**: Software Testing and Management Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 4^{th} / 1^{st} **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

The course is designed for practical implementations of theories and concepts taught in the corresponding theory course – CSE-06134111.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Implement strategies for testing CLI and GUI based software
CLO2	Implement bug-free and efficient codes for automated testing of different software
CLO3	Do teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations

Course Content:

SL No	Contents	Hrs	CLOs
1	**Projects based on known algorithms**: one or more mini projects based on theories and algorithms covered in the class can be chosen by the course instructor. Although shorter in length, these projects will cover many data analysis steps including data pre-processing, implementation of existing algorithms, tuning parameters, and improving algorithms based on different criteria, and so on. **Mini projects for manual and automated testing**: one or more mini projects to test different strategies for manual and automated testing of different CLI/GUI based software	15	1, 2
2	**Projects based on solving real-world problem**: one or more full projects based on addressing and solving real-world problems or in-class competition can be chosen by the students or assigned by the course instructor.	27	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3		3							
CLO2	3	3	3	3								
CLO3								3	3	3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, PrbL	A, PP
CLO3	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Software verification and validation for practitioners and managers, Second edition by Steve Rakitin.
2. Software Project Management for Dummies by Joseph Phillips and Teresa Luckey.
3. Introduction to Software Project Management by Book by Adolfo Villafiorita.

Course Code: CSE-06134113 **Course Title**: Digital Signal Processing
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st **Course Type**: Core Course
Prerequisites: MAT-05412205: Complex Variables, Laplace Transform and Fourier Series

Rationale of the Course:
This advanced course is designed to impart students with the knowledge of signal processing as a tool to analyze different practical computing and communication system.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Recognize, understand, and explain the fundamental concepts of DSP
CLO2	Analyze and evaluate the properties of different LTI systems in both time domain and frequency using different transforms like Fourier transform and Z-transforms
CLO3	Apply concepts learnt in this course to analyze different digital systems like filters
CLO4	Design digital systems to process real like signals based on practical requirements

Course Content:

SL No	Contents	Hrs	CLOs
1	**Signals and Systems:** Introduction to signals, classification of signals, mathematical operations on signals, common signal model like unit step, impulse, ramp, sinusoidal, and exponential function; Introduction to systems, mathematical model of systems, classification of systems. Analog to digital conversion, impulse response, finite impulse response (FIR) and infinite impulse response (IIR) of discrete-time systems, difference equation, convolution, transient and steady state response.	7.5	1
2	**Sinusoids and spectrum representation**: Mathematical model of sinusoidal signals in time and frequency domain, operations on sinusoids in time and frequency domain, representation of signals in time and frequency domain.	3	1
3	**Sampling and domain conversion**: Basic principles of sampling, changing sampling rate, prefiltering to avoid aliasing, quantization errors, Nyquist Criterion, aliasing.	1.5	1,2
4	**Fourier Transform**: Discrete Fourier series, discrete-time Fourier series, discrete Fourier transform (DFT) and properties, fast Fourier transform (FFT), inverse fast Fourier transform.	12	1,2
5	**Correlation**: Circular convolution, auto-correlation and cross correlation.	1.5	1
6	**Z Transform**: z-transformation, properties, transfer function, poles and zeros, ROC, and inverse z-transform.	7.5	1,2
7	**Filter** Digital Filters, Advantage of Digital Filter, Classes of Digital filters (FIR Filter and IIR Filter), Choosing Between FIR and IIF filter, Filter Design Steps, Key Characteristics of FIR filters, FIR filter Specification, Running average filter, filter design.	9	1,2, 3,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											

CLO2	3	3										
CLO3		3		3								3
CLO4			3									3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, A, V, MS, SF
CLO2	CL, T, OR, GD, PrbL	CT, Q, A, V, MS, SF
CLO3	CL, T, OR, GD, PrbL	CT, Q, A, V, SF
CLO4	CL, T, OR, GD, PrbL, PrjL	Prj, P, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, MS = Mid Semester, SF = Semester Final, Prj = Projects)

Recommended Readings:

1. Digital Signal Processing: Principles, Algorithms, and Applications by John G. Proakis and Dimitris G. Manolakis
2. DSP First by James H. McClellan, Ronald W. Schafer, and Mark A. Yoder
3. Discrete-Time signal processing by Alan V. Openheim, Ronald W. Schafer
4. Understanding Digital Signal Processing by Richard G. Lyons
5. Signal Processing and Linear Systems by B. P. Lathi
6. Digital Signal Processing: A Practical Approach by Emmanuel C. Ifeachor

Course Code: CSE-06134114 **Course Title**: Digital Signal Processing Lab

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st **Course Type**: Core Course

Prerequisites: None

Rationale of the Course:

This advanced course is designed to expose students to the tools of signal processing required to analyze different practical computing and communication system practically.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Use mathematical tools like MATLAB or Octave to design and simulate Digital Signal Processing systems
CLO2	Apply concepts learnt in this course to analyze different practical digital systems
CLO3	Design digital systems to process real like signals based on practical requirements as part group project

Course Content:

SL No	Contents	Hrs	CLOs
1	Introduction to software tools necessary for digital signal processing.	3	1

2	Generating basic signals and visualizing them.	3	1
3	Building simple systems with basic operating on any signals.	3	1
4	Building systems for computation of convolution, correlation, interpolation, etc.	3	1
5	Building systems for computation of Fourier (CTFT, DTFT, FFT) and Laplace transform.	6	1,2
6	Image signal generation, processing, and visualization.	3	1,2
7	Sound signal generation, processing, and visualization.	3	1,2
8	Filter design.	6	1,2
9	Multirate DSP (e.g. up-sampling, down-sampling, etc).	3	1
10	Lab project design, implementation, and submission.	9	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3				3							3
CLO2		3		3								3
CLO3		3	3						3		3	3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, V, PP, RW, LE
CLO2	CL, T, OR, PrbL, BL	CT, Q, V, PP, RW, LE
CLO3	OR, GD, PrbL, PrjL	Prj, RW, P, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(CT = Class Test, Q = Quiz, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Digital Signal Processing using MATLAB® by Vinay K. lngle and John G. Proakis
2. Digital Signal and Image Processing using MATLAB® by Gérard Blanchet and Maurice Charbit
3. Think DSP: Digital Signal Processing in Python by Allen B. Downey

Course Code: GED-02234101 **Course Title**: Engineering Ethics and Cyber Law
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

The course is designed to enable students with the knowledge of engineering ethics and motivate them to work under ethical standards relevant to engineering. This course also focuses on the issues of cyber law.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Understand the theoretical aspects of ethics and moral philosophy in engineering professional fields
CLO2	Apply diverse viewpoints to ethical dilemmas in the information technology field and recommend appropriate actions
CLO3	Identify and analyze statutory, regulatory, constitutional, and organizational laws that affect the information technology professional

Course Content:

SL No	Contents	Hrs	CLOs
1	**Engineering Ethics**: Introduction to Ethics; Theories of Ethics; Principles of Engineering Ethics;	4.5	1
2	**Ethical expectation**: Employers and employees, Inter-professional relationship.	4.5	1,2
3	**Standards and codes**: Fundamental Canons, NSPE codes, IEEE codes of conduct, ACM codes; Institutionalization of ethical conduct. Ethical Dilemmas, Choices (Whistle Blowing),	9	1
4	**Computer Ethics**: Computer Crime and Cyber Security, Privacy and Confidentiality issue in CSE, Legal Framework in CSE-Copyright laws, ICT Act, Right To Information (RTI), Patents, and Royalty etc. Ethical Challenges for CSE Engineers with the advancement of Technology; Case studies related to ethical issues in ICT and other Engineering disciplines.	12	1,2,3
5	**Engineers and the Environment**: The Environment in Law and Court Decisions; Criteria for a ‘‘Clean’’ Environment; The Progressive Attitude toward the Environment; Respect for Nature; The Scope of Professional Engineering Obligations to the Environment.	6	1,2,3
6	Introduction to Philosophy of Engineering, metaphysics, epistemology, axiology, and logic.	6	2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1							3	3		2		3
CLO2							3	3		2		3

CLO3							3	3		2		3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, V, MS, SF
CLO2	CL, T, OR, GD, BL	CT, Q, A, V, MS, SF
CLO3	CL, T, OR, GD, BL	A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Engineering Ethics: Concepts and Cases by Charles E. Harris
2. Engineering Ethics by Charles B. Fleddermann,
3. The Elements of Moral Philosophy by James Rachels & Stuart Rachels

Course Code: CSE-06134140 **Course Title**: Thesis I
Credit Value: 2.0 **Credit Hours**: 4 hours/week
Year/Semester: $4^{th}/1^{st}$ **Course Type**: Thesis/Project
Prerequisites: None

Rationale of the Course:
In this course students will learn how to conduct research and come up with novel ideas that can create impact on the contemporary research world.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Understand how to find research articles, read them efficiently, and summarize them
CLO2	Explore the research articles to find out noble scopes of scientific contributions and analyze research problems from the chosen scope to find appropriate research question
CLO3	Prepare research proposals addressing the chosen research question
CLO4	Initiate writing a thesis and Interactively present the research proposals and works

Course Content:
Research work based on all major courses.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2		3	2				3		2			
CLO3			2							3		
CLO4										3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	OR, GD	V
CLO2	OR, GD	V
CLO3	OR, GD, PrbL	RW, P, V
CLO4	OR, BL	RW, P, V

(OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)

(V = Viva-voce, P = Presentation, RW = Report Writing)

Course Code: CSE-06134142 **Course Title**: Project I

Credit Value: 2.0 **Credit Hours**: 4 hours/week

Year/Semester: $4^{th}/1^{st}$ **Course Type**: Thesis/Project

Prerequisites: None

Rationale of the Course:

This course is intended to allow students use knowledge achieved in their continuing undergraduate study to apply and solve real life problems through computing knowledge.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Identify real-life problem that can be solved using computing system
CLO2	Identify outcomes and functional requirements of the proposed solution considering software and/or hardware specification and standards
CLO3	Analyze, design, build, and evaluate computing system with given specifications and requirements using latest technologies
CLO4	Present their project

Course Content:

Project work based on all major courses.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3		3		2		2				
CLO2		2		2				2				
CLO3					3				3		3	
CLO4										3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	RA, OR, GD	RW, P
CLO2	RA, OR, T, GD, PrjL	RW, P, V
CLO3	OR, GD, PrbL, PrjL	Prj, RW, P, V,
CLO4	OR, BL	Prj, RW, P, V

(RA = Requirement AnalysisT = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(V = Viva-voce, P = Presentation, RW = Report Writing, Prj = Projects)

4th Year / 2nd Semester

Course Code: CSE-06134211 **Course Title**: Computer Graphics
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 4th/2nd **Course Type**: Core Course
Prerequisites: MAT-05411203: Linear Algebra

Rationale of the Course:
In engineering and imaging technology, computer graphics rapidly enhance the ability to visualize different designed shapes, structures, and images. Moreover, introducing several techniques, focusing on 3D modeling, image synthesis, and rendering, the goal is for students to learn a comprehensive study to grasp contemporary terminology, progress, issues, and trends to view and modify the models of shape and others interactively.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Select and analyze fundamentals such as digital image representation, color perception, image formation, and image processing
CLO2	Apply algorithms related to hidden surface removal that includes but are not limited to the Z-buffer algorithm and the Painter's algorithm
CLO3	Elaborate on the algorithmic and mathematical tools used to create a variety of digital images and effects
CLO4	Demonstrate three main subjects within computer graphics, modeling, rendering, and animation

Course Content:

SL No	Contents	Hrs	CLOs
1	**Raster Graphics:** Line Drawing, Anti-aliasing, Polygon Filling Algorithms.	9	1
2	**Matrix:** 2D and 3D Rotation and Translation Matrix.	6	4
3	**Camera Analogy:** Viewing, Windowing, Clipping.	6	3, 4
4	**Hidden Surface Removal:** z-buffering.	3	2
5	**Projective Transformation (Ray-tracing):** Orthogonal Projection, Perspective Projection.	3	4
6	**Vector:** Normal Vector, View Vector.	3	1
7	**Lighting and Surface Property:** Diffused Light, Ambient Light, Specular Light, Lighting Models for reflection.	3	3, 4
8	**Shading:** Flat Shading, Lambert Shading, Phong Shading.	3	3, 4
9	**Texture Mapping:** Texture Fundamentals.	3	3, 4
10	**Computer Graphics Programming:** OpenGL. **Animation:** Real-time animation.	3	4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	3									
CLO2	3	3	3									
CLO3	3	2	3	1	3							
CLO4	2	2	2	2	3							

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, A, MS, SF
CLO2	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO3	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF
CLO4	CL, T, OR, PrbL, BL	CT, Q, A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Theory and Problems of Computer Graphics (3rd Edition) – Zhigang Xiang, Roy A. Plastock; McGraw Hill (2000).
2. Computer Graphics C Version (3rd Edition) – Donald Hearn, M. Pauline Baker; Pearson Prentice Hall (2004).
3. Computer Graphics Principle and Practice (3rd Edition) – Donald Hearn, M. Pauline Baker; Addison-Wesley Professional (2013).

Course Code: CSE-06134212 **Course Title**: Computer Graphics Lab
Credit Value: 1.50 **Credit Hours**: 3 hours per week
Year/Semester: 3rd /2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:

This course motivates to develop and modify 2D and 3D visualization and transformation of any geometric object by using graphics library as well as working with texturing, lighting and coloring of such objects to develop different types of digital images with various effects.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Achieve a basic idea about the OpenGL graphics library
CLO2	Design and develop 2D and 3D graphical geometric objects using OpenGL
CLO3	Learning simple animation, lighting, coloring and texturing

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction to OpenGL**	9	1
2	**Line Drawing:** Bresenhams	3	2
3	**Region Filling:** Scan Line Algorithm	3	2
4	**Transformation:** 2D and 3D translation, Rotation, Scaling	9	2
5	**Clipping:** Line and Polygon	6	2, 3
6	**Projection:** Perspective and Parallel	6	2, 3
7	**Animation:** Morphing	6	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1					2		3					3
CLO2						3						
CLO3									3	2		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrjL, BL	A, LE, PP, Prj
CLO2	CL, T, OR, PrjL, BL	A, LE, PP, Prj
CLO3	CL, T, OR, GD, PrjL, BL	A, LE, PP, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. OpenGL Programming Guide: The Official Guide to Learning OpenGL (8th Edition) - Dave Shreiner, Graham Sellers, John Kessenich and Bill Licea-Kane; Addison Wesley Professional (2013).

Course Code: CSE-06134213 **Course Title**: Compiler Construction
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:

This course is intended for the students to learn to design, construct, and implement the internal structure of the compiler technologies that will assist them in taking a quick lesson

of any programming language to develop software and contribute to the related research fields.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Recognize the fundamental concept of the compiler and its phases
CLO2	Analyze the characteristics of some standard compilers and data structures such as syntax trees, symbol tables, three-address code, and stack machines
CLO3	Elaborate the lexical and syntax analyzer to construct scanners and parsers of the code, respectively
CLO4	Apply the optimization techniques of the compiler and its evaluation
CLO5	Apply the different address codes the compiler uses to make corresponding assembled code

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction to compilers:** Introductory concepts, types of compilers, applications, phases of a compiler.	3	1
2	**Lexical analysis:** Role of the lexical analyzer, input buffering, token specification, recognition of tokens, symbol tables.	3	2, 3
3	**Parsing:** Parser and its role, context-free grammars, top-down parsing.	9	2, 3
4	**Syntax-directed translation:** Syntax-directed definitions, construction of syntax trees, top-down translation.	3	2
5	**Type checking:** Type systems, type expressions, static and dynamic checking of types, error recovery.	3	2
6	**Run-time organization:** Run-time storage organization, storage strategies.	3	2
7	**Intermediate code generation:** Intermediate languages, declarations, assignment statements.	6	5
8	**Code optimization:** Basic concepts of code optimization, principal sources of optimization.	6	4
9	**Code generation:** Features of some common compilers: Characteristic features of C, Pascal, and Fortran compilers.	6	5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2		2									3
CLO2	3	2					2					
CLO3	3	1	2									
CLO4	3			2								

CLO5	3	2	1	2								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, PrbL	CT, Q, A, MS
CLO2	CL, T, PrbL, BL	CT, Q, A, MS, SF
CLO3	CL, T, OR, BL	CT, A, MS, SF
CLO4	CL, T, OR, PrbL	CT, A, V, SF
CLO5	CL, T, OR, BL	CT, Q, A, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman (Dragon book), Second Edition.
2. Engineering a Compiler - Keith Cooper, Linda Torczon.

Course Code: CSE-06134214 **Course Title**: Compiler Construction Lab

Credit Value: 1.5 **Credit Hours**: 3 hours per week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course is intended for the students to learn to design, construct, and implement the internal structure of the compiler technologies that will assist them in taking a quick lesson of any programming language to develop software and contribute to the related research fields.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Learn several generators and tools such as Lex/Flex/JFlex and CUP/Yacc
CLO2	Create scanner and parsers utilizing the lexical and syntactic analyzers
CLO3	Evaluate abstract syntax trees, symbol tables, three-address code, and stack machines, among other fundamental data structures used in compiler construction
CLO4	Create, design and implement a basic compiler by applying a software engineering methodology
CLO5	Analyze the features of some standard compilers

Course Content:

SL No	Contents	Hrs	CLOs
1	How to use scanner and parser generator tools (e.g., Flex, JFlex, CUP, Yacc, etc).	15	1, 5

2	For a given simple source language designing and implementing lexical analyzer, symbol tables, and parser.	15	2, 3
3	Design and implement the intermediate code generator and code generator for a given simple source language.	12	4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	2				3							
CLO2	3	3			3				2			
CLO3	3	3	3		3							
CLO4	3	3	3		3				2		3	
CLO5	2		2									

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, PrbL, BL	A, LE, PP
CLO2	CL, T, OR, BL	A, V, PP
CLO3	CL, T, OR, PrbL, BL	A, V, LE
CLO4	CL, OR, PrjL	V, Prj
CLO5	CL, T, OR, BL	A, V, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(A = Assignment, V = Viva-voce, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Modern Compiler Implementation in Java/C, Andrew W. Appel.

Course Code: CSE-06134250 **Course Title**: Thesis II

Credit Value: 2.0 **Credit Hours**: 4 hours/week

Year/Semester: $4^{th}/2^{nd}$ **Course Type**: Thesis/Project

Prerequisites: CSE-06134140: Thesis I

Rationale of the Course:

This course is the continuation of the Thesis I (CSE-06134140) and aims to achieve a novel research work that is publishable in good quality conferences/journals.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Complete the background study addressing the research question chosen in thesis I
CLO2	Analyze the research question and find an appropriate solution

CLO3	Write a complete thesis and prepare research articles publishable in good quality conferences/journals
CLO4	Interactively present the completed research works

Course Content:
Research work based on all major courses. This course will be a continuation of CSE-06134140.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2		3	2				3		2			
CLO3			2							3		
CLO4										3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	OR, GD	V
CLO2	OR, GD, PrbL	RW, P, V
CLO3	OR, GD, PrbL	RW, P, V
CLO4	OR, BL	RW, P, V

(OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)
(V = Viva-voce, P = Presentation, RW = Report Writing)

Course Code: CSE-06134252 **Course Title**: Project II
Credit Value: 2.0 **Credit Hours**: 4 hours/week
Year/Semester: 4th/2nd **Course Type**: Thesis/Project
Prerequisites: CSE-06134142: Project I

Rationale of the Course:
This course is a continuation of Project I (CSE-06134142) and intends to allow students to use knowledge achieved in their continuing undergraduate study to apply and solve real life problems through computing knowledge.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Identify real-life problem that can be solved using computing system
CLO2	Identify outcomes and functional requirements of the proposed solution considering software and/or hardware specification and standards

CLO3	Analyze, design, build, and evaluate computing system with given specifications and requirements using latest technologies
CLO4	Present their project

Course Content:
Project work based on all major courses. This course will be a continuation of CSE-06134142.

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		3		3		2		2				
CLO2		2		2				2				
CLO3					3				3		3	
CLO4										3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	RA, OR, GD	RW, P
CLO2	RA, OR, T, GD, PrjL	RW, P, V
CLO3	OR, GD, PrbL, PrjL	Prj, RW, P, V,
CLO4	OR, BL	Prj, RW, P, V

(RA = Requirement AnalysisT = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(V = Viva-voce, P = Presentation, RW = Report Writing, Prj = Projects)

Course Code: CSE-06134260 **Course Title**: Viva Voce
Credit Value: 2.0 **Credit Hours**: 4 hours/week
Year/Semester: 4th / 2nd **Course Type**: Core Course
Prerequisites: None

Rationale of the Course:
This course aims to make students get mentally prepared for real life interviews by recalling all the important and fundamental knowledge they have acquired during the full undergrad session.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Present skills on facing verbal sessions
CLO2	Recall fundamental information they acquired in their undergrad life
CLO3	Argue logically and defend their answer

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3									3		
CLO2	3									3		
CLO3	3									3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	V
CLO2		
CLO3		

(CL = Class Lectures, T = Textbook, OR = Online Resources)

(V = Viva-voce)

Elective Courses

Course Code: CSE-06134011 **Course Title**: Advanced Algorithm and Data Structure
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: CSE-06132113: Algorithm Design and Analysis

Rationale of the Course:
This course introduces students advanced methods of data structure and algorithmic design, analysis, and implementation to ensure that the students evolve into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Understand and analyze effective algorithmic paradigms and efficient data structures
CLO2	Comprehend and select algorithm design approaches in a problem specific manner
CLO3	Apply and implement learned algorithm design techniques and data structures in problem solving
CLO4	Prove the correctness of programs and reason about their space and time complexities

Course Content:

SL No	Content	Hrs	CLOs
1	Introduction to the analysis of algorithms; Review growth of functions and solving recurrences	3	1
2	Randomized algorithms and probabilistic analysis	4	1, 2
3	Binary search trees; Red-black trees; Hashing	4	1, 2
4	Heaps, Binomial heaps, and Fibonacci heaps	4	1, 2
5	Amortized analysis	3	1, 2
6	Graph algorithms, minimum spanning tree and shortest path algorithms	6	1, 2, 3
7	Dynamic programming (edit distance, RNA folding, chains of matrix multiplication, etc.)	6	1, 2, 3
8	Network flow and its use for solving problems (e.g., matching, survey design)	6	1, 2, 3
9	Linear programming; NP-completeness; Randomized algorithms	6	3, 4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3		2								
CLO2	3	3		3								
CLO3		3	3		1							
CLO4	3	3										

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, MS
CLO2	CL, T, OR, PrbL	CT, A, MS, SF
CLO3		
CLO4	CL, T, OR, GD	CT, A, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. Advanced Data Structures by Peter Brass
3. The Algorithm Design Manual by Steven S S. Skiena

Course Code: CSE-06134012 **Course Title**: Advanced Algorithm and Data Structure Lab

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course is designed to provide a practical understanding of advanced methods of algorithmic design, analysis, and implementation to ensure that the students evolve into a competent programmer capable of designing and analyzing implementations of algorithms and data structures for different kinds of problems.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Comprehend and select algorithm design approaches in a problem specific manner
CLO2	Apply and implement learned algorithm design techniques and data structures in problem solving
CLO3	Prove the correctness of programs and reason about their space and time complexities

Course Content:

SL No	Content	Hrs	CLOs
1	Laboratory works based on theory classes	42	1

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3		3								
CLO2		3	3		1							
CLO3	3	3										

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, PP, LE, V
CLO2		
CLO3		

(CL = Class Lectures, T = Textbook, OR = Online Resource, GD = Group Discussion, PrbL = Problem-based Learning)

(A = Assignment, V = Viva-voce, LE = Lab Examination, PP = Programming Problems)

Recommended Readings:

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
2. Advanced Data Structures by Peter Brass
3. The Algorithm Design Manual by Steven S S. Skiena

Course Code: CSE-06134013 **Course Title**: Advanced Database Systems
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: CSE-06132211: Database System

Rationale of the Course:

This course provides students with theoretical knowledge and practical skills in advanced topics in database systems, big data and modern data-intensive systems. The specific topics include indexing methods, query processing and optimization strategies for relational database systems, Object Relational Mapping and Object Database design, distributed database systems, data mining on large databases.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Explain and evaluate the fundamental theories and requirements that influence the design of modern database systems
CLO2	Assess and apply database functions and packages suitable for enterprise database development and database management
CLO3	Critically evaluate alternative designs and architectures for databases and data warehouses
CLO4	Discuss and evaluate methods of storing, managing and interrogating complex data
CLO5	Explore a research aspect of advanced databases

Course Content:

SL No	Content	Hrs	CLOs
1	**Object oriented database**: data model, design, languages	3	1
2	**Object relational database:** complex data types, querying with complex data types, design	6	1,2
3	**distributed database:** levels of distribution transparency, translation of global queries to fragment queries, optimization of access strategies	9	1,2
4	management of distributed transactions, concurrency control, reliability, administration	9	1,2
5	**Parallel Database:** different types of parallelism, design of parallel database	3	1,2
6	**Multimedia database systems:** basic concepts, design, optimization of access strategies, management of multimedia database systems, reliability	9	1,4
7	**Database warehousing/ data mining:** basic concepts and algorithms	3	3,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3		2	1								
CLO2	3	2	3	3								
CLO3		3	3	2	1							
CLO4	3			2	1							
CLO5	3			3		2						

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, MS
CLO2		
CLO3	CL, T, OR, GD	CT, A, MS, SF
CLO4		
CLO5	CL, T, BL	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, BL = Blended Learning)

(CT = Class Test, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Database System Concept, Abraham Silberschatz, Henry F. Korth, S. Sudarshan
2. Files and Databases- An Introduction, Peter D. Smith and G.M. Barnes, AddisonWesley
3. Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke

Course Code: CSE-06134014 **Course Title**: Advanced Database Systems Lab

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year: 4^{th} / 1^{st} or 2^{nd} **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course provides students with practical skills in advanced topics of database systems, big data and modern data-intensive systems.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Assess and apply database functions and packages suitable for enterprise database development and database management
CLO2	Design, develop and implement a mid-scale relational database for an application domain using a commercial-grade RDBMS
CLO3	Critically evaluate alternative designs and architectures for databases and data warehouses

Course Content:

SL No	Content	Hrs	CLOs
1	Laboratory works based on theory classes.	42	1, 2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	3	3								

CLO2		3	3	2	1							
CLO3	3			2	1							

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL, PrjL	A, PP, LE, V, Prj
CLO2		
CLO3		

(CL = Class Lectures, T = Textbook, OR = Online Resource, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(A = Assignment, V = Viva-voce, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Oracle Spatial User's Guide and Reference, 10g Release 1 – Chuck Murray.
2. Database System Concept, Abraham Silberschatz, Henry F. Korth, S. Sudarshan
3. Files and Databases- An Introduction, Peter D. Smith and G.M. Barnes, AddisonWesley
4. Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke

Course Code: CSE-06134015 **Course Title**: Digital Image Processing

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course provides an introduction to basic concepts, methodologies, and algorithms of digital image processing for image analysis and information retrieval.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Describe and explain basic principles of digital image processing
CLO2	Design and implement algorithms that perform basic image processing (e.g., noise removal and image enhancement)
CLO3	Design and implement algorithms for advanced image analysis (e.g., image compression, image segmentation & image representation)
CLO4	Assess the performance of image processing algorithms and systems

Course Content:

SL No	Content	Hrs	CLOs
1	**Digital image fundamentals**: visual perception, Light and Electromagnetic Spectrum	3	1
2	Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, Linear and Nonlinear operations	3	1

3	**Image Transforms:** First Fourier Transform (FFT), Discrete Cosine Transform (DCT), Karhunen and Loeve Transform (KLT), Wavelet transform and sub-band decomposition	6	2
4	**Image Enhancement:** Background, Enhancement by Point Processing	3	2
5	**Spatial Domain:** Gray level transformations, Histogram processing, Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filtering	3	2
6	**Frequency Domain:** Introduction to Fourier Transform, Smoothing and Sharpening frequency domain filters, Ideal, Butterworth and Gaussian filters	6	2
7	**Image Restoration:** Noise Models – Mean Filters, Order Statistics, Adaptive Filters, Band Reject Filters, Band Pass Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener Filtering	6	2,4
8	**Image Segmentation:** Detection of discontinuities, Edge linking and boundary detection, Region based segmentation, Morphological processing: erosion and dilation	6	3,4
9	**Image Compression**: Fundamentals, Image Compression Models, Error Free Compression, Variable Length Coding, Bit-Plane Coding, Lossless Predictive Coding, Lossy Compression, Lossy Predictive Coding, Compression Standards	6	3,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											
CLO2			3		3							
CLO3			3		3							
CLO4				3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, MS
CLO2	CL, T, OR, GD, PrbL	CT, Q, A, MS, SF
CLO3		
CLO4	CL, GD, PrbL	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Digital Image by R. C. Gonzalez and R.E. Woods (Pearson Prentice Hall)
2. Digital Image Processing Using MATLAB (Third Edition) by Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins

3. Fundamentals of Digital Image Processing by Anil Jain K.

Course Code: CSE-06134016 **Course Title**: Digital Image Processing Lab
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
This course is designed to provide a practical understanding of the essential properties of digital image processing for image analysis and information retrieval.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Design and implement algorithms that perform basic image processing (e.g., noise removal and image enhancement)
CLO2	Design and implement algorithms for advanced image analysis (e.g., image compression, image segmentation & image representation)
CLO3	Assess the performance of image processing algorithms and systems.

Course Content:

SL No	Content	Hrs	CLOs
1	Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale)	3	1
2	Implementation of Relationships between Pixels	3	1, 2
3	Implementation of Transformations of an Image	3	1, 2
4	Contrast stretching of a low contrast image, Histogram, and Histogram Equalization	3	1, 2
5	Display of bit planes of an Image	3	1, 2
6	Display of FFT (1-D & 2-D) of an image	3	1, 2
7	Computation of Mean, Standard Deviation, Correlation coefficient of the given Image	3	1, 2
8	Implementation of Image Smoothening Filters (Mean and Median filtering of an Image)	3	1, 2
9	Implementation of image sharpening filters and Edge Detection using Gradient Filters	3	1, 2
10	Image Compression by DCT, DPCM, HUFFMAN coding	6	1, 2
11	Implementation of image restoring techniques	3	1, 2
12	Implementation of Image Intensity slicing technique for image enhancement	3	1, 2
13	Canny edge detection Algorithm	3	1, 2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1			3		3							
CLO2			3		3							
CLO3				3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL, PrjL	A, PP, LE, V, Prj
CLO2		
CLO3		

(CL = Class Lectures, T = Textbook, OR = Online Resource, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(A = Assignment, V = Viva-voce, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Digital Image by R. C. Gonzalez and R.E. Woods (Pearson Prentice Hall)
2. Digital Image Processing Using MATLAB (Third Edition) by Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins
3. Fundamentals of Digital Image Processing by Anil Jain K.

Course Code: CSE-06134017 **Course Title**: Computer Vision
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:

This course provides a general introduction to computer vision. It will cover standard techniques in vision, as well as newer techniques based on machine learning and deep neural networks.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Analyze both the theoretical and practical aspects of computing with images
CLO2	Describe the foundation of image formation, measurement, and analysis
CLO3	Describe and apply common methods in various vision tasks, such as image segmentation, object recognition, image generation

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction and image formation**: human vision; geometry; photometry; quantization; camera calibration.	3	1, 2
2	**Image processing**: point operations; filtering; pyramids and wavelets; Hough transform.	6	1, 3

3	**Image segmentation and feature extraction**: various methods of image segmentation; edge detection; object proposals; SIFT features.	6	1, 3
4	**Object recognition – traditional methods**: HoG/SIFT features; Bayes classifiers; SVM classifiers.	6	1, 3
5	**Object recognition – deep neural networks**: Image classification; object detection and semantic segmentation; adversarial attacks; various neural network architectures (e.g., convolutional neural network-based architectures); visualization techniques.	15	1, 3
6	**Image generation**: generative adversarial networks; variational autoencoder.	6	1, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3	3	3							3
CLO2	3				3							
CLO3	3	3	3	3	3							3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, A, MS
CLO2	CL, T, OR	CT, A, SF
CLO3	CL, T, OR, GD, PrbL	CT, A, V, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning)

(CT = Class Test, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Computer Vision: algorithms and applications – Richard Szeliski
2. Computer Vision: A modern approach – David A. Forsyth, Jean Ponce

Course Code: CSE-06134018 **Course Title**: Computer Vision Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
The course is designed for practical implementations of theories and algorithms taught in the corresponding theory course – CSE-06134017.

Course Learning Outcomes (CLOs):

On successful completion of this course, students will be able to:

CLO1	Implement algorithms from a known/given pseudocode or theory
CLO2	Implement bug-free and efficient codes against all algorithms
CLO3	Do teamwork to solve complex real-world problems and communicate their findings on a written report and/or by oral presentations

Course Content:

SL No	Contents	Hrs	CLOs
1	**Projects based on known algorithms**: one or more mini projects based on theories and algorithms covered in the class can be chosen by the course instruction. Although shorter in length, these projects will cover many image analysis steps including image pre-processing, implementation of existing algorithms, tuning parameters, and improving algorithms based on different criteria, and so on.	15	1, 2
2	**Projects based on solving real-world problem**: one or more full projects based on addressing and solving real-world vision-based problems can be chosen by the students or assigned by the course instructor.	27	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	3	3		3							
CLO2	3	3	3	3								
CLO3								3	3	3		

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, GD, PrbL	A, LE, PP
CLO2	CL, T, OR, PrbL	A, PP
CLO3	GD, PrbL, PrjL, BL	V, P, RW, Prj

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)
(A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Computer Vision: algorithms and applications – Richard Szeliski
2. Computer Vision: A modern approach – David A. Forsyth, Jean Ponce

Course Code: CSE-06134021 **Course Title**: Natural Language Processing

Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
This course will introduce the basics of statistical natural language processing and machine learning techniques to understand, generate, translate and extract information from text data.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Develop the knowledge on natural language processing and to learn how to apply basic techniques for text-based processing of natural language.
CLO 2	Familiarize with the current methods for statistical approaches to machine learning techniques used in NLP
CLO 3	Develop the communication skill by presenting topics on Natural Language Processing

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction. Words:** Regular Expressions and Automata, Words and Transducers, N-Grams, Parts-of-Speech Tagging, Hidden Markov and Maximum Entropy Models,	15	1, 2
2	**Simple Word Vector representations:** word2vec, GloVe	6	1, 2
3	**Intro to Deep Learning:** Recurrent Neural Network, Long Short-Term Memory, Gated Recurrent Unit	9	1, 2
4	**Convolutional neural networks:** for sentence classification; Speech recognition; Machine Translation; Seq2Seq	6	1, 2
5	**Applications:** Information Extraction, Question Answering and Summarization, Dialogue and Conversational Agents, Machine Translation.	6	2, 3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	**3**											2
CLO2	2		3	2								2
CLO3	1					2	2			3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	CT, Q, A, MF
CLO2	CL, T, OR, PrbL	CT, Q, A, SF

CLO3	CL, T, OR, PrbL	CT, Q, SF

(CL= Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. J. H. Speech and Language Processing, Jurafsky, D. and Martin.
2. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schütze
3. A Primer on Neural Network Models for Natural Language Processing - Yoav Goldberg; Morgan & Claypool Publishers (2017)

Course Code: CSE-06134022 **Course Title**: Natural Language Processing Lab

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course will give students a hands on experience on statistical natural language processing by implementing various NLP techniques using Python. Students ability to produce real-world NLP task will be justified by developing a small project.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO 1	Develop the knowledge on natural language processing and to learn how to apply basic techniques for text-based processing of natural language.
CLO 2	Familiarize with the current methods for statistical approaches to machine learning techniques used in NLP
CLO 3	Design and analysis solution of a specific project and write report on different behavior on various scenarios.

Course Content:

SL No	Content	Hrs	CLOs
1	Morphological Analysis, N-grams Modeling, Language models	12	1,2
3	Word2Vec, GloVe	9	1,2
4	LSTM, GRU, Convolutional Neural Network	12	1,2
6	NLP Application	9	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	1	2	3									2
CLO2	2		3	2								2
CLO3	2							2	3	2		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD	PP, LE, V
CLO2	CL, OR, GD	PP, LE, V
CLO3	CL, OR, PrjL	PD, RW, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. J. H. Speech and Language Processing, Jurafsky, D. and Martin.
2. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schütze
3. A Primer on Neural Network Models for Natural Language Processing - Yoav Goldberg; Morgan & Claypool Publishers (2017)

Course Code: CSE-06134023 **Course Title**: Deep Learning

Credit Value: 3 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: CSE-06133213: Machine Learning

Rationale of the Course:

Deep learning has already playing vital role in the revolution of artificial intelligence. This course will introduce deep learning from the beginning to latest model with application in computer vision, natural language field and variety of other fields.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO 1	Understand how biological neural networks works and develop ability to create artificial neural networks.
CLO 2	Able to design deep learning models and do hyper parameter search to get best out of it.
CLO 3	Improve state of the art result by designing and analyzing experiments.
CLO 4	Develop communication skills by presenting deep learning topics.

Course Content:

SL No	Content	Hrs	CLOs
1	**History and Introduction:** History of Neural Network, Artificial Neuron and Biological Neuron, Hebbs Rule , **Perceptron**: vector addition, perceptron training	6	1,2,3
2	**Multi-Layer Perceptron:** Forward propagation, Back propagation, Activation Functions	6	1,2,3

3	**Optimization:** Computational Graph, Gradient Descent, Gradient Descent with Momentum, Nesterov Accelerated Momentum, RMSProp, Adagrad, Adam	6	1,2,3
4	**Convolutional Neural Network:** 2D Convolution, 1D Convolution, Max pool, Average Pool	6	1,2,3
5	**Recurrent Neural Network:** Simple RNN, Long Short Term Memory (LSTM), GRU	6	1,2,3
6	**Generative Models:** GAN, Variational Auto Encoder	3	1,2,3
7	**Model Training:** Hyper parameter tuning	3	1,2,3
8	**Deep Learning Applications:** Design models for real world problems.	3	3,4
9	**Special Topics:** Meta Learning, Self-supervised Learning, Fairness, Explainable AI	3	3,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	**3**											2
CLO2	3		3	2								2
CLO3	3		2	3								
CLO4	2					2	2			3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	CT, Q, A, MF
CLO2	CL, T, OR, PrbL	CT, Q, A, SF
CLO3	CL, T, OR, PrbL	CT, Q, SF
CLO4	CL, T, OR, PrbL	CT, Q, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Deep Learning. by Ian Goodfellow, YoshuaBengio, Aaron Courville.
2. Pattern Recognition and Machine Learning by Christopher Bishop

Course Code: CSE-06134024 **Course Title**: Deep Learning Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:

Hands-on training on implementing various deep learning algorithms in python and understanding and applying different algorithms for real world scenario.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO 1	Implementing major deep learning concepts in python.
CLO 2	Analysis and evaluating performance of deep learning models.
CLO 3	Apply deep learning models in real world large datasets.
CLO 4	Design and analysis solution of a specific project and write report on different behavior on various scenarios.

Course Content:

SL No	Content	Hrs	CLOs
1	Python and Linear algebra refresher	3	1,2,3
2	Introduction Pytorch and Tensorflow	3	1,2,3
3	Perceptron	3	1,2,3
4	Multi-Layer Perceptron	6	1,2,3
5	Optimization	3	1,2,3
6	Convolutional Neural Network	6	1,2,3
7	Simple RNN	3	1,2,3
8	LSTM	3	1,2,3
9	FC GAN and DC GAN	6	4,5
10	Practical Application: CIFAR 10 Dataset, MNIST Dataset	6	4,5

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		2	3									2
CLO2			3	2								2
CLO3			2	3								
CLO4									3	3	3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD	PP, LE, V
CLO2	CL, OR, GD	PP, LE, V
CLO3	CL, OR, PrjL	PD, RW, V

CLO4	CL, OR, PrjL	PD, RW, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. Deep Learning. by Ian Goodfellow, Yoshua Bengio, Aaron Courville.

Course Code: CSE-06134025 **Course Title**: Reinforcement Learning
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: CSE-06133115: Artificial Intelligence

Rationale of the Course:
Sequential decision making is a key tool to solve unpredictable stochastic environments. This course will help students to learn how to represent real world stochastic environments and solving them by implementing RL algorithms.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Understand RL terms and algorithms.
CLO 2	Able to apply RL algorithms on different stochastic environments.
CLO 3	Apply RL for real world problems.
CLO 4	Develop communication skills by presenting AI topics.

Course Content:

SL No	Content	Hrs	CLOs
1	**What is Reinforcement Learning:** Stochastic Environment, compare with classical AI. Markov Property, Markov Decision Process, value, state-action value, policy, discount factor, reward, return, expectation.	6	1,2,3
2	**Dynamic Programming:** Bellman expectation equation, Bellman optimality equation, value iteration, policy iteration	6	1,2,3
3	**Monte Carlo methods:** Monte Carlo approximation, Exploration vs Exploitation, Epsilon-Greedy policy, Monte Carlo Prediction and Control	6	1,2,3
4	**Temporal Difference (TD) Learning:** Idea of bootstrapping, SARSA, Q Learning, Expected SARSA, on policy vs off policy.	6	1,2,3

5	**Deep Q Learning:** Deep Q Network, Double deep Q network, Dueling Q Network	6	1,2,3
6	**Policy Gradient:** REINFORCE, Actor Critic, Proximal Policy Optimization	9	1,2,3
7	**Practical RL:** practical application	3	4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	**3**											2
CLO2			3	2								2
CLO3			2	3								
CLO4						2	2			3		2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	CT, Q, A, MF
CLO2	CL, T, OR, PrbL	CT, Q, A, SF
CLO3	CL, T, OR, PrbL	CT, Q, SF
CLO4	CL, T, OR, PrbL	CT, Q, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew Barto

Course Code: CSE-06134026 **Course Title**: Reinforcement Learning Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
Hands on training on implementing various artificial algorithms in python and understanding and applying different algorithms for real world scenario.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Implementing major RL concepts in python and experimenting with various simulated environments.
CLO 2	Analysis and evaluating programming skills in python.

CLO 3	Design and analysis solution of a specific project and write report on different behavior on various scenarios.

Course Content:

SL No	Content	Hrs	CLOs
1	**Environments:** Introduction to OpenAI Gym environments. CartPole, FrozenLake, MountainCar, Acrobot, Inverted Pendulam, Taxi, MuJoco Environments: Ant, Half-Cheetah, Humanoid, Hopper, Walker	6	1,2
2	**Dynamic Programming:** Value iteration, Policy iteration	6	1,2
3	**Monte Carlo:** MC Prediction, MC Control	6	1,2
4	**TD Learning:** SARSA, Q Learning, Expected SARSA	6	1,2
5	**Deep Q:** DQN, Double DQN, Dueling DQN	6	1,2
6	**Policy Gradient:** REINFORCE, Actor-Critic	6	1,2
7	**Practical Application:**	6	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		2	3									2
CLO2			3	2								2
CLO3			2	3								

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD	PP, LE, V
CLO2	CL, OR, GD	PP, LE, V
CLO3	CL, OR, PrjL	PD, RW, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew Barto

Course Code: CSE-06134027 **Course Title**: Bioinformatics
Credit Value: 3.00 **Credit Hours**: 3 hours per week
Year/Semester: 4^{th} / 1^{st} or 2^{nd} **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:

This course serves a student with comprehensive knowledge and methods of bioinformatics. Also, it will provide a certain level of understanding of molecular biology and a working knowledge of bioinformatics applications and databases covering the topics of sequence similarity and alignments, evolutionary processes, protein structure, genome characteristics, and gene expression.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Explain and learn the knowledge of essential topics regarding biology and bioinformatics and the significance of Biological Data analysis
CLO2	Define and describe the contents and properties of essential bioinformatics databases and searches
CLO3	Improve the significant steps in pairwise and multiple sequence alignment, explain the principle, and execute pairwise sequence alignment by dynamic programming
CLO4	Use tree data structure for genome sequencing

Course Content:

SL No	Contents	Hrs	CLOs
1	**Cell concept:** Structural organization of plant and animal cells, nucleus, cell membrane and cell wall. **Cell division:** Introducing chromosome, Mitosis, Meiosis and production of haploid/diploid cell. **Nucleic acids:** Structure and properties of different forms of DNA and RNA; DNA replication.	3	1
2	**Proteins:** Structure and classification, Central dogma of molecular biology. **Genetic code:** A brief account. **Genetics:** Mendel's laws of inheritance, Organization of genetic material of prokaryotes and eukaryotes, C-Value paradox, repetitive DNA, structure of chromatin - euchromatin and heterochromatin, chromosome organization and banding patterns, structure of gene - intron, exon and their relationships, overlapping gene, regulatory sequence (lac operon), Molecular mechanism of general recombination, gene conversion, Evolution and types of mutation, molecular mechanisms of mutation, site-directed mutagenesis, transposons in mutation.	3	1
3	**Introduction to Bioinformatics:** Definition and History of Bioinformatics, Human Genome Project, Internet and Bioinformatics, Applications of Bioinformatics	3	1
4	**Sequence alignment:** Dynamic programming. Global versus local. Scoring matrices. The Blast family of programs.	6	3

	Significance of alignments, Aligning more than two sequences. Genomes alignment. Structure-based alignment.		
5	**Hidden Markov Models in Bioinformatics:** Definition and applications in Bioinformatics. Examples of the Viterbi, the Forward and the Backward algorithms. Parameter estimation for HMMs.	9	3
6	**Combinatorial pattern matching:** Database Search, Rapid String Matching, BLAST, FASTA;	6	2
7	**Trees:** The Phylogeny problem. Distance methods, parsimony, bootstrap. Stationary Markov processes. Rate matrices. Maximum likelihood. Felsenstein's post-order traversal.	6	4
8	**Finding regulatory elements:** Finding regulatory elements in aligned and unaligned sequences. Gibbs sampling.	3	3
9	**Introduction to microarray data analysis:** Steady state and time series microarray data. From microarray data to biological networks. Identifying regulatory elements using microarray data**.**	3	1

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2										
CLO2	3	2										
CLO3	2	3	1	1								
CLO4	3		2									

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, A, MS
CLO2	CL, T, OR, PrbL, BL	CT, A, MS
CLO3	CL, T, OR, BL	CT, A, MS, FS
CLO4	CL, T, PrbL	CT, A, FS

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. An Introduction to Bioinformatics Algorithms (1st Edition)- Neil C. Jones, Pavel A. Pevzner; The MIT Press (2004).
2. Understanding Bioinformatics by Market Zvelebil, Jeremy O. Baum.
3. Bioinformatics for Biologists by Pavel Pevzner and Ron Shamir.

Course Code: CSE-06134028	**Course Title**: Bioinformatics Lab
Credit Value: 1.50	**Credit Hours**: 3 hours per week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
The lab is designed to demonstrate biocomputing techniques with local and remote servers. Student learning occurs when using actual data with existing biocomputing software. Also, they will apply theory learned in lectures to experimental settings yielding an advanced understanding of evolution, form, and function.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO1	Comprehend the fundamental and practical knowledge of Bioinformatics and related algorithms
CLO2	Evaluate the basic concepts and application of Bioinformatics tools to solve biological problems
CLO3	Illustrate and determine different biological structures from the sequence from databases

Course Content:

SL No	Contents	Hrs	CLOs
1	The concept of dynamic programming	3	1
2	Pairwise and multiple sequence alignments utilizing the dynamic programming	6	3
3	Revise the knowledge of tree data structure	3	1
4	Performing genome sequencing using the tree data structure	6	3
5	Introduction to Rosalind	3	2
6	Bioinformatics and programming through problem-solving in Rosalind	21	2

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3	2	2									
CLO2	2	3	2		3				2	2	2	
CLO3	2	3	2						2	2	2	

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	A, V, LE
CLO2	CL, OR, PrbL, BL	PP, LE
CLO3	CL, OR, GD, PrbL	A, PP, LE

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, BL = Blended Learning)
(A = Assignment, LE = Lab Examination, PP = Programming Problems)

Recommended Readings:

1. An Introduction to Bioinformatics Algorithms by Neil C. Jones and Pavel A. Pevzner.
2. Understanding Bioinformatics by Market Zvelebil, Jeremy O. Baum.
3. Biological Sequence Analysis.
4. Bioinformatics for Biologists by Pavel Pevzner and Ron Shami.

Course Code: CSE-06134033 **Course Title**: Cloud Computing
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
Cloud computing seamlessly integrated in everyday life as use of internet and IoT become increasing. This course will introduce how to use cloud computing features and configure them for real world problems.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Understand different types of cloud computing and discuss its strengths and limitations as well as its application to complex and human-centered problems.
CLO 2	Able to increase web security by applying cloud computing solution.
CLO 3	Develop communication skills by presenting cloud computing topics.

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction to different types of computing**: Edge computing, Grid computing, Distributed Computing, Cluster-computing, Utility computing, Cloud computing.	9	1,2
2	**Cloud computing architecture:** Architectural framework; Cloud deployment models; Virtualization in cloud computing; Parallelization in cloud computing; Green cloud. Cloud Bus;	9	1,2
3	**Cloud service models**: Software as a Service (SaaS); Infrastructure as a Service (IaaS); Platform as a Service (PaaS).	9	1,2
4	**Foundational elements of cloud computing**: Virtualization; Cloud computing operating System; Browser as a platform; Advanced web technologies (Web 2.0, AJAX and Mashup); Introduction to autonomic systems; Service Level Agreements (SLA); Security/Privacy; Cloud economics; Risks assessment; Current challenges facing cloud computing.	9	2,3
5	**Case Studies**	6	2,3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	**3**				3			1				2
CLO2			3	2	3							2
CLO3			2	3					3	3		3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	CT, Q, A, MF
CLO2	CL, T, OR, PrbL	CT, Q, A, SF
CLO3	CL, T, OR, PrbL	CT, Q, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.
2. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee.
3. Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.
4. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee

Course Code: CSE-06134034 **Course Title**: Cloud Computing Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
Hands on training on configuring and implementing various cloud service and understanding and applying different architecture for real world scenario.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Understand different types of cloud computing and discuss its strengths and limitations as well as its application to complex and human-centered problems.
CLO 2	Able to increase web security by applying cloud computing solution.
CLO 3	Design and analysis solution of a specific project and write report on different behavior on various scenarios.

Course Content:

SL No	Content	Hrs	CLOs
1	Creating Windows servers on the cloud	9	1,2
2	Creating Linux servers on the cloud	9	1,2
3	Deploying applications on the cloud	12	2,3
4	Major cloud solutions and troubleshooting	12	2,3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		2	3									2
CLO2			3	2								2
CLO3									3	3	3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD	PP, LE, V
CLO2	CL, OR, GD	PP, LE, V
CLO3	CL, OR, PrjL	PD, RW, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

1. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.
2. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee.
3. Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.
4. Cloud Computing, Principles , System and Applications- Antonopoulos, Nikos, Gillam, Lee

Course Code: CSE-06134035 **Course Title**: Parallel and Distributed Computing
Credit Value: 3 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:

Distributed system extends computation power significantly by utilizing large number of connected devices. This course introduce parallel computing and various methods to share computing among multiple devices.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO 1	Compare performance boost using parallel computing and understand how to configure devices.
CLO 2	Able to apply distributed system architecture for real world increasing computation needs.
CLO 3	Develop communication skills by presenting Parallel and Distributed Computing topics.

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction:** Scope, issues, applications and challenges of Parallel and Distributed Computing; Parallel and Distributed Architectures	9	1,2
2	**Parallel Computing:** Parallel Performance; Shared Memory and Threads; Parallel Algorithms; OpenMP; Scalable Algorithms; Message Passing; MPI; Grid Computing.	12	1,2,3
3	**Distributed Computing**: Distributed Systems; MapReduce; Clusters; Distributed Coordination; Distributed Consensus; Distributed File Systems (DFS); Distributed Shared Memory; Distributed Transactions and Replication; Applications of Distributed Computing in Security	12	1,2,3
4	**Cloud Computing**: Cloud Architectural Framework; Cloud Deployment Models: Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS); Cloud Economics; Service Level Agreements (SLA); Security and Privacy issues in Cloud Computing.	9	1,2,3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	**3**											2
CLO2	3		3	2								2
CLO3	3		2	3				2	3	2		3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL	CT, Q, A, MF
CLO2	CL, T, OR, PrbL	CT, Q, A, SF
CLO3	CL, T, OR, PrbL	CT, Q, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, PrbL = Problem-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Distributed Systems: Concepts and Designs - George Coulouris,JeanDollimore, Tim Kindberg and Gordon Blair
2. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.
3. Principles of Parallel Programming - Calvin Lin, Larry Snyder
4. Cloud Computing, Principles, System and Applications- Antonopoulos, Nikos, Gillam, Lee

Course Code: CSE-06134036 **Course Title**: Parallel and Distributed Computing Lab
Credit Value: 1.5 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
Distributed system extends computation power significantly by utilizing large number of connected devices. This course introduce parallel computing and various methods to share computing among multiple devices.

Course Learning Outcomes (CLOs):
On successful completion of this course students will be able to:

CLO 1	Compare performance boost using parallel computing and understand how to configure devices.
CLO 2	Able to apply distributed system architecture for real world increasing computation needs.
CLO 3	Develop communication skills by presenting Parallel and Distributed Computing topics.

Course Content:

SL No	Content	Hrs	CLOs
1	**Introduction:** Scope, issues, applications and challenges of Parallel and Distributed Computing; Parallel and Distributed Architectures	9	1,2
2	**Parallel Computing:** Parallel Performance; Shared Memory and Threads; Parallel Algorithms; OpenMP; Scalable Algorithms; Message Passing; MPI; Grid Computing.	12	1,2
3	**Distributed Computing**: Distributed Systems; MapReduce; Clusters; Distributed Coordination; Distributed Consensus; Distributed File Systems (DFS); Distributed Shared Memory; Distributed Transactions and Replication; Applications of Distributed Computing in Security	12	1,2,3
4	**Cloud Computing**: Cloud Architectural Framework; Cloud Deployment Models: Software as a Service (SaaS), Infrastructure as a Service (IaaS) and Platform as a Service (PaaS); Cloud Economics;	9	2,3

	Service Level Agreements (SLA); Security and Privacy issues in Cloud Computing.		

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1		2	3									2
CLO2			3	2								2
CLO3									3	3	3	2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, OR, GD	PP, LE, V
CLO2	CL, OR, GD	PP, LE, V
CLO3	CL, OR, PrjL	PD, RW, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrjL = Project-based Learning)

(V = Viva-voce, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, PD = Project Demonstration)

Recommended Readings:

2. Distributed Systems: Concepts and Designs - George Coulouris,JeanDollimore, Tim Kindberg and Gordon Blair
3. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things- Kai Hwang, Jack Dongarra, Geoffrey C. Fox.
4. Principles of Parallel Programming - Calvin Lin, Larry Snyder
5. Cloud Computing, Principles, System and Applications- Antonopoulos, Nikos, Gillam, Lee

Course Code: CSE-06134037 **Course Title**: Mobile and Wireless Communication

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course has been designed to provide a broad-spectrum knowledge of wireless and mobile communication systems. It begins with the basic cellular system modeling and then proceeds towards the characterization and modeling of radio fading channels, multiplexing techniques in wireless communications and major standards of mobile radio systems.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Recognize, understand, and explain various wireless communication systems and recognize their multiple access technologies in accordance with their use in current and future wireless and cellular communications standards
CLO2	Explain cellular radio concepts such as frequency reuse, handover, capacity and traffic and relate interference between mobiles and/or base stations with the capacity of cellular systems
CLO3	Apply the knowledge of multiple access techniques, cellular concept, trunking, system capacity and large- and small-scale fading to solve for various performance parameters
CLO4	Analyze propagation effects such as fading, time delay spread and Doppler spread, and analyze their impact on the instantaneous received signal strength in multipath channels

Course Content:

SL No	Contents	Hrs	CLOs
1	**Introduction**: overview of telecommunication, history, evolution, convergence of telecommunication and data networks, frequencies & regulations.	3	1
2	**Wireless Transmission**: signals, noise, noise analysis, antennas, signal propagation, multiplexing, modulation, spread spectrum, cellular system, Characteristics and applications of twisted pairs, coaxial cables and optical fibers, Terrestrial and satellite microwave, radio waves, Large-scale and small-scale propagation models.	9	1,3,4
3	**Medium Access Control**: SDMA, FDMA, TDMA (fixed, Aloha, CSMA, DAMA, PRMA, MACA, collision avoidance, polling), CDMA.	4.5	1,3
4	**Cellular communication**: Frequency reuse, frequency management, channel alignment, handoff strategies, channel interference and capacity, Introduction to satellite communication, Optical fiber communication, Submarine cables, Digital Radio Microwave, etc.	7.5	1,2,3
5	**Traffic analysis**: Traffic characterization, trunking, grades of service, network blocking probabilities, delay system and queuing, Integrated services digital network (ISDN), Digital subscriber loop (DSL).	6	1,2,3
6	**Telecommunication Systems**: GSM (HSCSD, GPRS), TETRA, UMTS/IMT-2000, LTE. **Future Outlook**: 5th generation, IP-based networks.	6	2,3
7	**Antenna**: Definition, radiation mechanism, properties of antenna, antenna types, cell site antennas.	6	1,4

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3											2
CLO2	3											2
CLO3		3										2

CLO4		3	2									2

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR	CT, Q, V, MS, SF
CLO2	CL, T, OR, GD	CT, A, Q, V, MS, SF
CLO3	CL, T, OR, GD, PrbL	CT, A, Q, V, MS, SF
CLO4	CL, T, OR, GD, PrbL	CT, A, V, MS, SF

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, MS = Mid Semester, SF = Semester Final)

Recommended Readings:

1. Mobile Communications by Jochen Schiller
2. Wireless Communications Principle and Practice by Theodore S. Rappaport
3. Communication Systems Engineering by John G. Proakis
4. Modern Digital and Analog Communication System by B.P. Lathi

Course Code: CSE-06134038 **Course Title**: Mobile and Wireless Communication Lab

Credit Value: 1.5 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This advanced course is designed to expose students to the tools of signal processing required to analyze different practical computing and communication system practically.

Course Learning Outcomes (CLOs):

On successful completion of this course students will be able to:

CLO1	Use simulation tools to simulate different simple communication systems
CLO2	Model different communication system parameters in simulators
CLO3	Design cellular communication systems as part group project

Course Content:

SL No	Contents	Hrs	CLOs
1	Introduction to simulation tools for communication system.	6	1
2	Simulation of simple communication systems in simulator.	12	1
3	Analyzing communication systems in simulator.	12	2
4	Lab project design, implementation, and submission.	12	3

Mapping of CLOs with Program Learning Outcomes (PLOs):

Course Learning Outcomes (CLO)	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO1	3				3							3
CLO2		3		3								3
CLO3		3	3						3		3	3

(3 = High, 2 = Medium, 1 = Low)

Mapping Course Learning Outcomes (CLOs) with the Teaching-Learning and Assessment Strategy:

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	CL, T, OR, PrbL, BL	CT, Q, V, PP, RW, LE
CLO2	CL, T, OR, PrbL, BL	CT, Q, V, PP, RW, LE
CLO3	OR, GD, PrbL, PrjL	Prj, RW, P, V

(CL = Class Lectures, T = Textbook, OR = Online Resources, GD = Group Discussion, PrbL = Problem-based Learning, PrjL = Project-based Learning, BL = Blended Learning)

(CT = Class Test, Q = Quiz, A = Assignment, V = Viva-voce, P = Presentation, RW = Report Writing, LE = Lab Examination, PP = Programming Problems, Prj = Projects)

Recommended Readings:

1. Mobile Communications by Jochen Schiller
2. Wireless Communications Principle and Practice by Theodore S. Rappaport

Course Code: CSE-06134041 **Course Title**: Contemporary Course on Computer Science and Engineering – I

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:

This course will be designed by the course instructor to address recent trends of computing. Such a course aims to lead students to learn about current research and engineering development of computer science that will enable them to improve their research and job prospect.

Course Learning Outcomes (CLOs):

The course teacher will design CLO of the course.

Course Content:

SL No	Contents	Hrs	CLOs
1	Course teacher will design a complete syllabus against a contemporary course and get the contents approved by the department committee.	42	As designed

Course Code: CSE-06134042 **Course Title**: Contemporary Course on Computer Science and Engineering – I Lab

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:
The course is designed for practical implementations of theories and algorithms taught in the corresponding theory course – CSE-06134041.

Course Learning Outcomes (CLOs):
The course teacher will design CLO of the course.

Course Content:

SL No	Contents	Hrs	CLOs
1	Course teacher will design a complete syllabus against a contemporary course and get the contents approved by the department committee.	42	As designed

Course Code: CSE-06134043 **Course Title**: Contemporary Course on Computer Science and Engineering – II
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
This course will be designed by the course instructor to address recent trends of computing. Such a course aims to lead students to learn about current research and engineering development of computer science that will enable them to improve their research and job prospect.

Course Learning Outcomes (CLOs):
The course teacher will design CLO of the course.

Course Content:

SL No	Contents	Hrs	CLOs
1	Course teacher will design a complete syllabus against a contemporary course and get the contents approved by the department committee.	42	As designed

Course Code: CSE-06134044 **Course Title**: Contemporary Course on Computer Science and Engineering – II Lab
Credit Value: 3.0 **Credit Hours**: 3 hours/week
Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course
Prerequisites: None

Rationale of the Course:
The course is designed for practical implementations of theories and algorithms taught in the corresponding theory course – CSE-06134043.

Course Learning Outcomes (CLOs):
The course teacher will design CLO of the course.

Course Content:

SL No	Contents	Hrs	CLOs
1	Course teacher will design a complete syllabus against a contemporary course and get the contents approved by the department committee.	42	As designed

Course Code: CSE-06134045 **Course Title**: Contemporary Course on Computer Science and Engineering – III

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:
This course will be designed by the course instructor to address recent trends of computing. Such a course aims to lead students to learn about current research and engineering development of computer science that will enable them to improve their research and job prospect.

Course Learning Outcomes (CLOs):
The course teacher will design CLO of the course.

Course Content:

SL No	Contents	Hrs	CLOs
1	Course teacher will design a complete syllabus against a contemporary course and get the contents approved by the department committee.	42	As designed

Course Code: CSE-06134046 **Course Title**: Contemporary Course on Computer Science and Engineering – III Lab

Credit Value: 3.0 **Credit Hours**: 3 hours/week

Year/Semester: 4th / 1st or 2nd **Course Type**: Elective Course

Prerequisites: None

Rationale of the Course:
The course is designed for practical implementations of theories and algorithms taught in the corresponding theory course – CSE-06134045.

Course Learning Outcomes (CLOs):
The course teacher will design CLO of the course.

Course Content:

SL No	Contents	Hrs	CLOs
1	Course teacher will design a complete syllabus against a contemporary course and get the contents approved by the department committee.	42	As designed

Part – D
Grading and Evaluation

1. Grading Scale and Grade Point:

Letter Grade and corresponding Grade-Point will be as follows:

Grade	Approx. Percentage	Points	Meaning
A+	80-100	4.00	Outstanding
A	75-79	3.75	Excellent
A-	70-74	3.50	Very Good
B+	65-69	3.25	Good
B	60-64	3.00	Above Average
B-	55-59	2.75	Average
C+	50-54	2.50	Below Average
C	45-49	2.25	Poor
D	40-44	2.00	Pass
F	00-39	0.00	Fail
I	Incomplete		
W	Withdrawal		

Grades: Grades A+, A, A-, B+, B, B-, C+, C and D- are all passing grades. Grade F is a fail grade.

2. Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA):

GPA: Grade Point Average (GPA) is the weighted average of the grade point (GP) obtained in all the courses completed by a student in a semester.

$$GPA = \frac{\sum(course\ GP\ \times course\ credit)}{\Sigma\ gradable\ credit}$$

CGPA: Cumulative Grade Point Average (CGPA) will be calculated by the weighted average of previous CGPA and current GPA.

3. Course Withdrawal:

A student can withdraw from a course by a written application to the Head of the discipline through the course advisor in two weeks' time after the course registration. The Head of the discipline will inform about the change to the Registrar and the Controller of Examinations. The Controller of Examinations will send the revised registration list to the disciplines before the examination.

4. Incomplete (I) courses:

A student needs to register his incomplete courses, if offered, from preceding semesters before he can register courses from the current or successive semesters; otherwise, he takes the courses when the desired course is offered next time. An advanced student may be allowed to take a course of immediate next semester. In no way he will be allowed to take a course from the 3rd year skipping a course of the 2nd year or a course from the 4th year skipping a course of the 3rd year simultaneously.

5. Grade Improvement:

Student will get the opportunity to improve their CGPA by taking courses on which he/ she obtained below GPA 2.75 or Grade B-. A student can repeat maximum of 4 courses for improvement. For a course taken multiple times, the best grade will be counted in CGPA calculation. However, all the attempts will be listed in the transcript.

6. Dropout:

Once the semester begins, the process of changing the student's course schedule is referred to as dropping/adding courses. A student has several opportunities within a semester to drop a course, but different consequences apply at each stage. Before dropping a course, students should consult with their academic advisors. Dropping courses not only affects a student's academic progress, but also may have consequences for financial aid. There is no refund of tuition for individual courses dropped after the last day of the change of program period. Courses that are not presently offered by the department may be dropped depending on the situations of the student and the departments.

7. Distribution of Marks (Continuous and Summative assessment):

The marks of a given course will be as follows:

Class attendance:	10%
Assignment/Tutorial exam	10%
Presentation /Viva	10%
Mid-Semester exam	30%
Semester final exam	40%

Class attendance: The marks for class attendance will be as follows:

Level of Attendance	**Marks**	**Level of Attendance**	**Marks**
95% and above	10	70% to 74%	5
90% to 94%	9	65% to 69%	4
85% to 89%	8	60% to 64%	3
80% to 84%	7	Less than 60%	0
75% to 79%	6		

A student will not be allowed to appear at the semester final examination of a course if his class attendance in that course is less than 50%.

8. Duration of the Mid-Semester and Semester Final Examination

For all semesters there should be a 2-hour final examination for every course of 3 credits or more after the 14 weeks. For courses less than 3 credits, the duration should be proportional to the credit hours. The Mid-Semester examination should be of 1.5 hours.

9. Make-up Procedures

If a student drops or remains absent in any course in the mid-semester and semester final exam because of medical or any unavoidable grounds, he will have to sit for makeup exam paying a nominal fee (Fee is to be decided by the Exam Committee) for that. The makeup exam will be held within two weeks after the scheduled exam is over by the notification of the Registrar office.