B.Sc. in Data Science

Department of Computer Science and Engineering
United International University

Contents

Chapter 1

General Information

Rapid development in the fields of Data Science (DS) over the last decade has made Data Science an emerging field of specialization. The objective of the undergraduate program in Data Science is to develop skilled and competent graduates to meet the current and future needs at home and abroad.

1.1 Vision

The vision of the program is to become the center of excellence in producing top quality data science professionals to meet the local and global challenges.

1.2 Mission

The mission of the program is to enable our students with knowledge, skills and attitude for complex problem solving, lifelong learning, and leadership who will be able to create, share and apply their knowledge in multidisciplinary areas to earn sustainable benefits for humanity.

The mission is broken into following mission statements:

MS1 Leadership skill

MS2 Complex problem solvers

MS3 Lifelong learners

MS4 Expert in multidisciplinary areas

MS5 Sustainable benefits for the humanity

1.3 Program Educational Objectives

The general objective of the program is to prepare graduates to become successful in their selected career paths. The specific objectives are:

1. Graduates will successfully engage in careers in the field of data science with the knowledge, skills and attitude acquired through the program.
2. Graduates will engage in continuous learning and professional development in data science and other professional fields.
3. Graduates will develop as leaders in their chosen profession and contribute to the sustainable growth.

Mapping between program educational objectives and mission statements

PEO	MS1	MS2	MS3	MS4	MS5
PEO1		x		x	
PEO2			x		
PEO3	x				x

1.4 Program Outcomes

Graduates of the program will have an ability to:

1. Analyze a complex problem and to apply principles of data science and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate solutions of complex problems to meet a given set of requirements.
3. Apply theory, techniques, and tools throughout the data science lifecycle and employ the resulting knowledge to satisfy stakeholders' needs.
4. Communicate effectively in a variety of professional contexts.
5. Recognize professional responsibilities and make informed judgments based on legal and ethical principles in practice.
6. Function effectively as a member or leader of a team engaged in activities to solve a wide variety of infrequently encountered problems in diverse areas.
7. Acquire and apply new knowledge as needed, using appropriate learning strategies.
8. Demonstrate understanding of the skills required to be an entrepreneur and ability to apply entrepreneurial skills.

Mapping between program educational objectives and program outcomes

PEO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
PEO1	x	x	x	x				
PEO2					x		x	
PEO3					x	x		x

Chapter 2

Curriculum Structure

Rapid development in the fields of Data Science (DS) over the last decade has made Data Science an emerging field of specialization. Bachelor of Science in Data Science involves the study of a number of core courses which every Data Science graduate should know and a significant number of courses from specialized areas. Core courses build the foundation (i.e., breadth of the curriculum) and specialized courses prepare the students for the specific areas (i.e., depth of the curriculum) of Data Science. To understand the underpinning theory of the courses of Data Science, a number of courses on Mathematics and Basic Science have been felt mandatory to be included in the syllabus. In addition some social science, management, accounting, economics and communication-skills development related courses have been incorporated to make the syllabus a balanced and reasonably complete one. The objective of the undergraduate program in Data Science is to develop skilled and competent graduates to meet the current and future needs at home and abroad.

The letter prefix in any course number indicates the discipline/subject offering the course viz. ACT for Accounting, PHY for Physics, MATH for Mathematics, CSE for Computer Science and Engineering and DS for Data Science.

2.1 Admission Requirements

Every applicant, without any exception, must fulfill the admission requirements as laid down by the university. Admission test and interview for admission into a trimester will be held as decided by the university.

A higher secondary certificate or its equivalent in science with mathematics and physics or other fields of study are the basic educational requirements to get admission to this program.

2.2 Degree Requirements

The B.Sc. in Data Science degree requirements will be as follows:

(a) Completion of 138.0 credit hours

(b) Completion of the capstone project with at least a `C' grade

(c) Passing of all courses individually and maintaining a minimum CGPA of 2.00

2.3 Course List

I. General Education

A. Language (6 Credits)

Sl.	Course Code	Course Title	C. H.
1	ENG 1011	English I	3.0
2	ENG 1013	English II	3.0
		Subtotal	6.0

B. Sciences (7 Credits)

Sl.	Course Code	Course Title	C. H.
1	PHY 2105	Physics	3.0
2	PHY 2106	Physics Laboratory	1.0
3	BIO 3107	Biology	3.0
		Subtotal	7.0

C. Humanities (2 credits)

Sl.	Course Code	Course Title	C. H.
1	BDS 1201	History of the Emergence of Bangladesh	2.0
		Subtotal (Any three)	2.0

D. Humanities Optional (9 credits - select any three)

Sl.	Course Code	Course Title	C. H.
1	SOC 2102	Society, Environment and Computing Ethics	3.0
2	TEC 2499	Technology Entrepreneurship	3.0
3	ECO 4101	Economics	3.0
4	PMG 4101	Project Management	3.0
5	ACT 2111	Financial and Managerial Accounting	3.0
6	SOC 4101	Introduction to Sociology	3.0
7	IPE 3401	Industrial and Operational Management	3.0
8	BAN 2501	Bangla	3.0
9	URC 1101	Life Skills for Success	3.0
10	SOC 4301	Introduction to Anthropology	3.0
11	FLN 1101	Introduction to a Foreign Language (Name of the Language)	3.0
12	SWL 4101	Software and Law	3.0
13	BHV 2101	Introduction to Behavioral Science	3.0
14	MKT 4313	Digital Marketing	3.0
15	PSY 2101	Psychology	3.0
		Subtotal	9.0

II. Mathematics (12 Credits)

Sl.	Course Code	Course Title	C. H.
1	MATH 1151	Fundamental Calculus	3.0
2	MATH 1153	Advanced Calculus	3.0
3	MATH 2107	Linear Algebra	3.0
4	MATH 2205	Probability and Statistics	3.0
		Subtotal	12.0

III. Core Courses

A. Programming (8 Credits)

Sl.	Course Code	Course Title	C. H.
1	DS 1501	Programming for Data Science	3.0
2	DS 1502	Programming for Data Science Laboratory	1.0
3	DS 1115	Object Oriented Programming for Data Science	3.0
4	DS 1116	Object Oriented Programming for Data Science Laboratory	1.0
		Subtotal	8.0

B. Foundations in Statistics (9 Credits)

Sl.	Course Code	Course Title	C. H.
1	DS 3101	Advanced Probability and Statistics	3.0
2	DS 4523	Simulation and Modelling	3.0
3	DS 2251	Bayesian Statistics	3.0
		Subtotal	9.0

C. Foundations in Computing (15 Credits)

Sl.	Course Code	Course Title	C. H.
1	CSE 2213	Discrete Mathematics	3.0
2	CSE 2215	Data Structures and Algorithms I	3.0
3	CSE 2216	Data Structures and Algorithms I Laboratory	1.0
4	CSE 2217	Data Structures and Algorithms II	3.0
5	CSE 2218	Data Structures and Algorithms II Laboratory	1.0
6	CSE 3521	Database Management Systems	3.0
7	CSE 3522	Database Management Systems Laboratory	1.0
		Subtotal	15.0

D. Systems Optional (6 Credits - select any two)

Sl.	Course Code	Course Title	C. H.
1	CSE 4511	Operating Systems and Scripting	3.0
2	CSE 3411	System Analysis and Design	3.0
3	CSE 3421	Software Engineering	3.0
4	CSE 4197	Introduction to Internet of Things (IoT)	3.0
5	CSE 4587	Cloud Computing	3.0
6	CSE 4531	Computer Security	3.0
		Subtotal (Any two)	6.0

E. Data Science and Analytics (34 Credits)

Sl.	Course Code	Course Title	C. H.
1	DS 1101	Fundamentals of Data Science	3.0
2	DS 3885	Data Wrangling	3.0
3	DS 4217	Data Privacy and Ethics	3.0
4	DS 3521	Data Visualization	3.0
5	DS 3522	Data Visualization Laboratory	1.0
6	DS 4891	Data Analytics	3.0
7	DS 4892	Data Analytics Laboratory	1.0
8	DS 4889	Machine Learning	3.0
9	DS 4817	Big Data	3.0
10	DS 4211	Deep Learning	3.0
11	DS 4491	Machine Learning Systems Design	3.0
12	DS 3881	Regression and Time Series Analysis	3.0
13	DS 3120	Technical Report Writing and Presentation	2.0
		Subtotal	34.0

IV. Option - I Advanced Data Science and Computing (12 Credits - select any four)

V. Option - II Application Area (12 Credits - select any four)

VI. Capstone Project - 6 Credits

Sl.	Course Code	Course Title	C. H.
1	DS 4000A	Capstone Project I	2.0
2	DS 4000B	Capstone Project II	2.0
3	DS 4000C	Capstone Project III	2.0
		Subtotal	6.0

Option - I Courses (Advanced Data Science and Computing)

Sl.	Course Code	Course Title	C. H.
1	DS 4213	Natural Language Processing	3.0
2	DS 4215	Social Media Analytics	3.0
3	DS 4219	Game Theory	3.0
4	DS 4221	Complex Systems	3.0
5	DS 4223	Recommender Systems	3.0
6	DS 4225	Probabilistic Graphical Models	3.0
7	DS 4227	Mathematical Optimization	3.0
8	DS 4229	Data Warehousing	3.0
9	CSE 4337	Robotics	3.0
10	CSE 3811	Artificial Intelligence	3.0
11	DS 4821	Generative Machine Learning	3.0
12	DS 4823	Reinforcement Learning	3.0
13	DS 4825	Deep Learning for Computer Vision	3.0
14	DS 4921	Special Topic I	3.0
		Subtotal (Any four)	12.0

Option - II Courses (Application Area)

Sl.	Course Code	Course Title	C. H.
1	DS 4111	Genomic Data Analysis	3.0
2	DS 4113	Spatial Analytics	3.0
3	DS 4115	Marketing Analytics	3.0
4	DS 4117	Computational Finance	3.0
5	DS 4119	Health Informatics	3.0
6	DS 4121	Introduction to Actuarial Science	3.0
7	DS 4123	Human Computer Interaction	3.0
8	DS 4125	Medical Image and Signal Processing	3.0
9	DS 4127	Computational Epidemiology	3.0
10	DS 4129	Remote Sensing of Environment	3.0
11	DS 4131	Precision Agriculture	3.0
12	DS 4923	Special Topic II	3.0
		Subtotal (Any four)	12.0

2.4 Summary of the curriculum

#	Group	Theory	Lab	Project	Credits
1	GED - Language	2			6.0
2	GED - Sciences	2	1		7.0
3	GED - Humanities	4			11.0
4	Mathematics	4			12.0
5	Core Courses - Programming	2	2		8.0
6	Core Courses - Foundations in Statistics	3			9.0
7	Core Courses - Foundations in Computing	4	3		15.0
8	Core Courses - Systems	2			6.0
9	Core Courses - Data Science	11	2		34.0
10	Option - I	4			12.0
11	Option - II	4			12.0
12	Capstone Project			3	6.0
#	Total	42	8	3	138.0

2.5 Trimester-wise course Distribution

Trimester 1

Sl.	Course Code	Course Title	C. H.
1	DS 1501	Programming for Data Science	3.0
2	DS 1502	Programming for Data Science Laboratory	1.0
3	ENG 1011	English I	3.0
4	BDS 1201	History of the Emergence of Bangladesh	2.0
		Subtotal	9.0

Trimester 2

Sl.	Course Code	Course Title	C. H.
1	DS 1115	Object Oriented Programming for Data Science	3.0
2	DS 1116	Object Oriented Programming for Data Science Laboratory	1.0
3	ENG 1013	English II	3.0
4	MATH 1151	Fundamental Calculus	3.0
		Subtotal	10.0

Trimester 3

Sl.	Course Code	Course Title	C. H.
1	DS 1101	Fundamentals of Data Science	3.0
2	BIO 3105	Biology	3.0
3	MATH 2107	Linear Algebra	3.0
4	PHY 2105	Physics	3.0
5	PHY 2106	Physics Laboratory	1.0
		Subtotal	13.0

Trimester 4

Sl.	Course Code	Course Title	C. H.
1	CSE 2215	Data Structures and Algorithms I	3.0
2	CSE 2216	Data Structures and Algorithms I Laboratory	1.0
3	MATH 1153	Advanced Calculus	3.0
4		Humanities Optional - I	3.0
5	CSE 2213	Discrete Mathematics	3.0
		Subtotal	13.0

Trimester 5

Sl.	Course Code	Course Title	C. H.
1	CSE 2217	Data Structures and Algorithms II	3.0
2	CSE 2218	Data Structures and Algorithms II Laboratory	1.0
3	MATH 2205	Probability and Statistics	3.0
4	DS 3885	Data Wrangling	3.0
		Subtotal	10.0

Trimester 6

Sl.	Course Code	Course Title	C. H.
1	CSE 3521	Database Management Systems	3.0
2	CSE 3522	Database Management Systems Laboratory	1.0
3	DS 3101	Advanced Probability and Statistics	3.0
4	DS 3521	Data Visualization	3.0
5	DS 3522	Data Visualization Laboratory	1.0
		Subtotal	11.0

Trimester 7

Sl.	Course Code	Course Title	C. H.
1	DS 4889	Machine Learning	3.0
2	DS 4523	Simulation and Modeling	3.0
3	DS 4891	Data Analytics	3.0
4	DS 4892	Data Analytics Laboratory	1.0
5	DS 3120	Technical Report Writing and Presentation	2.0
		Subtotal	12.0

Trimester 8

Sl.	Course Code	Course Title	C. H.
1	DS 4429	Machine Learning Systems Design	3.0
2	DS 2251	Bayesian Statistics	3.0
3	CSE ****	Systems Optional - I	3.0
4	DS 3881	Regression and Time Series Analysis	3.0
		Subtotal	12.0

Trimester 9

Sl.	Course Code	Course Title	C. H.
1	DS 4211	Deep Learning	3.0
2	CSE ****	Systems Optional - II	3.0
3	DS ****	Option - I	3.0
4	DS ****	Option - II	3.0
		Subtotal	12.0

Trimester 10

Sl.	Course Code	Course Title	C. H.
1	DS 4000A	Capstone Project I	2.0
2	DS 4217	Data Privacy and Ethics	3.0
3	DS ****	Option - I	3.0
4	DS ****	Option - II	3.0
5	DS 4817	Big Data	3.0
		Subtotal	14.0

Trimester 11

Sl.	Course Code	Course Title	C. H.
1	DS 4000B	Capstone Project II	2.0
2		Humanities Optional - II	3.0
3	DS ****	Option - I	3.0
4	DS ****	Option - II	3.0
		Subtotal	11.0

Trimester 12

Sl.	Course Code	Course Title	C. H.
1	DS 4000C	Capstone Project III	2.0
2		Humanities Optional - III	3.0
3	DS ****	Option - I	3.0
4	DS ****	Option - II	3.0
		Subtotal	11.0

Credit hours distribution in twelve trimesters

Trimester	Theory Credits	Lab. Credits	Total Credits
Trimester 1	8.0	1.0	9.0
Trimester 2	9.0	1.0	10.0
Trimester 3	12.0	1.0	13.0
Trimester 4	12.0	1.0	13.0
Trimester 5	9.0	1.0	10.0
Trimester 6	9.0	2.0	11.0
Trimester 7	11.0	1.0	12.0
Trimester 8	12.0		12.0
Trimester 9	12.0		12.0
Trimester 10	14.0		14.0
Trimester 11	11.0		11.0
Trimester 12	11.0		11.0
Total	128.0	10.0	138.0

2.6 Course Equivalence

Several of the courses are equivalent to existing courses already offered by the Department of Computer Science and Engineering for the Bachelor of Science in Computer Science and Engineering Program.

Existing Course			New Course		
Course Code	Course Title	Cr.	Course Code	Course Title	Cr.
BIO 3105	Biology for Engineers	3.0	BIO 3107	Biology	3.0
SOC 2101	Society, Environment and Engineering Ethics	3.0	SOC 2102	Society, Environment and Computing Ethics	3.0
MATH 2201	Coordinate Geometry and Vector Analysis	3.0	MATH 1153	Advanced Calculus	3.0
MATH 2183	Calculus and Linear Algebra	3.0	MATH 2107	Linear Algebra	3.0
CSE 1111	Structured Programming Language	3.0	DS 1501	Programming for Data Science	3.0
CSE 1112	Structured Programming Language Laboratory	3.0	DS 1502	Programming for Data Science Laboratory	1.0
CSE 1115	Object Oriented Programming	3.0	DS 1507	Advanced Programming for Data Science	3.0
CSE 1116	Object Oriented Programming Laboratory	1.0	DS 1508	Advanced Programming for Data Science Laboratory	1.0
CSE 4523	Simulation and Modeling	3.0	DS 4523	Simulation and Modelling	3.0
CSE 4509	Operating System Concepts	3.0	CSE 4511	Operating Systems and Scrinpting	3.0
CSE 4889	Machine Learning	3.0	DS 4889	Machine Learning	3.0
CSE 4451	Human Computer Interaction	3.0	DS 4123	Human Computer Interaction	3.0
CSE 4000A	Final Year Design Project – I	2.0	DS 4000A	Capstone Project - I	2.0
CSE 4000B	Final Year Design Project – II	2.0	DS 4000B	Capstone Project - II	2.0
CSE 4000C	Final Year Design Project – III	2.0	DS 4000C	Capstone Project - III	2.0

Chapter 3

Course Details

ENG 1011 English I

Prerequisite: None
Credit Hours: 3.0

Reading and Writing: Cohesion, Skimming, Coherence, Scanning; Reading and Annotation; Main ideas, Brainstorming and Taking notes; Comprehensions; Linking and Transitional words; Grammatical Knowledge: Parts of Speech, Punctuation, Subject Verb Agreement, Tense; WH Questions; Paraphrasing; Summarizing; News Report Writing; Creative Writing; Presentation. Speaking and Listening: Speaking and Listening strategies; Pronunciation and Intonation; Vocabulary, Educated guess from content; Linking words and Fillers; Introduction to Drama; Performing Play; Art of Questioning; Famous Speeches; Listening Activities; How to make and present a brochure; News Reporting; Impromptu Speaking; Group Presentation.

Course Outcomes

CO1	Create and develop ideas through fluent and error free writing.
CO2	Skim, scan and infer from different reading texts in target language.
CO3	Interpret different listening texts of the target language.
CO4	Apply target language for establishing spoken communication in different contexts.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				x				
CO2				x				
CO3				x				
CO4				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, group discussion, exercise	Assignment, class test, exam
CO2	Lecture, group discussion, exercise	Assignment, class test, exam
CO3	Lecture, group discussion, exercise	Assignment, class test, exam
CO4	Lecture, group discussion, exercise	Assignment, class test, exam

Textbooks

1. Intensive English I, United International University

References

1. Intermediate English Grammar: Raymond Murphy; Oxford English Dictionary (9th Edition)

ENG 1013 English II

Prerequisite: ENG 1011
Credit Hours: 3.0

Reading and Writing: Writing process: Outlining, Drafting, Editing, Revising, Final Draft, Publishing; Prewriting Techniques: Free writing, Scratching out, Clustering, Questioning; Differences between a paragraph and an essay; Format of a paragraph; Adding details/ Body paragraphs: Ordering paragraphs, Time order, Emphatic order, Use of transitional words; Structure of a traditional essay; Types of Essays: Descriptive, Narrative, Cause-Effect, Argumentative, Compare and Contrast, Persuasive essay; Writing a good conclusion; Academic reading: Using index, choosing a book; Narrator's point of view; Preventing regression; Critical thinking; Expanding fixations; Return sweep. Speaking and Listening: Greetings and Expressions; Practice speaking; Role play (using modals and phrases); Handling situations; Listening tracks and speeches; Developing public speaking: Increasing confidents;Critical thinking and Vocabulary list;Newspaper project; Human rights discussion; Special occasion speech; Impromptu; Developing presentation skills; Developing argumentative skill: Argumentative presentation. Grammar Contents: Overview of verb tenses; Present and Past, Simple and Progressive; Perfect progressive tenses and Future time.

Course Outcomes

CO1 Organize and create ideas and sentences maintaining cohesion , coherence and appropriate diction.
CO2 Interpret and analyze different reading texts in the target language.
CO3 Interpret different listening texts of the target language.
CO4 Apply target language for establishing spoken communication in different contexts.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				x				
CO2				x				
CO3				x				
CO4				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, group discussion, exercise	Assignment, class test, exam
CO2	Lecture, group discussion, exercise	Assignment, class test, exam
CO3	Lecture, group discussion, exercise	Assignment, class test, exam
CO4	Lecture, group discussion, exercise	Assignment, class test, exam

Textbooks

1. Intensive English II, United International University.

References

1. College Writing Skills with Readings by John Langan (Sixth Edition)

PHY 2105 Physics

Prerequisite: None
Credit Hours: 3.0

Waves and Oscillations
Periodic motion: periodic waves, elastic restoring force, simple harmonic motion (SHM), differential equation of SHM and its solutions, examples of SHM, energy calculation of SHM, time period, velocity, acceleration, frequency calculation with graph, Lissajou's figure design, spring mass system and torsional pendulum, DHM, characteristic graph, differential equations for spring mass system with damping mechanism and RLC circuit-series and parallel analysis, resonant frequency, reactance, impedance, FHM; Mechanical Waves; Vibrating bodies and acoustic phenomena: progressive wave and its differential equation, EM wave, group velocity, phase velocity, standing waves, node and antinode; The Doppler effects, application of acoustic Phenomena.

Electricity magnetism
Electrostatic Force and Electric Field; Concept of charge, Coulomb's law, concept of electric field and its calculation, electric dipole; Gauss's law in electrostatic and its application, electric field due to dipole, torque on a dipole in uniform e-field, electric flux, flux density, Gauss's law and Coulomb's law; Electric Potential: electric potential and its calculation, electric potential energy, relationship between field and potential, potential due to a point charge, dipole, continuous charge distribution, electric field calculation from electric potential, equipotential surface, potential gradient; Capacitance and Dielectric : capacitors, capacitors in series and parallel, energy of charged capacitors, electrical energy density in terms of electric field, electron volt, dielectric media, polarization vector and displacement vector, Laplace's and Poission's equations, capacitor with a dielectric material, Gauss's law with dielectric; Current, Resistance and Electromotive Force: current and current density, resistance and resistivity, Ohm's law, EMF, power, resistance in series and parallel, Kirchhoff's Rules, RC circuit; Magnetic Field: magnetic field, magnetic flux and flux density, Lorentz force, Gauss's law for magnetism, motion of a charged particles in magnetic field : Hall effect; Magnetic field intensity, magnetic dipole moment, Biot-Savart Law, Ampere's law and its applications; Magnetic properties of material, magnetization, hysteresis; Inductions and Inductance: induced emf and Faraday's law of induction; Lenz's law; Mutual inductance ; Self inductance; Energy in an inductor; Inductance in series, in parallel, and their combination, MMF, leakage and fringing flux, Transformers.

Quantum Physics
Quantum theory: quantum theory of radiation, energy of photons, photo-electric Effect, work function, threshold frequency, threshold voltage, Compton effect, X-rays production, properties and application, Bragg Diffraction, De Broglie wavelength, Heisenberg' s Uncertainty Principle, correspondence principle, pair production, pair annihilation; Schrodinger equation: wave function, Schrodinger equation-time dependent and time independent form, expectation value, quantum operator, tunneling effect, quantum numbers, energy of trapped electron, quantum dots and corrals, quantization of Bohr orbital energy.

Course Outcomes

CO1 Define, explain, and show examples of different parameters and laws related with waves, oscillations, electricity, magnetism and quantum physics.
CO2 Solve different numerical problems related to waves, oscillations, electricity, magnetism and quantum physics. based on wave

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, problem solving, group activities	Quiz, class test, assignment, exam
CO2	Lecture, problem solving, group activities	Quiz, class test, assignment, exam

Textbooks

1. Fundamentals of Physics - D. Halliday, R. Resnick & J. Walker (10th Ed.) ISBN 978-1-118-23072-5 (Extended edition)

References

1. "Concept of Modern Physics" by Arthur Beiser, 6th Edition (international edition), McGraw-Hill Higher Education, 2003;
2. "Physics Volume 1" by Robert Resnick, David Halliday, & Kenneth S. Krane, 5th edition (Indian edition), John Wiley & Sons Inc., October 18, 2007;
3. "Vibrations and Waves" by A. P. French, 2003 edition (The MIT Introductory Physics Series), W. W. Norton & Company, Inc. New York, USA;
4. "University Physics" by Sears, Zemansky, Hugh D. Young, Roger A. Freedman, Lewis Ford, 12th edition, Addison-Wesley, March 5, 2007;
5. "Waves and Oscillations" by N. Subramanyam & Brij Lal, 2nd revised Edition, Vikas Publishing House, January 1, 2018;
6. "Physics for Engineers" by Dr. Giasuddin Ahmad, (Part-1 & 2), Hafiz Book Center, Bangladesh, 2013;
7. Fundamental of Electrical Circuits- Alexander & Sadiku(5th Edition).
8. "Atomic and Nuclear Physics" by N. Subrahmanyam & Brij Lal and revised by Jivan Seshan, Reprint edition, S. Chand Publisher, December 1, 2007.

PHY 2106 Physics Laboratory

Prerequisite: None
Credit Hours: 1.0

Experiments based on PHY 2105.

Course Outcomes

CO1 Apply the concepts based on theorem and explain various physical quantities by measuring numerous parameters involved with waves, oscillations, electricity and magnetism.
CO2 Evaluate and analyze different physical entities related with waves, oscillations, electricity and magnetism.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration	Teamwork, Viva, Report, Experiments, Quiz
CO2	Lecture, Demonstration	Teamwork, Viva, Report, Experiments, Quiz

Textbooks

1. Practical Physics by Dr. Giasuddin Ahmad, 4th edition, Hafiz Book Center, Bangladesh, 1992.

References

1. "Practical Physics" by R. K. Shukla and Anchal Srivastava, New Age International (P) Ltd. Publishers, 2006 and
2. "A Textbook of Practical Physics" by Dr. Samir Kumar Ghosh, 4th Revised edition, New Central Book Agency, India, 1st January, 2017

BIO 3105 Biology

Prerequisite: None
Credit Hours: 3.0

Introduction; The Basics of Life: Chemistry; Organic Molecules: The Molecules of Life; Cell Structure and Function; Enzymes, Coenzymes, and Energy; Biochemical Pathways: Cellular Respiration, Photosynthesis; DNA and RNA: The Molecular Basis of Heredity; Cell Division; Patterns of Inheritance; Applications of Biotechnology; Diversity within Species and Population Genetics; Evolution and Natural Selection; The Formation of Species and Evolutionary Change; Ecosystem Dynamics: The Flow of Energy and Matter; Community Interactions; Population Ecology; Evolutionary and Ecological Aspects of Behavior; The Origin of Life and Evolution of Cells; The Classification and Evolution of Organisms; The Nature of Microorganisms; The Plant Kingdom; The Animal Kingdom Materials Exchange in the Body; Nutrition: Food and Diet; The Body's Control Mechanisms and Immunity; Human Reproduction, Sex, and Sexuality.

Course Outcomes

CO1 Describe different biological quantities.
CO2 Apply the knowledge of biological systems in a real-life problem.
CO3 Design several biological systems with constraints.
CO4 Explain several procedures for solving biological systems within constraints.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3		x						
CO4	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Demonstration, Group Activities	Exam, quiz, assignment
CO2	Lecture, Q/A, Demonstration, Group Activities	Exam, quiz, assignment
CO3	Lecture, Q/A, Demonstration, Group Activities	Exam, quiz, assignment
CO4	Lecture, Q/A, Demonstration, Group Activities	Exam, quiz, assignment

Textbooks

1. Biology for Engineers - Arthur T. Johnson (2 nd Ed.)

References

1. Applied Cell and Molecular Biology for Engineers – Editors: Gabi Nindl Waite and Lee R. Waite
2. Biology for Dummies – Rene Fester Kratz and Donna Rae Siegfried (2 nd Ed.)
3. Biology for Engineers – G. K. Suraishkumar
4. A New Biology for the 21st Century – National Research Counsil of the National Academic, The National Academic Press, Washington D. C.

BDS 1201 History of the Emergence of Bangladesh

Prerequisite: None
Credit Hours: 2.0

Partition of Bengal (1947); Language Movement (1952); Movement for Autonomy; 6-point and 11-Point Programs; The 1970 Election; Speech on 7th of March 1971; Military Action, Genocide in the East Pakistan; The Liberation War; The Emergence of Bangladesh as a Sovereign Independent Statein 1971; Consitution of Bangladesh and citizen rights; Culture: Cultural diffusion and change,Bengali culture and problems of society; socialproblems of Bangladesh; Social change: theories of social change; social change in Bangladesh; urbanization process and its impact on Bangladesh society.

Course Outcomes

CO1 Students will be able to know the social changes of Bangladesh in different era.
CO2 Students will have a theoretical understanding of the social changes in Bangladesh.
CO3 Students will be able to know the historical background of the emergence of Bangladesh.
CO4 Students will have knowledge over the philosophy and forms of development of Bangladesh.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Presentation, Q/A	Assignment, Field Report, Exam, Class Tests, Poster
CO2	Lecture, Presentation, Q/A	Assignment, Field Report, Exam, Class Tests, Poster
CO3	Lecture, Presentation, Q/A	Assignment, Field Report, Exam, Class Tests, Poster
CO4	Lecture, Presentation, Q/A	Assignment, Field Report, Exam, Class Tests, Poster

Textbooks

1. রমেশচন্দ্র মজমুদার (২০২১). বাংলাদে শে র ইতি হাস - ১ম খণ্ড (প্রাচীন যুগ). [দি ব্য প্রকাশ]
2. মুহাম্মদ হাবিবুর রহমান (২০২০). গঙ্গাঋদ্ধি থেকে বাংলাদেশ [বাংলা একাডেমি]
3. মনুতাসীর মামনু এবং মোঃ মাহববুর রহমান (২০১৩). স্বাধীন বাংলাদে শে র অভ্যুদয়ের ইতিহাস [সুবর্ণ]
4. Willem van Schendel (2009). A History of Bangladesh [Cambridge University Press]

References

1. Ramesh Chandra Majumdar (Ed.) (1943). The History of Bengal - Volume 1. [University of Dacca, Dacca]
2. Sirajul Islam (ed.) (1997). History of Bangladesh, 1704-1971. [Asiatic Society of Bangladesh, Dhaka]
3. Badruddin Umar (2004). The Emergence of Bangladesh: Class Struggle in East Pakistan, 1947-1958. [Oxford University Press]

4. David Lewis (2011). Bangladesh: Politics, Economy and Civil Society. [Cambridge University Press]
5. Ali Riaz (2016). Bangladesh. A Political History since Independence. [I.B. Tauris & Co. Ltd, London]
6. Ahmed, Kamruddin (1975). A Social Political History of Bengal and the Birth of Bangladesh. [Dhaka: Inside Library]
7. Ahmed, Sufia (1996). Bangladesh Studies [The University Press Ltd.]
8. ড. সৈ য়দ মাহমদুলু হাসান (২০১২). বাংলার ইতিহাস (১৭৫৭ - ১৯১৭) [নভেল পাবলিশিং হাউস]
9. জাহানারা ইমাম (২০১৬). একাত্তরের দিনগুলি [সন্ধানী প্রকাশনী, ঢাকা]
10. বঙ্গবন্ধু শেখ মুজিবুর রহমান (২০১৪). অসমাপ্ত আত্মজীবনী [দি ইউনি ভার্সিটি প্রেস লিমিটেড (ইউ পি এল)]
11. বঙ্গবন্ধু শেখ মুজিবুর রহমান (২০১৭). কারাগারের রোজনামচা [বাংলা একাডেমি]
12. মঈদুল হাসান (২০১৭). মলূধারা' ৭১ [দি ইউনি ভার্সিটি প্রেস লিমিটেড (ইউ পি এল)]

SOC 2101 Society, Environment and Computing Ethics

Prerequisite: None
Credit Hours: 3.0

Society: emergence of Sociology as moral lessons for society; Basic institutions in society, organization and institutions in society, Types of Society; Culture: basics of culture, elements of culture, cultural change, socialization, and social issues around us; Technology and society: interaction between technology and society; Data ethics: understanding ethics, computing and data ethics; Moral reasoning and computing as social experimentation; The computing professional's concern for safety, professional responsibility; Employer authority; Rights of a data scientist; Global issues; Career choice and professional outlook; Ethical problems are like design problems; Genetically modified objects (GMO); Environment: environment and environmental issues– environmental degradation, waste management and renewable energy; Basic understanding of sustainable development, SDGs, climate change adaptation; Disability and Accessibility.

Course Outcomes

CO1 Students will have ability to explain relationship of society and technology.
CO2 Students will be able to define Sustainable Development.
CO3 Students will have ability to identify the relationship between environment and technology.
CO4 Students will have ability to understand professional responsibilities and apply ethical principles in computing practices.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			
CO4					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, group activities	Exam, Class Test, Assignment, Project
CO2	Lecture, group activities	Exam, Class Test, Assignment, Project
CO3	Lecture, group activities	Exam, Class Test, Assignment, Project
CO4	Lecture, group activities	Exam, Class Test, Assignment, Project

Textbooks

1. Introduction to Sociology by Anthony Giddens (7th Edition);
2. Environmental Science: Earth as a living planet by Daniel B. Botkin and Edward Keller, th edition, John Wiley & Sons, Inc
3. Engineering Ethics: Challenges and Opportunities by W. Richard Bowen

References

1. Ethics, Technology, and Engineering: An Introduction by Ibo van de Poel and Lamber Royakkers

TEC 2499 Technology Entrepreneurship

Prerequisite: None
Credit Hours: 3.0

Defining the startup vision: Start: How and when to start a new venture, what one needs to start, forming a suitable team; Define: Defining the core idea of a new venture, technological feasibility, market feasibility; Learn: Get the basic business model canvas, value propositions, partners, and customers; Experiment: How to get a working prototype, what is a working prototype, how to evaluate a prototype. Steering a new startup: Leap: Plunging in with your startup; Test: Test the prototype with potential customers, how to define customers, what to test, what questions to ask; Measure: How to interpret and evaluate the feedback, finding the early evangelists; Pivot (or Persevere): Do we change or keep the prototype based on the feedback? when to pivot, why pivoting is paramount, some of the successful companies that radically changed their business model. Accelerating towards success: Batch Production: Getting to mass production, mass producing software vs mass producing hardware, scaling in the cloud, scaling for connected devices; Grow: Evaluating and utilizing feedback from the bigger market audience, navigating legal and promotional problems; Adapt: Change with changing technology and market conditions, change due to size and scope; Innovate: How to keep being a leader, responding to competitors, intellectual property rights.

Course Outcomes

CO1 Identify and evaluate opportunities for creating a tech business.
CO2 Understand the principal issues of entrepreurship on a human, technical, commercial, environmental and financial level.
CO3 Apply entrepreneurship basics to create a technilogy startup

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1								x
CO2					x			
CO3								x

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Lecture, Group Activities	Presentation, Report, Project
CO2	Demonstration, Lecture, Group Activities	Presentation, Report, Project
CO3	Demonstration, Lecture, Group Activities	Presentation, Report, Project

Textbooks

1. "The Lean Startup" by Eric Ries

References

1. Technology Entrepreneurship Taking Innovation to the Marketplace, 3rd Edition, Authors: Thomas N. Duening, Robert A. Hisrich, Michael A. Lechter

ECO 4101 Economics

Prerequisite: None
Credit Hours: 3.0

Definition of Economics; Economics and engineering; Principles of economics. Micro-Economics: Introduction to various economic systems – capitalist, command and mixed economy; Fundamental economic problems and the mechanism through which these problems are solved; Theory of demand and supply and their elasticities; Theory of consumer behavior; Cardinal and ordinal approaches of utility analysis; Price determination; Nature of an economic theory; Applicability of economic theories to the problems of developing countries; Indifference curve techniques; Theory of production, production function, types of productivity; Rational region of production of an engineering firm; Concepts of market and market structure; Cost analysis and cost function; Small scale production and large scale production; Optimization; Theory of distribution; Use of derivative in economics: maximization and minimization of economic functions, relationship among total, marginal and average concepts. Macro-Economics: Savings; investment, employment; national income analysis; Inflation; Monetary policy; Fiscal policy and trade policy with reference to Bangladesh; Economics of development and planning.

Course Outcomes

CO1 Apply basic concepts of Micro, Macro and Development Economics in real engineering systems.
CO2 Develop strategies to determine the best price- output combination.
CO3 Investigate about proper decision making tools.
CO4 Address the nature of products and identify the market strategies accordingly.
CO5 Engage in solving basic major economic problems related to technological changes.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			
CO4					x			
CO5					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Activities	Class Test, Assignment, Exam
CO2	Lecture, Q/A, Activities	Class Test, Assignment, Exam
CO3	Lecture, Q/A, Activities	Class Test, Assignment, Exam
CO4	Lecture, Q/A, Activities	Class Test, Assignment, Exam
CO5	Lecture, Q/A, Activities	Class Test, Assignment, Exam

Textbooks

1. Principles of Economics: 8 th Edition, , N. Gregory Mankiw, South Western, CENGAGE LEARNING

References

1. Economics, 18 th Ed, Paul A. Samuelson & William D. Nordhaus, McGraw Hill

PMG 4101 Project Management

Prerequisite: None
Credit Hours: 3.0

Triple Constraint in Project Management: Time, Scope and Cost; Process methodology, Requirement Collection, Plan, schedule a project including risk assessment with proper documentation and presentation. Cost Estimation, Optimization, and performance calculation, Change management, Quality improvement, Use of Modern tools in project planning, resource allocation and estimation.

Course Outcomes

CO1 Adapt a process methodology to develop a project
CO2 Collect Requirement, Plan, schedule a project including risk assessment with proper documentation and presentation.
CO3 Estimate Cost, Optimization, and performance calculation.
CO4 Execute Change management, Quality improvement.
CO5 Able to use modern tools in project planning, resource allocation and estimation.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		x						
CO2		x						
CO3		x						
CO4			x					
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Group Work, Tools Usage	Exam, Handson Lab, Assignment, Report
CO2	Lecture, Group Work, Tools Usage	Exam, Handson Lab, Assignment, Report
CO3	Lecture, Group Work, Tools Usage	Exam, Handson Lab, Assignment, Report
CO4	Lecture, Group Work, Tools Usage	Exam, Handson Lab, Assignment, Report
CO5	Lecture, Group Work, Tools Usage	Exam, Handson Lab, Assignment, Report

Textbooks

1. Project Management Absolute Beginner's Guide by Greg Horine

References

1. Agile Project Management for Dummies by Mark C. Layton, Steven J. Ostermiller, and Dean J. Kynaston
2. The Mythical Man-Month: Essays on Software Engineering, Fred Brooks

ACT 2111 Financial and Managerial Accounting

Prerequisite: None
Credit Hours: 3.0

Financial Accounting: Objectives and importance of accounting; Accounting as an information system; Computerized system and applications in accounting. Recording system: double entry mechanism; accounts and their classification; Accounting equation; Accounting cycle: journal, ledger, trial balance; Preparation of financial statements considering adjusting and closing entries; Accounting concepts (principles) and conventions. Financial statement analysis and interpretation: ratio analysis. Cost and Management Accounting: Cost concepts and classification; Overhead cost: meaning and classification; Distribution of overhead cost; Overhead recovery method/rate; Job order costing: preparation of job cost sheet and quotation price; Inventory valuation: absorption costing and marginal/variable costing techniques; Cost-Volume-Profit analysis: meaning breakeven analysis, contribution margin approach, sensitivity analysis. Short-term investment decisions: relevant and differential cost analysis. Long-term investment decisions: capital budgeting, various techniques of evaluation of capital investments.

Course Outcomes

CO1 Explain and apply accounting concepts, principles and conventions.
CO2 Apply steps of recording process & thereby produce accounting information in the form of financial statements.
CO3 Analyze, interpret and communicate the information contained in basic financial statements.
CO4 Identify cost classifications based on how the cost will be used: whether for preparing external reports, predicting cost behavior, assigning costs to cost objects, or decision making.
CO5 Describe the elements of financial planning and create budget.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2			x					
CO3		x						
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO2	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO3	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO4	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO5	Lecture, Q/A, Presentations	Assignments, Class Test, Exam

Textbooks

1. Jerry J. Weygandt , Donald E. Kieso, and Paul D. Kimmel, “Accounting Principles”, Latest Edition, John Wiley & Sons, Inc.

2. Ray Garrison, Eric Noreen and Peter Brewer, “Managerial Accounting”, Latest Edition, Mcgrew-Hill.

References

1. Belverd E. Needles, Marian Powers, Susan V. Crosson, “Principles of Accounting”, Latest Edition, Cengage Learning, Inc.

2. Anthony A. Atkinson, Robert S. Kaplan, S. Mark Young, “Management Accounting”, Latest Edition, Pearson Education.

SOC 4101 Introduction to Sociology

Prerequisite: None
Credit Hours: 3.0

Concept and theory: major schools of sociology - functionalism, critical theory, gender, interactionism and postmodernism; Sociology of communications: the impacts of contemporary media institutions and communications technologies on the social construction of knowledge and the construction of socially significant identities and ideologies; Society: discussion on key concepts of society, social institutions, social structure and stratification, religion and so on; Sociology of development: technology, gender, business, globalization, and how do we formulate reasonable expectations? Global and social issues; Social research: importance of research, research methods and techniques.

Course Outcomes

CO1 Evaluate society and culture using sociological theories.
CO2 Demonstrate an understanding of sociological research methods.
CO3 Explain processes of socialization.
CO4 Understand the ways in which social institutions are interdependent.
CO5 Organize the components of social structure.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1			x					
CO2	x							
CO3	x							
CO4					x			
CO5					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO2	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO3	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO4	Lecture, Q/A, Presentations	Assignments, Class Test, Exam
CO5	Lecture, Q/A, Presentations	Assignments, Class Test, Exam

Textbooks

1. Introduction to Sociology by Anthony Giddens (7th Edition)

References

1. Introduction to Sociology Eleventh Edition by Deborah Carr, Anthony Giddens and Mitchell Duneier

IPE 3401 Industrial and Operational Management

Prerequisite: None
Credit Hours: 3.0

Introduction, evolution, management function, organization and environment. Organization: Theory and structure; Coordination; Span of control; Authority delegation; Groups; Committee and task force; Manpower planning. Personnel Management: Scope; Importance; Need hierarchy; Motivation; Job redesign; Leadership; Participative management; Training; Performance appraisal; Wages and incentives; Informal groups; Organizational change and conflict. Cost and Financial Management; Elements of costs of products depreciation; Break-even analysis; Investment analysis; Benefit cost analysis. Management Accounting: Cost planning and control; Budget and budgetary control; Development planning process. Marketing Management: Concepts; Strategy; Sales promotion; Patent laws. Technology Management: Management of innovation and changes; Technology life cycle; Case studies.

Course Outcomes

CO1 Use Engineering economics and simple mathematics for Solving project selection problems for choosing the best possible project.
CO2 Analyze various industrial problems by using operation management technique, operation research technique and cost accounting technique and solve it.
CO3 Understand the importance of quality control, and various industrial engineering techniques to improve the process in any engineering sector and how this affects the organization and customers.
CO4 Analyze the optimization problems and solve it by using graphical method or simplex method

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		x						
CO2	x							
CO3	x							
CO4	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Group Discussion	Assignment, Class Test, Exams
CO2	Lecture, Q/A, Group Discussion	Assignment, Class Test, Exams
CO3	Lecture, Q/A, Group Discussion	Assignment, Class Test, Exams
CO4	Lecture, Q/A, Group Discussion	Assignment, Class Test, Exams

Textbooks

1. Industrial Engineering and Operations Management by Courtney Hoover

References

1. Management: Tasks, Responsibilities, Practices by Peter F. Drucker

BAN 2501 Bangla

Prerequisite: None
Credit Hours: 3.0

(অ) বাংলা সাহিত্য
ক. নির্বাচিত প্রবন্ধ : (সহায়ক গ্রন্থ হতে নির্বাচিত যে কোনো ২টি)
খ. নির্বাচিত গল্প : (সহায়ক গ্রন্থ হতে নির্বাচিত যে কোনো ২টি)
গ. নির্বাচিত কবিতা : (সহায়ক গ্রন্থ হতে নির্বাচিত যে কোনো ২ টি)
ঘ. নাটক মুনীর চৌধুরীঃ কবর
(আ) প্রায়োগিক বাংলা
ক. বাংলা ভাষায় লিখন-দক্ষতা
(১) বাংলা ধ্বনিতত্ত্ব (ধ্বনি, বর্ণ, ধ্বনি পরিবর্তন, যুক্তবর্ণ) (২) বাংলা বানান : বাংলা একাডেমির বাংলা বানানের নিয়ম, শব্দের অপপ্রয়োগ, শব্দের বানান ও অশুদ্ধি (৩) বাক্যের শুদ্ধি-অশুদ্ধি : বাক্যের গঠনগত শুদ্ধি-অশুদ্ধি, বিরাম চিহ্ন (৪) বাংলা লিখন কৌশল : প্রতিবেদন লিখন, অনুষ্ঠান সঞ্চালন, পাণ্ডুলিপি প্রস্তুত, বিজ্ঞাপন লিখন, প্রুফ সংশোধন, ক্ষুদে গল্প লিখন, বঙ্গানুবাদ।
খ. বাংলা ভাষায় শ্রবণ ও কথন-দক্ষতা
(১) বাংলা উচ্চারণের নিয়ম : স্বরবর্ণ ও ব্যঞ্জনবর্ণের উচ্চারণের স্থান, উচ্চারণরীতি
সহায়ক গ্রন্থ : বিশ্ববিদ্যালয় মঞ্জুরি কমিশন কর্তৃক নির্ধারিত "বাংলা ভাষা ও সাহিত্য"

Course Outcomes

CO1	Create and develop ideas through fluent and error free writing in Bangla.
CO2	Skim, scan and infer from different reading texts in Bangla.
CO3	Interpret different listening texts of the Bangla.
CO4	Apply Bangla for establishing spoken communication in different contexts.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				x				
CO2				x				
CO3				x				
CO4				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, group discussion, exercise	Assignment, class test, exam
CO2	Lecture, group discussion, exercise	Assignment, class test, exam
CO3	Lecture, group discussion, exercise	Assignment, class test, exam
CO4	Lecture, group discussion, exercise	Assignment, class test, exam

Textbooks

1. বিশ্ববিদ্যালয় মঞ্জুরি কমিশন কর্তৃক নির্ধারিত "বাংলা ভাষা ও সাহিত্য"

References

1. লাল নীল দীপাবলি বা বাঙলা সাহিত্যের জীবনী by হুমায়ুন আজাদ

URC 1101 Life Skills for Success

Prerequisite: None
Credit Hours: 3.0

The course is intended for fresh entrants at the first trimester who need to be oriented and adapted to university survival skills, as well as achieving soft skills for success as a responsible citizen in the society. Complementary to this core object, students need to be motivated and inspired to study attentively with a sense of integrity and ethical orientation. In addition, this course will create students' awareness to build a successful career as well as becoming a successful individual in the society. The course will cover lectures on rules and regulations of the university, the importance of student life, contribution of family, building professional ethics and personal integrity, time management, study skills, etiquette and manners, social responsibility including environmental concerns, effective communication, dealing with health and psychological issues, etc. The course is expected to take care of this broad gamut of soft skills that would immensely inspire towards developing a quality person.

Course Outcomes

CO1 Describe various types of life skills and self-dependency skills.
CO2 Recognize different types of university rules, regulation and student service.
CO3 Explain how to use different tips and techniques of study skills.
CO4 Apply time management strategies to take better control of own life.
CO5 Demonstrate ability to communicate effectively.
CO6 Practice exam skills, and show honesty, proper manner and etiquettes and social responsibility.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			
CO4					x			
CO5				x				
CO6					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture Slides, Readings	Self-Assessment, Teamwork
CO2	Lecture Slides, Readings	Self-Assessment, Teamwork
CO3	Lecture Slides, Readings	Self-Assessment, Teamwork
CO4	Lecture Slides, Readings	Self-Assessment, Teamwork
CO5	Lecture Slides, Readings	Self-Assessment, Teamwork
CO6	Lecture Slides, Readings	Self-Assessment, Teamwork

Textbooks

1. No specific textbook to follow. Students will be provided handouts and copies of lecture slides.

References

1. Course instructors will provide reference materials and course resources.

SOC 4301: Introduction to Anthropology

Prerequisite: None
Credit Hours: 3.0

Scope and History of anthropology; Anthropology and Colonialism; Different branches of anthropology; Anthropology and other Disciplines; Theory and methods in anthropology; Core Concepts: Culture, Marriage and Family, Kinship, Descent and Social Structure; Economic Systems, Political Systems; Applying Anthropology: Applied Anthropology; Recent Trends in Anthropology: Changes and Direction; Research methods to study human behavior; Computational Methods in Anthropology.

Course Outcomes

CO1 To Familiarize with the foundation of Anthropology and its branches.
CO2 To Explain the core ideas, and theoretical and methodological approaches of general anthropology.
CO3 To explore cultural, socio-economical, religious, and political diversity of humankind.
CO4 To Apply various research methods to study human behavior.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			
CO4					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Group Activities	Exam, Assignment, Class Tests
CO2	Lecture, Q/A, Group Activities	Exam, Assignment, Class Tests
CO3	Lecture, Q/A, Group Activities	Exam, Assignment, Class Tests
CO4	Lecture, Q/A, Group Activities	Exam, Assignment, Class Tests

Textbooks

1. Introduction to Anthropology by OpenStax

References

1. Perspectives: An Open Invitation to Cultural Anthropology
2. Think Like an Anthropologist by Matthew Engelke

FLN 1101: Introduction to a Foreign Language (Name of the Language)

Prerequisite: None
Credit Hours: 3.0

Elementary proficiency in oral expression, listening comprehension, reading and writing in a foreign language; cultural understanding on topics related to daily activities and personal environment; basic grammatical knowledge and vocabulary for common use; ability to communicate in the most predictable and common situations using high-frequency words, expressions, and phrases.

Course Outcomes

CO1 Create and develop ideas through fluent and error free writing.
CO2 Skim, scan and infer from different reading texts in target language.
CO3 Interpret different listening texts of the target language.
CO4 Apply target language for establishing spoken communication in different contexts.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				x				
CO2				x				
CO3				x				
CO4				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, group discussion, exercise	Assignment, class test, exam
CO2	Lecture, group discussion, exercise	Assignment, class test, exam
CO3	Lecture, group discussion, exercise	Assignment, class test, exam
CO4	Lecture, group discussion, exercise	Assignment, class test, exam

Textbooks

1. Books will be suggested based on the language.

References

1. References will be suggested based on the language.

SWL 4101: Software and Law

Prerequisite: None
Credit Hours: 3.0

Introduction: Why law is necessary, the laws relevant to software and its use, taking a global perspective. Intellectual property (IP) rights: intellectual-property law, copyright, patents, marks and brands; common and public goods. The issue of who owns software and digital content how that ownership can be protected using instruments like copyright and patents. Contracts: how contracts are used to formalize the relationship between purchasers and suppliers of software. Responsibilities to employees and the public: the laws that apply to information technology and software to ensure that organizations meet their responsibility of care towards employees, customers, and the general public.

Course Outcomes

CO1 To Summarize various laws related to software and intellectual property available world-wide.
CO2 To Familiarize with the standards of contracting among various stakeholders of a software.
CO3 To interpret different responsibilities and professional codes of conducts of a software engineering personnel.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Group Activities	Assignment, Exams
CO2	Lecture, Q/A, Group Activities	Assignment, Exams
CO3	Lecture, Q/A, Group Activities	Assignment, Exams

Textbooks

1. Software Law and Its Applications (Aspen Casebook) by Robert W. Gomulkiewicz

References

1. Software and Internet Law by Mark A. Lemley
2. Open Source Licensing: Software Freedom and Intellectual Property Law by Lawrence Rosen

BHV 2101: Introduction to Behavioral Science

Prerequisite: None
Credit Hours: 3.0

Basic scientific theoretical perspectives, epistemological views and theories of the behavioral sciences; central concepts, theories, models and research results in the behavioral sciences; integration of educational, psychological, and sociological theories in the behavioral science field; diversity perspectives based on class, gender and ethnicity in relation to behavioral science theories; relevant search tools and critically review search results.

Course Outcomes

CO1 To Familiarize with the basic concepts, theories, and epistemological views of the behavioral sciences.
CO2 To Understand the concept, theories, and models in the behavioral science field.
CO3 To Explain the fusion and diversity of different behavioral science theories.
CO4 To apply various understandings for relevant search tools and critically review search results.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Group Activities	Assignment, Exams
CO2	Lecture, Q/A, Group Activities	Assignment, Exams
CO3	Lecture, Q/A, Group Activities	Assignment, Exams
CO4	Lecture, Q/A, Group Activities	Assignment, Exams

Textbooks

1. An Introduction to Behavioural Science, by Martin o Grady

References

1. Designing for Behavior Change: Applying Psychology and Behavioral Economics by Stephen Wendel

MKT 4313: Digital Marketing

Prerequisite: None
Credit Hours: 3.0

Digital Marketing Essentials: The Digital Marketing Environment; The Digital Consumer; Content Marketing; Digital Marketing Tools and Channels: Social Media Marketing; Augmented, Virtual and Mixed Reality, Search Engine Optimization (SEO); Search Engine Marketing (SEM); Digital Marketing Strategy and Planning: Digital Marketing Strategy and Objectives; Digital Marketing Management: Integrating, Improving and Transforming Digital Marketing; Further issues in legal and social Sensitivity.

Course Outcomes

CO1 To Familiarize with the basic concepts, types, and importance of digital marketing.
CO2 To Understand the concepts of increasing visibility; analysis, and keyword research.
CO3 To Analyze the fundamental theories on SEO; Digital marketing ethics, planning, and strategy.
CO4 To apply various understandings for practical applications on digital marketing.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Group Activities	Assignment, Exams
CO2	Lecture, Q/A, Group Activities	Assignment, Exams
CO3	Lecture, Q/A, Group Activities	Assignment, Exams
CO4	Lecture, Q/A, Group Activities	Assignment, Exams

Textbooks

1. Digital Marketing Strategy: An Integrated Approach to Online Marketing By Simon Kingsnorth

References

1. Shoot The HiPPO: How to be a killer Digital Marketing Manager By Tom Bowden & Tom Jepson
2. Digital Marketing By Dave Chaffey & Fiona Ellis-Chadwick
3. Marketing Communications: Integrating Online and Offline, Customer Engagement and Digital Technologies By PR Smith & Ze Zook
4. Traffic Secrets: The Underground Playbook for Filling Your Websites and Funnels with Your Dream Customers By Russell Brunson
5. Brand Storytelling: Put Customers at the Heart of Your Brand Story By Miri Rodriguez
6. Marketing 5.0: Technology for Humanity By Philip Kotler

PSY 2101: Psychology

Prerequisite: None
Credit Hours: 3.0

The objective of this course is to provide knowledge about the basic concepts and principles of psychology pertaining to real-life problems. The course will familiarize students with the fundamental processes that occur within organism-biological basis of behavior, perception, motivation, emotion, learning, memory and forgetting and also to the social perspective-social perception and social forces that act upon the individual.

Course Outcomes

CO1 Describe principles of psychology.
CO2 Depict formation of human behaviour.
CO3 Understand impact of society on individual.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1					x			
CO2					x			
CO3					x			

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A, Group Activities	Assignment, Exams
CO2	Lecture, Q/A, Group Activities	Assignment, Exams
CO3	Lecture, Q/A, Group Activities	Assignment, Exams

Textbooks

1. Cognitive Psychology: A Student's Handbook by Mark Keane and Michael Eysenck

References

1. Understanding Psychology by Robert S. Feldman

MATH 1151 Fundamental Calculus

Prerequisite: None
Credit Hours: 3.0

Function: domain and range of a function, Translation, reflection, compression and stretches of a function; Even and odd functions; Inverse functions; One to One and many to one functions; Family of exponential, logarithmic, sine and cosine functions; Limit, continuity and differentiability; Tangent line; Derivative and chain rule; An overview of area problem; Newton's antiderivative method in finding area; Indefinite integral, fundamental theorem of calculus; Definite integral; Area between two curves, arc length.

Course Outcomes

CO1 Define relation of two variables, interval, function, domain and range of different types of function, Composite, odd and even functions, inverse functions, family of functions, Limit, continuity and differentiability of various functions.
CO2 Analyze graph of functions (Translations, reflections, Stretch and compress), limits, continuity and differentiability.
CO3 Compute differentiations and integrations of functions.
CO4 Apply differentiation to find the rate of change of functions, velocity of a moving particle, average velocity, instantaneous velocity and slope of secant and tangent line.
CO5 Interpret the relationship of definite integral with area problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving, Q/A	Exam, Assignments
CO2	Lecture, Problem Solving, Q/A	Exam, Assignments
CO3	Lecture, Problem Solving, Q/A	Exam, Assignments
CO4	Lecture, Problem Solving, Q/A	Exam, Assignments
CO5	Lecture, Problem Solving, Q/A	Exam, Assignments

Textbooks

1. "CALCULUS Early Transcendentals" By: Anton, Bivans and Davis, 11th Edition Publisher: Wiley.

References

1. "CALCULUS Early Transcendentals", By: James Stewart, 8th Edition, Publisher: Cengage Learning

MATH 1153 Advanced Calculus

Prerequisite: MATH 1151
Credit Hours: 3.0

Vector Calculus: Vector and scalar fields; Differentiation and integration of vectors; Gradient of a scalar field: directional derivative; Divergence and curl of a vector field; Vector calculus identities: Jacobian, Hessian, Laplacian; Line integrals.
Complex Calculus: Functions of a complex variable; Limits and continuity of functions of complex variables; Complex differentiation: analytic functions, Cauchy-Riemann equations; Elementary complex functions: Euler's formula; Line integral of a complex function.
Ordinary Differential Equations (ODE): Definition. Formation of differential equations. Solution of first order differential equations by various methods. Solution of differential equations of first order and higher degrees. Solution of general linear equations of second and higher orders with constant coefficient. Solution of Euler's homogeneous linear equations.
Partial Differential Equations (PDE): Introduction and formation of PDE; Solution of linear and non-linear PDE of order one; Second order linear PDE: classifications to standard forms; Parabolic: heat and diffusion equations; Elliptic: Laplace and Poisson equations; Hyperbolic: wave equation; Solution of second order linear PDE by separation of variables.

Course Outcomes

CO1 Apply different theorems of vector calculus to solve the real life applications.
CO2 Analyze complex numbers and differentiate complex functions.
CO3 Solve 1st order, 2nd order and higher order ordinary differential equation.
CO4 Solve partial differential equation.
CO5 Apply differential equation to solve science and engineering problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving, Q/A	Exam, Assignments
CO2	Lecture, Problem Solving, Q/A	Exam, Assignments
CO3	Lecture, Problem Solving, Q/A	Exam, Assignments
CO4	Lecture, Problem Solving, Q/A	Exam, Assignments
CO5	Lecture, Problem Solving, Q/A	Exam, Assignments

Textbooks

1. Calculus 10-th Edition by Howard Anton, Irl Bivens and Stephen Davis

References

1. Engineering Mathematics, H. K. Das (HKD)- 15th Edition

MATH 2107 Linear Algebra

Prerequisite: None
Credit Hours: 3.0

Introduction to vectors, their products, matrices and systems of linear equations; Solving linear equations: Gaussian elimination, inverse and transpose of a matrix, factorization into $A = LU$; Vector spaces and subspaces: four fundamental subspaces, solving $Ax = 0$ and $Ax = b$, independence, basis and dimension, dimensions of the four subspaces; Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt; Determinants: properties, formulas, co-factors, Cramer's rule, inverses and volumes; Eigenvalues and eigenvectors: eigendecomposition, systems of differential equations, symmetric and positive definite matrices; Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations; Complex vectors and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.

Course Outcomes

CO1 Analyze system of linear equations.
CO2 Demonstrate the operations of matrices and determinants.
CO3 Apply theorems of linear algebra to solve real life problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving, Q/A	Exam, Assignments
CO2	Lecture, Problem Solving, Q/A	Exam, Assignments
CO3	Lecture, Problem Solving, Q/A	Exam, Assignments

Textbooks

1. Contemporary Linear Algebra, Howard Anton, Robert C. Busby (HR)

References

1. Engineering Mathematics, H. K. Dass (HKD) [15th Edition].
2. Mathematics for Machine Learning by A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth

MATH 2205 Probability and Statistics

Prerequisite: None
Credit Hours: 3.0

Introduction to Statistics: variability in data, populations and samples, descriptive statistics, inferential statistics and probability, sampling procedures; Measures of location: mean, median; Measures of variability: standard deviation, variance; Higher moments: skewness, kurtosis; Graphical representation of data: scatter plot, stem and leaf plot, histogram, box plot; Probability: sample space and events, rules of probability, conditional probability, independence, Bayes' rule; Random variables: discrete and continuous probability distributions, joint probability distributions, marginal distributions and independence; Expectations, variance and covariance of random variables and their properties, Chebyshev's theorem; Discrete probability distributions: Bernoulli, binomial, multinomial, Poisson distributions and their properties; Continuous probability distributions: uniform, Gaussian (normal), chi-square distributions and their properties; Sampling distributions: sample mean, central limit theorem, sample variance, t-distribution, F-distribution, quantile and probability plots; Statistical inference: parameter estimation, confidence intervals; Hypothesis testing: null and alternative hypotheses, test statistic, P-values and significance levels, Z-test, t-test, goodness-of-fit test; Regression and correlation: least squares, coefficient of determination, correlation coefficient; Analysis of variance (ANOVA).

Course Outcomes

- CO1 Analyze experimental and collected data and their behavior using statistical methods, such as, measures of central tendency, measures of dispersion, moments, skewness and kurtosis, and point estimation.
- CO2 Explain interpretation and exploratory analysis of data by analytical and graphical tools for multi-variable events.
- CO3 Describe fundamental probability theory and related theorems.
- CO4 Evaluate the probability of random variables and corresponding statistical characteristics of any random experiment by using discrete and continuous distributions.
- CO5 Assess confidence intervals, decisions on hypothesis testing.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving, Q/A	Exam, Assignments
CO2	Lecture, Problem Solving, Q/A	Exam, Assignments
CO3	Lecture, Problem Solving, Q/A	Exam, Assignments
CO4	Lecture, Problem Solving, Q/A	Exam, Assignments
CO5	Lecture, Problem Solving, Q/A	Exam, Assignments

Textbooks

1. Introduction to Statistics, David Lane, Rice University

References

1. Probability, Random Variables, and Random Signal Principles" – by Peyton Peebles, Fourth Edition Published by Tata McGraw-Hill, ISBN: 978- 0073660073
2. "Probability, Random Variables and Stochastic Processes" – by Athanasios Papoulis and S. Unnikrishna Pillai, Published by Tata McGraw-Hill, ISBN: 978-0071226615

DS 1501 Programming for Data Science

Prerequisite: None
Credit Hours: 3.0

Branching and iteration; String Manipulation, Guess and Check, Approximations, Bisection; Decomposition, Abstractions, Functions; Tuples, Lists, Aliasing, Mutability, Cloning; Recursion, Dictionaries; Testing, Debugging, Exceptions, Assertions, Files and I/O.

Course Outcomes

CO1 Understand basic concepts of Structured Programming.
CO2 Comprehend basic and intermediate concepts of a structured programming language.
CO3 Apply programming language skills to solve basic and intermediate level programming problems.
CO4 Interpret programs written in a structured programming language.
CO5 Develop simple data science applications using a structured programming language.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3		x						
CO4	x							
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Assignment, Exams
CO2	Lecture, Demonstration, Q/A	Assignment, Exams
CO3	Lecture, Demonstration, Q/A	Assignment, Exams
CO4	Lecture, Demonstration, Q/A	Assignment, Exams
CO5	Lecture, Demonstration, Q/A	Assignment, Exams

Textbooks

1. Introduction to Computation and Programming Using Python By John V. Guttag

References

1. Automate the Boring Stuff with Python (Practical Programming for Total Beginners) by Al Sweigart
2. Learn to Program with Python by Irv Kalb

DS 1502 Programming for Data Science Laboratory

Prerequisite: None
Credit Hours: 3.0

Laboratory work based on DS 1501.

Course Outcomes

CO1 Design, compile and execute software programs to solve basic to moderate problems using a popular IDE.
CO2 Implementation of modular programs using different data structures like array, lists, functions.
CO3 Work in a team and complete a data science project.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x			x		

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Worksheets	Assignments, Project
CO2	Lecture, Demonstration, Worksheets	Assignments, Project
CO3	Lecture, Demonstration, Worksheets	Assignments, Project

Textbooks

1. Introduction to Computation and Programming Using Python By John V. Guttag

References

1. Automate the Boring Stuff with Python (Practical Programming for Total Beginners) by Al Sweigart
2. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes

DS 1115 Object Oriented Programming for Data Science

Prerequisite: DS 1501
Credit Hours: 3.0

Philosophy of Object Oriented Programming (OOP); Advantages of OOP over structured programming; Abstraction and Encapsulation, classes and objects, access specifiers, static and non-static members; Constructors, destructors and copy constructors; Array of objects, object pointers, and object references; Inheritance: single and multiple inheritance; Polymorphism:overloading, abstract classes, virtual functions and overriding; Exceptions; Object Oriented I/O; Template functions and classes; Multithreaded Programming.

Course Outcomes

CO1 Understand the basic characteristics of an object oriented programming language.
CO2 Explain the fundamental concepts and features of Object-Oriented Programming and use these to write programs for solving computational problems.
CO3 Understand the core concepts of GUI programming, Threads, Sockets, File IO, Collections framework and use these to solve programming problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Assignment, Exams
CO2	Lecture, Demonstration, Q/A	Assignment, Exams
CO3	Lecture, Demonstration, Q/A	Assignment, Exams

Textbooks

1. Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries by Steven F. Lott, Dusty Phillips
2. Object-Oriented Programming in Python by Michael H. Goldwasser and David Letscher

References

1. Beyond the Basic Stuff with Python: Best Practices for Writing Clean Code by Al Sweigart

DS 1116 Object Oriented Programming for Data Science Laboratory

Prerequisite: DS 1501, DS 1502
Credit Hours: 3.0

Laboratory work based on DS 1115.

Course Outcomes

CO1 Apply the Object-Oriented Programming Features in solving programming problems.
CO2 Understand using modern/popular IDEs to develop OOP based applications.
CO3 Develop OOP based Data Science Project using standard framework specific libraries.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Lecture, Q/A	Assignment, Project
CO2	Demonstration, Lecture, Q/A	Assignment, Project
CO3	Demonstration, Lecture, Q/A	Assignment, Project

Textbooks

1. Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries by Steven F. Lott, Dusty Phillips
2. Object-Oriented Programming in Python by Michael H. Goldwasser and David Letscher

References

1. Beyond the Basic Stuff with Python: Best Practices for Writing Clean Code by Al Sweigart

DS 3101 Advanced Probability and Statistics

Prerequisite: MATH 2107, MATH 2205
Credit Hours: 3.0

Random variables; Stochastic process; Markov chains: discrete parameter, continuous parameter, birth-death process; Queuing models: birth-death model, Markovian model, open and closed queuing network; Application of queuing models (Computation, simulation, and visualization using R will be used throughout the course).

Course Outcomes

CO1 Explain and apply basic concepts and methods of stochastic modeling.
CO2 Solve problems related to the rich diversity of applications of stochastic processes.
CO3 Select and apply simple stochastic analysis to solve appropriate problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Problem Solving, Lecture, Q/A	Exams, Assignments
CO2	Problem Solving, Lecture, Q/A	Exams, Assignments
CO3	Problem Solving, Lecture, Q/A	Exams, Assignments

Textbooks

1. Introduction to Probability Models by Sheldon M. Ross

References

1. Simulation basics in R: https://bookdown.org/rdpeng/rprogdatascience/simulation.html
2. Advanced Probability and Statistics MAFS5020 HKUST, Instructor-Kani Chen

DS 4523 Simulation and Modelling

Prerequisite: MATH 2107, MATH 2205
Credit Hours: 3.0

Simulation methods, model building, random number generator, statistical analysis of results, validation and verification techniques; Digital simulation of continuous system; Simulation and analytical methods for analysis of computer systems and practical problems in business and practice; Introduction to simulation packages.

Course Outcomes

CO1 Explain a given real-world system in terms of its essential elements, that is, purpose, parameters, constraints, performance requirements, subsystems and interconnections.

CO2 Develop and validate a modeling strategy to approximate solutions to mathematical or real-world problems, which considers probabilistic events and evaluation against design criteria, and incorporates subsystems to introduce stochasticity.

CO3 Compare and select a model and its necessary distributions with validation using real data for a system taking into consideration its suitability to facilitate decision making and predicted advantages over alternatives.

CO4 Analyze the simulation results of a real-world system model, within the context of its capabilities and limitations, to address critical issues in a system.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving	Project, Exams
CO2	Lecture, Problem Solving	Project, Exams
CO3	Lecture, Problem Solving	Project, Exams
CO4	Lecture, Problem Solving	Project, Exams

Textbooks

1. Simulation Modeling and Analysis by Averill Law

References

1. Simulation basics in R :https://pubs.wsb.wisc.edu/academics/analytics-using-r-2019/simulation-basics.html

2. Discrete-Event System Simulation by Jerry Banks

DS 2251 Bayesian Statistics

Prerequisite: MATH 2107, MATH 2205
Credit Hours: 3.0

Data in an uncertain world, perfect knowledge of the uncertainty; Bayesian inference with known priors, probability intervals; Conjugate priors; Data in an uncertain world, imperfect knowledge of the uncertainty; Bayesian inference with unknown priors; Frequentist significance tests and confidence intervals; Resampling methods: bootstrapping; Bayesian regression, Graphical Models. (Computation, simulation, and visualization using R will be used throughout the course.)

Course Outcomes

CO1 Understand Bayesian concepts, create and estimate Bayesian models using R software.
CO2 Effectively use the Bayesian approach to estimate likely event outcomes, or probabilities, using data.
CO3 Be able to apply a range of Bayesian functions using R software in order to model and estimate single parameter, multi-parameter, conjugate mixture, multinomial, and rejection and importance sampling Bayesian models.
CO4 Understand and use both predictive priors and predictive posteriors in Bayesian applications.
CO5 Compare and evaluate alternative, competing Bayesian models.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4	x							
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Lecture, Q/A	Exam, assignments
CO2	Demonstration, Lecture, Q/A	Exam, assignments
CO3	Demonstration, Lecture, Q/A	Exam, assignments
CO4	Demonstration, Lecture, Q/A	Exam, assignments
CO5	Demonstration, Lecture, Q/A	Exam, assignments

Textbooks

1. Artificial Intelligence: A Modern Approach by Peter Norvig and Stuart J. Russell
2. Simulation basics in R : https://bookdown.org/rdpeng/rprogdatascience/simulation.html

References

1. Bayesian Methods for Nonlinear Classification and Regression by David G. T. Denison , Christopher C. Holmes, Bani K. Mallick , Adrian F. M. Smith
2. A First Course in Bayesian Statistical Methods by Peter D. Hoff
3. Bayesian Essentials with R by Jean-Michel Marin, Christian P. Robert

CSE 2213 Discrete Mathematics

Prerequisite: None
Credit Hours: 3.0

Set theory: sets, relations, functions; Mathematical Logic: propositional calculus and predicate calculus; Mathematical reasoning and proof techniques; Counting: permutations, combinations, Discrete Probability principles of inclusion and exclusion; Recurrence relations; Graph Theory: graphs, paths, and trees.

Course Outcomes

CO1 Represent logical sentences in terms of propositions, predicates, quantifiers and logical connective and also understand basic properties of sets and functions.
CO2 Produce convincing arguments for basic mathematical proofs using propositions and proof techniques.
CO3 Apply simple and advanced counting techniques to solve mathematical and real-life problems.
CO4 Solve problems using different properties and basic algorithms of graphs and trees.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3		x						
CO4		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving	Exams, Assignment
CO2	Lecture, Problem Solving	Exams, Assignment
CO3	Lecture, Problem Solving	Exams, Assignment
CO4	Lecture, Problem Solving	Exams, Assignment

Textbooks

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

References

1. Essentials of Discrete Mathematics FOURTH EDITION
   David J. Hunter, PhD

CSE 2215 Data Structures and Algorithms - I

Prerequisite: None
Credit Hours: 3.0

Internal data representation; Abstract data types; Introduction to algorithms; Asymptotic analysis: growth of functions, O, Ω and Θ notations; Correctness proof and techniques for analysis of algorithms; Master Theorem; Elementary data structures: arrays, linked lists, stacks, queues, trees and tree traversals, graphs and graph representations, heaps, binary search trees; Graph Traversals: DFS, BFS, Applications of DFS and BFS; Sorting: heap sort, merge sort, quick sort, linear-time sorting; Data structures for set operations.

Course Outcomes

CO1 Able to choose appropriate data structure as applied to specified problem definition.
CO2 Able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
CO3 Able to use linear and non-linear data structures like stacks, queues, linked list etc.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Problem Solving	Exams, Assignments
CO2	Lecture, Problem Solving	Exams, Assignments
CO3	Lecture, Problem Solving	Exams, Assignments

Textbooks

1. Introduction to Algorithms – Thomas H. Cormen (4 th edition, MIT Press & McGraw Hill, 2022)

References

1. Data Structures and Algorithms in Python Book by Michael H. Goldwasser, Michael T. Goodrich, and Roberto Tamassia

CSE 2216 Data Structures and Algorithms - I Laboratory

Prerequisite: None
Credit Hours: 1.0

Laboratory works based on CSE 2215.

Course Outcomes

CO1 Implement appropriate data structure to handle large datasets efficiently as applied to specified problem definition.
CO2 Able to handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
CO3 Able to use linear and non-linear data structures like stacks, queues, linked list etc.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Problem Solving, Lecture	Assignments, Exams
CO2	Demonstration, Problem Solving, Lecture	Assignments, Exams
CO3	Demonstration, Problem Solving, Lecture	Assignments, Exams

Textbooks

1. Introduction to Algorithms – Thomas H. Cormen (4 th edition, MIT Press & McGraw Hill, 2022)

References

1. Data Structures and Algorithms in Python Book by Michael H. Goldwasser, Michael T. Goodrich, and Roberto Tamassia

CSE 2217 Data Structures and Algorithms - II

Prerequisite: CSE 2215
Credit Hours: 3.0

Methods for the design of efficient algorithms: divide and conquer, greedy methods, dynamic programming; Graph algorithms: MST algorithms, shortest path algorithms, maximum flow and maximum bipartite matching; Advanced data Structures: balanced binary search trees (AVL trees, red-black trees, splay trees), skip lists, advanced heaps (Fibonacci heaps, binomial heaps); Hashing; String matching algorithms; NP-completeness; NP-hard and NPcomplete problems; Coping with hardness: backtracking, branch and bound, approximation algorithms.

Course Outcomes

CO1 Analyze worst-case running times of algorithms using asymptotic analysis. Explain what complexity classes are. Be familiar with the complexity classes and conversion, relation, and reduction between them.

CO2 Describe different algorithm paradigms and explain when algorithmic design situations call for them. Recite algorithms that employ these paradigms. Synthesize such algorithms. Derive and solve problems describing the performance of the algorithms.

CO3 Compare between different data structures. Pick an appropriate data structure for a design situation.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Problem Solving, Lecture	Assignments, Exams
CO2	Problem Solving, Lecture	Assignments, Exams
CO3	Problem Solving, Lecture	Assignments, Exams

Textbooks

1. Introduction to Algorithms – Thomas H. Cormen (4 th edition, MIT Press & McGraw Hill, 2022)

References

1. Data Structures and Algorithms in Python Book by Michael H. Goldwasser, Michael T. Goodrich, and Roberto Tamassia

CSE 2218 Data Structures and Algorithms - II Laboratory

Prerequisite: CSE 2215, CSE 2216
Credit Hours: 1.0

Laboratory works based on CSE 2217.

Course Outcomes

CO1 Implement correct algorithms to handle large datasets efficiently.
CO2 Analyze worst-case running times of algorithms using asymptotic analysis.
CO3 Describe different algorithm paradigms and explain when algorithmic design situations call for them. Recite algorithms that employ these paradigms. Synthesize such algorithms. Derive and solve problems describing the performance of the algorithms.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Problem Solving, Lecture	Assignment, Exams
CO2	Demonstration, Problem Solving, Lecture	Assignment, Exams
CO3	Demonstration, Problem Solving, Lecture	Assignment, Exams

Textbooks

1. Introduction to Algorithms – Thomas H. Cormen (4 th edition, MIT Press & McGraw Hill, 2022)

References

1. Data Structures and Algorithms in Python Book by Michael H. Goldwasser, Michael T. Goodrich, and Roberto Tamassia

CSE 3521 Database Management Systems

Prerequisite: None
Credit Hours: 3.0

Concepts of database systems; Data Models: Entity-Relationship model, Relational model; Query Languages: SQL, Relational algebra, Constraints, View; Security and Integrity Management; Unstructured databases: NoSQL, Graph database; Functional dependencies and normalization; Indexing: primary and secondary indexes, B+ trees; Hashing: Static and Dynamic hashing, Collision Problem in Hashing; Transaction management; Recovery: RAID Different levels; File storage management

Course Outcomes

CO1 Understand the fundamentals of database systems including: data models, database architectures, database manipulations, file organization and retrieval.
CO2 Learn the theories and techniques in developing database applications, management and security.
CO3 Demonstrate the management and administration of database systems.
CO4 Prescribe new developments and trends in databases using commercial languages on contemporary issues.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4							x	

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Problem Solving, Lecture	Assignments, Exams
CO2	Problem Solving, Lecture	Assignments, Exams
CO3	Problem Solving, Lecture	Assignments, Exams
CO4	Problem Solving, Lecture	Assignments, Exams

Textbooks

1. Database System Concepts by by Abraham Silberschatz, Henry F. Korth and S. Sudarshan, 7th Edition, 2019.

References

1. Database Systems: The Complete Book by by Garcia-Molina, Ullman and Widom, 2nd Edition, 2008.

CSE 3522 Database Management Systems Laboratory

Prerequisite: None
Credit Hours: 1.0

Laboratory works based on CSE 3521.

Course Outcomes

CO1 Implement relational database models and capable to manage correlated data based on software requirements.

CO2 Extrapolate the theories and techniques in developing database applications, management, and security.

CO3 Engage in effective communication through presentation of the project work, database modeling and project reports.

CO4 Contribute to the DBMS project development using enterprise DBMS products such as SQL server and lead the team.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3				x				
CO4			x			x		

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Problem Solving	Project, Assignment, Exams
CO2	Lecture, Demonstration, Problem Solving	Project, Assignment, Exams
CO3	Lecture, Demonstration, Problem Solving	Project, Assignment, Exams
CO4	Lecture, Demonstration, Problem Solving	Project, Assignment, Exams

Textbooks

1. Database System Concepts by by Abraham Silberschatz, Henry F. Korth and S. Sudarshan, 7th Edition, 2019.

References

1. Database Systems: The Complete Book by by Garcia-Molina, Ullman and Widom, 2nd Edition, 2008.

CSE 4511 Operating Systems and Scripting

Prerequisite: None
Credit Hours: 3.0

Operating system: its role in computer systems; multitasking, multiuser, multiprocessing OS; Operating system structures; Process: process concept and scheduling, inter-process communication, communication in client-server systems; CPU scheduling: scheduling criteria and algorithms, thread scheduling, multiple-processor scheduling; Process synchronization: critical-section problem, semaphores, monitors; Deadlock: resource allocation and deadlock, deadlock detection, prevention and recovery; Memory management: swapping, paging, segmentation, virtual memory; File Systems: files, directories, security, protection; Case study of some operating systems; Linux OS: Architecture, Distributions, Terminal, Software; Linux Commands: Files, Directories, Viewing, Wrangling, Archiving, Compression; Linusx Scripting: Filters, Pipes, and Variables; Bash Shell; Cron.

Course Outcomes

CO1 Describe the Linux architecture and common Linux distributions and update and install software on a Linux system.
CO2 Perform common informational, file, content, navigational, compression, and networking commands in Bash shell.
CO3 Develop shell scripts using Linux commands, environment variables, pipes, and filters.
CO4 Schedule cron jobs in Linux with crontab and explain the cron syntax.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2			x					
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Problem Solving	Assignments, Exams
CO2	Lecture, Demonstration, Problem Solving	Assignments, Exams
CO3	Lecture, Demonstration, Problem Solving	Assignments, Exams
CO4	Lecture, Demonstration, Problem Solving	Assignments, Exams

Textbooks

1. Operating System Concepts by Abraham Silberschatz, Peter B. Galvin, Greg Gagne, John Wiley & Sons, Limited, 9th/10th Edition, 2019.

References

1. Modern Operating Systems by Andrew S. Tanenbaum, Herbert Bos, Pearson, 4th Edition, 2015.
2. Shell Scripting: How to Automate Command Line Tasks Using Bash Scripting and Shell Programming by Jaosn Cannon
3. Wicked Cool Shell Scripts, 2nd Edition: 101 Scripts for Linux, OS X, and UNIX Systems by Brandon Perry and Dave Taylor

CSE 3411 System Analysis and Design

Prerequisite: None
Credit Hours: 3.0

Fundamentals on System and System Study: system concept, system organogram, system development life cycle (SDLC). Steps and functionalities of SDLC, prototyping SDLC etc. Information Gathering: Types of information, sources of information, detail study on information gathering tools, pros and cons of each method etc. Different types of feasibility study for IT products, SWOT analysis, profit–loss calculation for software products (cash flow/NPV methods); System Design: Structured and Object Oriented Design, Design with UML tools Class diagram, Use case, Context, DFD, Sequence diagram, State diagram, deployment diagram etc., Effective design of Input, Output and UI design; Writing Software Requirement Specifications (SRS) etc. Project management, scheduling by Gantt Chart, PERT/CPM method etc. Industry experience sharing/industry visit etc.

Course Outcomes

CO1 CO1 Understand fundamental underlying principles of System Analysis and Design and functionality of different steps of SDLC.

CO2 Study on Information gathering Techniques and tools, comparative study among those, analytical study on the effectiveness of different techniques for different scenario.

CO3 Study and Understand best practices (Benchmark) on practical software projects design and working with system designing tools to do detail Object Oriented design in UML or Structured Design, UI design and Demonstrate the proposed System Design Computer Architecture (tier architecture and cloud computing), Functional and Non-functional requirements.

CO4 Study and Assess different types of feasibility analysis, cost-benefit analysis, financial options, H/W and S/W criteria for selection, Security of IT system, negotiation and convergence for IT projects

CO5 Demonstrate Project Management (PM) tools and Create scheduling, managing, controlling, monitoring software project by a PM tool.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4		x						
CO5		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Group Activities, Q/A	Exams, Report, Assignment
CO2	Lecture, Group Activities, Q/A	Exams, Report, Assignment
CO3	Lecture, Group Activities, Q/A	Exams, Report, Assignment
CO4	Lecture, Group Activities, Q/A	Exams, Report, Assignment
CO5	Lecture, Group Activities, Q/A	Exams, Report, Assignment

Textbooks

1. System Analysis and Design – Dennis, Wixom, Roth, 7 Edition, Dec 2018.

References

1. Software Engineering: A Practitioner's Approach 8th Edition by Roger S. Pressman, 2014

CSE 3421 Software Engineering

Prerequisite: None
Credit Hours: 3.0

Basic Concepts: software, software engineering, recent trends and challenges; Process Models: waterfall, incremental, iterative; Requirements Engineering: software requirements specification, system requirements specification, stakeholder requirements specification; Architecture: monolithic architecture, service-oriented architecture, micro-service architecture, model-view controller pattern and variants, system design; Services Computing: application programming interface, web services, cloud services, representational state transfer, JavaScript object notation, simple object access protocol; User Interface Design: web and mobile platform, wireframe model, methods and tools; Software Testing: manual and automated test, black box and white box test, unit test, integration test, regression test, acceptance test, non-functional test, test planning, test documentation; Version Control and Repository: version numbering, version control software, code repository systems; Documentation: requirements, architecture, technical, end user, marketing; Legal and Ethical Aspects: terms and conditions, end-user license agreement, software engineering code of ethics, privacy engineering; Business Case Study: case study on local and international popular software products.

Course Outcomes

CO1 Understand the basics of software engineering.
CO2 Apply modern techniques of software engineering.
CO3 Understand legal and ethical aspects.
CO4 Learn to use modern software engineering tools.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2			x					
CO3					x			
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Assignments, Exams
CO2	Lecture, Q/A	Assignments, Exams
CO3	Lecture, Q/A	Assignments, Exams
CO4	Lecture, Q/A	Assignments, Exams

Textbooks

1. Software Engineering, Eighth edition, Roger Pressman, 2015

References

1. Design Patterns: Elements of Reusable Object-Oriented Software 1st Edition by by Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides and Grady Booch

CSE 4197 Introduction to Internet of Things (IoT)

Prerequisite: None
Credit Hours: 3.0

The Internet of Things: Definitions, implications, perspectives, and some stats, a simplified model, architecture, Industry Markets and Applications, Issues and Challenges, Planning a Deployment, Industry and academic trends, Business models and projected growth, Case Study and Examples; Internet: layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia; Local Area Networks; Mobile Networking; Real-time networking; Data Storage in Cloud.

Course Outcomes

CO1 Design, Code and Build IOT products.
CO2 Work with Micro controllers (Arduino Uno, Nano, NodeMCU), Sensors , Relays, Displays, Keypads, work with main (220/110).
CO3 Use Ethernet and Wifi shields.
CO4 Connect to cloud IOT Platforms, Persist Data, Program Triggers.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		x						
CO2	x							
CO3	x							
CO4	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Lecture	Project, Exams
CO2	Demonstration, Lecture	Project, Exams
CO3	Demonstration, Lecture	Project, Exams
CO4	Demonstration, Lecture	Project, Exams

Textbooks

1. "Internet of Things: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti

References

1. The Internet of Things by Samuel Greengard
2. Internet of Things by Zordi Salazar, Santiago Silvestre
3. Internet of Things Architecture and Design Principles by Raj Kamal
4. Introduction to IoT Book by Anandarup Mukherjee, Arijit Roy, and Sudip Misra

CSE 4587: Cloud Computing

Prerequisite: None
Credit Hours: 3.0

Basic Concepts: cloud computing and applications, assessing the value proposition, issues and challenges, cloud architecture, service models, deployment models; Cloud Platforms: abstraction and virtualization, capacity planning, platform as a service, Amazon web services , Microsoft Azure, Google cloud platform; Cloud Infrastructure: managing the cloud, cloud security; Services and Applications: service-oriented architecture, moving applications to the cloud, cloud-based storage, media and streaming, cloud based mobile apps and web services.

Course Outcomes

CO1 Explain introductory, intermediate and advanced overview of cloud computing concepts.
CO2 Explain benefits and challenges of cloud computing.
CO3 Design projects with compliance and privacy of cloud computing.
CO4 Apply security, design, architecture, and construction of cloud computing.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3		x						
CO4		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Demonstration, Lecture	Project, Exams
CO2	Demonstration, Lecture	Project, Exams
CO3	Demonstration, Lecture	Project, Exams
CO4	Demonstration, Lecture	Project, Exams

Textbooks

1. Cloud Computing: Concepts, Technology & Architecture Book by Ricardo Puttini, Thomas Erl, and Zaigham Mahmood

References

1. Infrastructure as Code: Managing Servers in the Cloud by Kief Morris

CSE 4531: Computer Security

Prerequisite: None
Credit Hours: 3.0

Fundamental concepts: confidentiality, integrity and availability, assurance, authenticity and anonymity; threats and attacks, security principles; Encryption, symmetric and asymmetric key encryption; Security: OS access control, Web and mobile application security, software security, hardware security, memory protection, data base security; Security Attacks: malware, DDos, Trojan and backdoors, buffer overflow, social engineering.

Course Outcomes

CO1 Identify common Computer security vulnerabilities/attacks.
CO2 Explain the foundations of Cryptography and Computer security.
CO3 Understand security threats, apply principles and practices of computer security to solve them.
CO4 Analyze security requirements and design and implement secure systems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exam, Assignments
CO2	Lecture, Q/A	Exam, Assignments
CO3	Lecture, Q/A	Exam, Assignments
CO4	Lecture, Q/A	Exam, Assignments

Textbooks

1. Computer Security Principles and Practice by William Stallings and Lawrie Brown, Pearson, 4 th Edition, 2017

References

1. Introduction to Computer Security by Michael Goodrich, Roberto Tamassia, Pearson, 1st edition, 2010.

DS 1101 Fundamentals of Data Science

Prerequisite: None
Credit Hours: 3.0

Elements of Data Science: data collection and management; summarizing and visualizing data; basic ideas of statistical inference; machine learning; Computational thinking and programming; Data Scientist's toolbox; Getting and Cleaning data; Exploratory data analysis; Reproducible Research; Statistical Inference; Developing Data Products.

Course Outcomes

CO1 Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.
CO2 Explain how data is collected, managed and stored for data science.
CO3 Demonstrate an understanding of statistics and machine learning concepts that are vital for data science.
CO4 Critically evaluate data visualisations based on their design and use for communicating stories from data.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignment
CO2	Lecture, Q/A	Exams, Assignment
CO3	Lecture, Q/A	Exams, Assignment
CO4	Lecture, Q/A	Exams, Assignment

Textbooks

1. Fundamentals of Data Science: Take the first Step to Become a Data Scientist by Samuel Burns
2. Python for Data Analysis by Wes McKinney

References

1. The Art of Data Science: A Guide for Anyone Who Works with Data by Roger D. Peng and Elizabeth Matsui.

DS 3885 Data Wrangling

Prerequisite: None
Credit Hours: 3.0

Understand various data formats, including CSV, TSV, XML, JSON, and HTML; acquire data through various sources, such as plain text, databases, the Web and API; clean and prepare both structured and unstructured data.

Course Outcomes

CO1 Use and manipulate complex and simple data structures.
CO2 Perform web scraping using libraries.
CO3 Execute advanced string search and manipulation with Regular Expressions.
CO4 Handle outliers and perform data imputation
CO5 Use descriptive statistics and plotting techniques.
CO6 Practice data wrangling and modeling using data generation techniques.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							
CO6	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Problem Solving	Exams, Assignments
CO2	Lecture, Demonstration, Problem Solving	Exams, Assignments
CO3	Lecture, Demonstration, Problem Solving	Exams, Assignments
CO4	Lecture, Demonstration, Problem Solving	Exams, Assignments
CO5	Lecture, Demonstration, Problem Solving	Exams, Assignments
CO6	Lecture, Demonstration, Problem Solving	Exams, Assignments

Textbooks

1. "Data Wrangling with Python" by Dr. Jacqueline Kazil and Katharine Jarmul
2. "Data Wrangling with R" by Bradley Boehmke

References

1. "Python for Data Analysis" by Wes McKinney
2. "R for Data Science" by Hadley Wickham and Garrett Grolemund

DS 4217 Data Privacy and Ethics

Prerequisite: None
Credit Hours: 3.0

Introduction to privacy, economics and incentives, crypto-based solution for privacy, hiding data from the database user, hiding access patterns from the database owner, anonymous routing and TOR, privacy in online social networks, privacy in cellular and Wi-Fi networks, location privacy, privacy in e-cash systems, privacy in e-voting, genomic privacy; Ethical issues faced by data science professionals including those related to computing in the workplace, security, crime, privacy, property rights, risk, liability, and the internet.

Course Outcomes

CO1 Explain various conceptions of ethics and privacy
CO2 Analyse research literature at the intersection of computer science, philosophy and the law.
CO3 Explain the effect of, and the source of, bias or discrimination in a data-intensive system.
CO4 Understand the need for, and carry out, an ethical, social or privacy assessment of data-intensive project.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4		x	x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Project, Assignment, Exams
CO2	Lecture, Q/A	Project, Assignment, Exams
CO3	Lecture, Q/A	Project, Assignment, Exams
CO4	Lecture, Q/A	Project, Assignment, Exams

Textbooks

1. "Data and Goliath: The Hidden Battles to Collect Your Data and Control Your World" by Bruce Schneier
2. "The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power" by Shoshana Zuboff

References

1. "Crypto: How the Code Rebels Beat the Government Saving Privacy in the Digital Age" by Steven Levy

DS 3521 Data Visualization

Prerequisite: None
Credit Hours: 3.0

Visualization of high dimensional data including interactive methods directed at exploration and assessment of structure and dependencies in data. Methods for finding groups in data including traditional and modern methods of cluster analysis. Dimension reduction methods including multi-dimensional scaling, nonlinear and other methods.

Course Outcomes

CO1 Analyze data using exploratory visualization.
CO2 Build commonly requested types of visualizations as well as more advanced visualizations using ground-up customization.
CO3 Constructively critique existing visualizations, identifying issues of integrity as well as excellence.
CO4 Create useful, performant visualizations from real-world data sources, including large and complex datasets.
CO5 Design aesthetically pleasing static and interactive visualizations with perceptually appropriate forms and encodings.
CO6 Improve your own work through usability testing and iteration, with attention to context.
CO7 Select appropriate tools for building visualizations, and gain skills to evaluate new tools.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4		x						
CO5		x						
CO6		x						
CO7			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments
CO6	Lecture, Q/A	Exams, Assignments
CO7	Lecture, Q/A	Exams, Assignments

Textbooks

1. Graph-Based Clustering and Data Visualization Algorithms by Agnes Vathy-Fogarassy, Janos Abonyi
2. "The Visual Display of Quantitative Information" by Edward R. Tufte

References

1. Statistical Analysis of Complex Data, Dimensionality reduction and classification methods by Mario Fordellone

DS 3522 Data Visualization Laboratory

Prerequisite: None
Credit Hours: 1.0

Laboratory works based on DS 3521.

Course Outcomes

CO1 Analyze data using exploratory visualization.
CO2 Build commonly requested types of visualizations as well as more advanced visualizations using ground-up customization.
CO3 Constructively critique existing visualizations, identifying issues of integrity as well as excellence.
CO4 Create useful, performant visualizations from real-world data sources, including large and complex datasets.
CO5 Design aesthetically pleasing static and interactive visualizations with perceptually appropriate forms and encodings.
CO6 Improve your own work through usability testing and iteration, with attention to context.
CO7 Select appropriate tools for building visualizations, and gain skills to evaluate new tools.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4		x						
CO5		x						
CO6		x						
CO7			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments
CO6	Lecture, Q/A	Exams, Assignments
CO7	Lecture, Q/A	Exams, Assignments

Textbooks

1. Graph-Based Clustering and Data Visualization Algorithms by Agnes Vathy-Fogarassy, Janos Abonyi
2. "The Visual Display of Quantitative Information" by Edward R. Tufte

References

1. Statistical Analysis of Complex Data, Dimensionality reduction and classification methods by Mario Fordellone

DS 4891 Data Analytics

Prerequisite: None
Credit Hours: 3.0

Data analysis process; exploratory data analysis; selection of descriptive analytics techniques; identification of important attributes; development of derived attributes; predictive and prescriptive analytics; discovering patterns in datasets; data mining concepts and methodologies including classification, clustering, associations, and anomaly detection; selecting appropriate data mining algorithms.

Course Outcomes

CO1 Analyze and interpret data using an ethically responsible approach.
CO2 Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues.
CO3 Apply computing theory, languages, and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses.
CO4 Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges.
CO5 Interpret data findings effectively to any audience, orally, visually, and in written formats.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					
CO5				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. "Python for Data Analysis" by Wes McKinney
2. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei

References

1. "Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett

DS 4892 Data Analytics Laboratory

Prerequisite: None
Credit Hours: 1.0

Laboratory works based on DS 4891.

Course Outcomes

CO1 Analyze and interpret data using an ethically responsible approach.
CO2 Use appropriate models of analysis, assess the quality of input, derive insight from results, and investigate potential issues.
CO3 Apply computing theory, languages, and algorithms, as well as mathematical and statistical models, and the principles of optimization to appropriately formulate and use data analyses.
CO4 Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges.
CO5 Interpret data findings effectively to any audience, orally, visually, and in written formats.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					
CO5				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. "Python for Data Analysis" by Wes McKinney
2. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei

References

1. "Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett

DS 4889 Machine Learning

Prerequisite: None
Credit Hours: 3.0

Introduction to Machine Learning; Regression analysis: linear regression; Classification techniques: classification trees, support vector machines; Statistical performance evaluation: bias variance trade-off; VC dimension; Reinforcement Learning; Neural networks; EM Algorithm; Unsupervised Learning: k-means clustering; Principal component analysis; Deep Learning; Practical applications of machine learning.

Course Outcomes

CO1 Understand the concept of learning and the basic approach to the development of machine learning algorithms.
CO2 Implement and analyze existing learning algorithms, including well-studied methods for classification, regression, structured prediction, clustering, and representation learning
CO3 Demonstrate proficiency in applying scientific method to models of machine learning.
CO4 Apply machine learning techniques to real-world problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Assignment, Project, Exams
CO2	Lecture, Demonstration, Q/A	Assignment, Project, Exams
CO3	Lecture, Demonstration, Q/A	Assignment, Project, Exams
CO4	Lecture, Demonstration, Q/A	Assignment, Project, Exams

Textbooks

1. Learning From Data Hardcover by Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin
2. Dive into Deep Learning by Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola

References

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig

DS 4817 Big Data

Prerequisite: None
Credit Hours: 3.0

Introduction to Big Data: characteristics of Big Data and dimensions of scalability; Data Science: getting value out of Big Data, foundations for Big Data systems and programming, getting started with Hadoop; Big Data Modelling and Management Systems: Big Data modelling, Big Data management, designing a Big Data management system; Big Data Integration and Processing: retrieving Big Data, Big Data integration, processing Big Data, Big Data analytics using Spark; Machine Learning with Big Data: introduction to machine learning with Big Data, data exploration, classification, evaluation of machine learning models, regression, cluster analysis, and association analysis; Graph Analytics for Big Data: introduction to graphs, graph Analytics, graph analytics techniques, computing platforms for graph analytics.

Course Outcomes

CO1 Understand Big Data and its analytics in the real world
CO2 Analyze the Big Data framework like Hadoop and NOSQL to efficiently store and process Big Data to generate analytics.
CO3 Design of Algorithms to solve Data Intensive Problems using Map Reduce Paradigm.
CO4 Design and Implementation of Big Data Analytics using pig and spark to solve data intensive problems and to generate analytics.
CO5 Implement Big Data Activities using Hive.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Exams,Assignment
CO2	Lecture, Demonstration, Q/A	Exams,Assignment
CO3	Lecture, Demonstration, Q/A	Exams,Assignment
CO4	Lecture, Demonstration, Q/A	Exams,Assignment
CO5	Lecture, Demonstration, Q/A	Exams,Assignment

Textbooks

1. "Big Data: A Revolution That Will Transform How We Live, Work, and Think" by Viktor Mayer-Schonberger and Kenneth Cukier

References

1. "Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large-Scale Data Processing" by Mohammed Guller

DS 4211 Deep Learning

Prerequisite: DS 4889
Credit Hours: 3.0

Gradient descent and logistic regression; Probability, continuous and discrete distributions; maximum Likelihood; Neural Networks: cost functions, hypotheses and tasks; training data; maximum likelihood based cost, cross entropy, MSE cost; feed-forward networks; MLP, sigmoid units; neuroscience inspiration; Learning in neural networks: output vs hidden layers; linear vs nonlinear networks; Backpropagation: learning via gradient descent; recursive chain rule (backpropagation); if time: bias-variance tradeoff, regularization; output units: linear, softmax; hidden units: tanh; Deep learning strategies; SCC/TensorFlow overview; Convolutional neural networks; Deep Belief Nets: probabilistic methods; Recurrent neural networks; Other DNN variants; Neural Turing Machines; Unsupervised deep learning; Deep reinforcement learning.

Course Outcomes

CO1 Evaluate, in the context of a case study, the advantages and disadvantages of deep learning neural network architectures and other approaches.
CO2 Implement different types od deep learning models in using library and train them with real-world datasets.
CO3 Evaluate the performance of different deep learning models.
CO4 Perform regularization, training optimization, and hyperparameter selection on deep models.
CO5 Analyze a deep learning model's hardware node and GPU scalability in preparation for deployment.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		x						
CO2		x						
CO3			x					
CO4			x					
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1		
CO2		
CO3		
CO4		
CO5		

Textbooks

1. Dive into Deep Learning by Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola

References

1. Learning From Data Hardcover by Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin
2. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig

DS 4491 Machine Learning Systems Design

Prerequisite: DS 4889
Credit Hours: 3.0

This project-based course covers the iterative process for designing, developing, and deploying machine learning systems. It focuses on systems that require massive datasets and compute resources, such as large neural networks. Students will learn about the different layers of the data pipeline, approaches to model selection, training, scaling, as well as how to deploy, monitor, and maintain ML systems. In the process, students will learn about important issues including privacy, fairness, and security.

Course Outcomes

CO1 Construct, measure, and identify metrics relating to performance of a system in order to optimize costs and latency of serving inferences for machine learning models.
CO2 Describe the difference between a monolithic and microservice architecture, assess and select appropriate use cases for each.
CO3 Describe the differences between a development and production system particularly for Machine Learning where the boundaries are blurry.
CO4 Know when to leverage a cache for serving machine learning models to reduce load on production systems.
CO5 Understand continuous integration and continuous delivery (CI/CD) pipeline for automated code deployment, particularly for ML models.
CO6 Understand how stateful systems add complexities to systems engineering.
CO7 Understand how to serve machine learning models over an API in real-time.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		x						
CO2		x						
CO3		x						
CO4		x						
CO5	x							
CO6	x							
CO7	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Exams,Assignment
CO2	Lecture, Demonstration, Q/A	Exams,Assignment
CO3	Lecture, Demonstration, Q/A	Exams,Assignment
CO4	Lecture, Demonstration, Q/A	Exams,Assignment
CO5	Lecture, Demonstration, Q/A	Exams,Assignment
CO6	Lecture, Demonstration, Q/A	Exams,Assignment
CO7	Lecture, Demonstration, Q/A	Exams,Assignment

Textbooks

1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurelien Geron

References

1. "Data Science for Business" by Foster Provost and Tom Fawcett

DS 3881 Regression and Time Series Analysis

Prerequisite: None
Credit Hours: 3.0

Simple Linear Regression, Multiple Linear Regression, Polynomial Regression; Model Selection for Multiple Linear Models; Multiple Linear Regression -- Diagnostics; Analysis of Variance: Fixed Effects; Experimental Design; Penalized Regression; Robust Regression; Nonlinear Regression; Generalized Linear Models; Mixed Effects Models; Time Series Regression: Correlated Errors; Functional Linear Models; Additive Models Introduction to principal components, cluster analysis, discriminant analysis, factor analysis, self-organizing maps, matrix estimation and other commonly used multivariate techniques.

Modelling techniques for forecasting time series data: smoothing methods, regression including penalty/regularization methods, the Box-Jenkins framework, stationary and non-stationary processes, both with and without seasonal effects. Other topics may include: ARCH/GARCH models, Bayesian methods, dynamic linear models, Markov Chain Monte Carlo simulation, spectral density analysis, and periodograms.

Course Outcomes

CO1 Apply and interpret linear regression and generalized regression models of different types of data.
CO2 Diagnose and apply corrections to problems with the generalized linear model found in real data.
CO3 Forecast, analyze and estimate the trend and cyclic patterns exhibited by the given data by using various methods.
CO4 Run and interpret time series models and regression models for time series data.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1			x					
CO2			x					
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Assignment, Exams
CO2	Lecture, Q/A	Assignment, Exams
CO3	Lecture, Q/A	Assignment, Exams
CO4	Lecture, Q/A	Assignment, Exams

Textbooks

1. "Introduction to Linear Regression Analysis" by Douglas C. Montgomery, Elizabeth A. Peck, and G. Geoffrey Vining

References

1. "Time Series Analysis and Its Applications: With R Examples" by Robert H. Shumway and David S. Stoffer

DS 3120 Technical Report Writing and Presentation

Prerequisite: None
Credit Hours: 2.0

Issues of technical writing and effective oral presentation in Data Science; Writing styles of definitions, propositions, theorems and proofs; Preparation of reports, research papers, theses and books: abstract, preface, contents, bibliography and index; Writing of book reviews and referee reports; Writing tools: Latex; Diagram drawing software; presentation tools.

Course Outcomes

CO1 Use modern presentation skills.
CO2 Write correct technical English in proposal preparation, research papers and reports preparations.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1				x				
CO2				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Group Activities	Report, Presentation
CO2	Lecture, Group Activities	Report, Presentation

Textbooks

1. How to write thesis and research papers Hardcover by Mosamsinha

References

1. LaTeX - en.wikibooks.org

DS 4213 Natural Language Processing

Prerequisite: None
Credit Hours: 3.0

Word representations: Representing documents for neural networks, Introduction to embeddings. Continuous bag-of-words representations; Pre-training word embedding models: introduction, SGNS algorithm, Evaluation and interpretation of word embeddings, Subword representations; Language modelling: N-gram language models, Recurrent neural networks, The LSTM architecture, Recurrent neural network language models, Contextualized word embeddings; Introduction to generation tasks, Evaluation of generation systems; Introduction to machine translation, Neural machine translation; Attention, The Transformer architecture; Pre-trained transformer models: GPT, BERT; Summarization; Dialogue Systems; Domain Adaptation; Structured prediction.

Course Outcomes

CO1 Explain and analyze state-of-the-art deep learning architectures for NLP.
CO2 Implement current NLP architectures and apply them to practical problems.
CO3 Design and carry out evaluations of deep learning architectures for NLP.
CO4 Use current approaches to NLP in your own field of research

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1		
CO2		
CO3		
CO4		
CO5		

Textbooks

1. Speech and Language Processing (3rd edition) by Daniel Jurafsky and James H. Martin.

References

1. Natural Language Processing with Python (nltk.org/book/)

DS 4215 Social Media Analytics

Prerequisite: None
Credit Hours: 3.0

Introduction; Phenomenology of social media; Analysis Basics; Sentiment Analysis; Network Analysis; Influence and Centrality in Social Networks; Information diffusion; Social ties and information diffusion; Social ties and link prediction; Social Spam and Malicious Behavior; Geospatial social data mining; Privacy in a Networked World; Predicting the future with social media; Emotional contagion; Friendship paradox and detection of contagions; Social tagging and folksonomies.

Course Outcomes

CO1 Understand and apply key concepts in social media metrics.
CO2 Understand and apply social media analytics tools.
CO3 Collect social media data.
CO4 Monitor consumers and competitors and glean deeper consumer insights based on advanced social media data modelling.
CO5 Develop social media strategy and measure social media campaign effectiveness.
CO6 Make better business decisions by leveraging social media data.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4		x						
CO5		x						
CO6			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments
CO6	Lecture, Q/A	Exams, Assignments

Textbooks

1. Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media by Matthew Ganis

References

1. Social Media Lab (socialmedialab.ca)

DS 4219 Game Theory

Prerequisite: None
Credit Hours: 3.0

Solution Concepts for Static Games: Complete information: rationalizability, Nash equilibrium, epistemic foundations; Incomplete information: Bayesian Nash equilibrium, interim correlated rationalizability; Solution Concepts for Extensive-form Games; Backwards induction, subgame perfection, iterated conditional dominance; Bargaining with complete information; Equilibrium Concepts for Games with Imperfect Information; Signaling and Forward Induction; Stable equilibrium, the intuitive criterion, iterated weak dominance, epistemic foundations; Repeated Games; Reputation Formation: Reputation with short-lived opponents, Screening and reputation in bargaining; Supermodular Games; Global Games; Cooperative Games; Nash bargaining solution, core, Shapley value; Non-cooperative implementations.

Course Outcomes

CO1 Identify strategic situations and represent them as games.
CO2 Solve simple games using various techniques.
CO3 3 Analyse real life situations using game theoretic techniques.
CO4 Recommend and prescribe which strategies to implement.
CO5

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments

Textbooks

1. Game Theory: Analysis of Conflict by Roger B. Myerson.

References

1. Stanford Encyclopedia of Philosophy - Game Theory (plato.stanford.edu/entries/game-theory/)

DS 4221 Complex Systems

Prerequisite: None
Credit Hours: 3.0

Complex systems: definitions, methodologies; Dynamical systems, Nonlinear dynamics; Chaos, Bifurcations and Feigenbaum constant, Predictability, Randomness and Chaos; Models of complex systems, Cellular automata, Wolfram's classification, Game of life; Autonomous agents, Flocking, Schooling, Synchronization, Formation creation; Cooperation and Competition, Game theory basics, Nash equilibrium; Game theory: Prisoner's Dilemma, Coordination games, Mixed strategy games; Adaptation, Evolution, Genetic algorithms, Evolutionary games; Network Science: Definitions and examples; Graph theory, Basic concepts and definitions; Diameter, Path length, Clustering, Centrality metrics; Structure of real networks, Degree distribution, Power-laws, Popularity; Models of network formation; The Erdos-Renyi random model; Clustered models; Models of network growth, Preferential attachment; Small-world networks, Network navigation; Peer-to-peer systems and overlay networks; Structured overlays, DHTs, Key-based routing, Chord; Distributed network formation: Newscast, Cyclon, T-Man; Processes on networks: Aggregation; Rational dynamics: Cooperation in selfish environments, Homophily, Segregation; Diffusion, Percolation, Tipping points, Peer-effects, Cascades.

Course Outcomes

- CO1 Understand and analyse the dynamics of complex systems using intermediate critical analysis skills
- CO2 Create, analyse and evaluate single and multi-agent models of complex systems using scientific programming.
- CO3 Understand the nature, structure, function and evolution of complex systems and emergent behaviour in multiple different fields.
- CO4 Select and apply different approaches to analysing complex systems in different domains.
- CO5 Design and evaluate large systems that satisfy structural and functional criteria within given domains and contexts integrating complex systems approaches.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3	x							
CO4			x					
CO5		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. Complexity: A Guided Tour by Melanie Mitchell.

References

1. Santa Fe Institute (santafe.edu)

DS 4223 Recommender Systems

Prerequisite: None
Credit Hours: 3.0

Introduction to recommender systems; Non-personalized and Content Based: Taxonomy, past, present and future, preferences and ranking; Non-Personalized and Stereotype-Based Recommenders, demographics and related approaches; Content based filtering; User collaborative filtering; Trust based recommendation; Item-item algorithm; The Cold Start Problem; Recommending for Groups; Threat Models; Hidden Data Evaluation; Prediction Accuracy Metrics; Decision Support Metrics; Rank-Aware Top-N Metrics; Advanced Metrics and Offline Evaluation; Online evaluation: Usage Logs and Analysis, A/B Studies (Field Experiments); Matrix factorization; Hybrid Recommenders.

Course Outcomes

CO1 Explain a variety of approaches for building recommender systems.
CO2 Describe system evaluation methods from both algorithmic and users' perspectives.
CO3 Describe applications of recommender systems in various domains Professional Skill.
CO4 Reproduce recommender algorithms using an open source toolkit.
CO5 Conduct experimental evaluations on implemented algorithms.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4			x					
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. Recommender Systems: An Introduction by Dietmar Jannach, Markus Zanker, Alexander Felfernig, and Gerhard Friedrich.

References

1. Recommender Systems (www.recsys.net)

DS 4225 Probabilistic Graphical Models

Prerequisite: None
Credit Hours: 3.0

Introduction, Probability Theory, Bayesian Networks; Undirected models; Learning Bayes Nets; Exact Inference; Message Passing; Sampling; MAP Inference; Structured prediction; Parameter Learning; Bayesian Learning; Structure Learning; Exponential families; variational inference; Advanced topics.

Course Outcomes

CO1 Understand the mathematical framework of probabilistic graphical models
CO2 Implement the basic algorithms for probabilistic inference in graphical models.
CO3 Implement the basic algorithms for learning graphical models.
CO4 Recognize and apply Bayesian principles behind modeling domain knowledge under uncertainty.
CO5 Understand the difference between statistical and causal models.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2			x					
CO3			x					
CO4		x						
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1		
CO2		
CO3		
CO4		
CO5		

Textbooks

1. Pattern Recognition and Machine Learning by Christopher M. Bishop

References

1. Probabilistic Graphical Models - Stanford Online (online.stanford.edu/courses/soe-ycs222-probabilistic-graphical-models)

DS 4227 Mathematical Optimization

Prerequisite: None
Credit Hours: 3.0

Introduction; Classical methods with single and multi variables; Basics of Mathematical Programming; Linear programming; Graphical method with mathematical definitions and theorems; Nonlinear programming: one dimensional problems by elimination and interpolation methods; Unconstrained and constrained techniques; Geometrical programming, stochastic programming; Calculus of variations; Optimality and relaxation, Lagrangian Relaxation; Convexity and Subgradient Optimization; Subgradient Optimization for the Lagrangian Dual.

Course Outcomes

CO1 Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.
CO2 Applying optimization techniques in solving research problems of Engineering and Technology.
CO3 Solve the mathematical results and numerical techniques of optimization theory to concrete Engineering problems by using computer software

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2							x	
CO3			x					
CO4								

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Exam, Assignments
CO2	Lecture, Demonstration, Q/A	Exam, Assignments
CO3	Lecture, Demonstration, Q/A	Exam, Assignments

Textbooks

1. Convex Optimization by Stephen Boyd and Lieven Vandenberghe.

References

1. Optimization Online (www.optimization-online.org/)

DS 4229 Data Warehousing

Prerequisite: None
Credit Hours: 3.0

Data Warehouses, Data Marts, and Data Lakes; Popular Data Warehouse Systems; Selecting a Data Warehouse System; Overview of Data Warehouse Architectures; CUBEs, ROLLUPs, Materialized Views and Tables; Facts and Dimensional Modeling; Data Modeling using Star and Snowflake Schemas; Staging Areas for Data Warehouses; Verify Data Quality; Populating a Data Warehouse; Querying the Data; Introduction BI Tools; Dashboards.

Course Outcomes

CO1 Explain data warehousing and its relationship to decision-making.
CO2 Explain the main concepts underlying data warehouse design and implementation, data quality and retrieval and analysis of data
CO3 Explain the role of data warehousing in customer relationship management systems.
CO4 Apply dimensional modeling technique for designing a data warehouse.
CO5 Explain and apply data warehouse architectures, OLAP and the project planning aspects in building a data warehouse.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4			x					
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Exam, Assignments
CO2	Lecture, Demonstration, Q/A	Exam, Assignments
CO3	Lecture, Demonstration, Q/A	Exam, Assignments
CO4	Lecture, Demonstration, Q/A	Exam, Assignments
CO5	Lecture, Demonstration, Q/A	Exam, Assignments

Textbooks

1. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling by Ralph Kimball and Margy Ross.

References

1.

CSE 4337 Robotics

Prerequisite: None
Credit Hours: 3.0

Introduce the basic concepts of robotics, types of robots, robotics and AI; Automation & autonomy architectures; Robot hardware: sensors, actuators; Robotic mapping: localization, Monte Carlo localization, multi-object localization; Robotic navigation and locomotion: motion planning, dynamics and control; Human-robot interaction: Natural language learning; Multi-agents: tasks and teams.

Course Outcomes

CO1 Analyze manipulation and navigation problems using knowledge of coordinate frames, kinematics, optimization, and control.
CO2 Compute forward and inverse kinematics for a small serial kinematic chain.
CO3 Consider trade-offs among position control, velocity control, and force control when solving a robot control problem.
CO4 Perform stability analysis of a controller-robot system, and describe why it is important.
CO5 Describe how sensors used in robotics applications work.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Exam, Assignments
CO2	Lecture, Demonstration, Q/A	Exam, Assignments
CO3	Lecture, Demonstration, Q/A	Exam, Assignments
CO4	Lecture, Demonstration, Q/A	Exam, Assignments
CO5	Lecture, Demonstration, Q/A	Exam, Assignments

Textbooks

1. Introduction to Autonomous Robots: Mechanics, Sensors, Actuators, and Algorithms by Nikolaus Correll, Bradley Hayes, et al.

References

1. Robotics: Modelling, Planning and Control by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo.

CSE 3811 Artificial Intelligence

Prerequisite: None
Credit Hours: 3.0

Survey and concepts in Artificial Intelligence; Problem solving agents; Uninformed and Informed search techniques; Local Search Techniques; Game playing; Constraint Satisfaction Problems; Bayesian learning; Supervised Learning: Classification, Perceptrons; Stationary processes and Markov assumptions; Hidden Markov Models; Human Aware AI Systems.

Course Outcomes

- CO1 Understand the role of decision making strategies in simulating intelligence, and gain familiarity to approaches towards such.
- CO2 Analyze and apply search strategies for solutions of problems with complete information.
- CO3 Understand and apply reasoning strategies for inference in the presence of incomplete information.
- CO4 Demonstrate familiarity with approaches to exploiting regularity in data and areas of application.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4		x						

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exam, Assignments
CO2	Lecture, Q/A	Exam, Assignments
CO3	Lecture, Q/A	Exam, Assignments
CO4	Lecture, Q/A	Exam, Assignments

Textbooks

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig.

References

1. Pattern Recognition and Machine Learning by Christopher M. Bishop.

DS 4821 Generative Machine Learning

Prerequisite: None
Credit Hours: 3.0

Introduction; Auto-regressive Models; Variational auto-encoders; Normalizing flows; Generative Adversarial Networks; Energy based models; Score based models; Evaluation of generative models; Combining generative model variants; Applications of generative models.

Course Outcomes

CO1 Apply probabilistic methods for generating data.
CO2 Apply variational methods for generating artificial data.
CO3 Explain and use deep generative models.
CO4 Apply and evaluate state-of-the-art methods currently used in data generation processes.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exam, Assignments
CO2	Lecture, Q/A	Exam, Assignments
CO3	Lecture, Q/A	Exam, Assignments
CO4	Lecture, Q/A	Exam, Assignments

Textbooks

1. Deep Learning by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

References

1. Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play by David Foster.

DS 4823 Reinforcement Learning

Prerequisite: None
Credit Hours: 3.0

Multi-arm bandits; Markov Decision Process; Tabular methods: dynamic Programming; Sample based methods: Monte Calro and temporal difference learning; Planning and Learning: Dyna and its variants; Function Approximation and coding, tiling; Policy Gradient methods, actor-critic algorithm; Deep Reinforcement Learning; frontiers.

Course Outcomes

CO1 Model a control task in the framework of MDPs.
CO2 Identify the model based from the model free methods.
CO3 Identify stability/convergence and approximation properties of RL algorithms.
CO4 Use deep learning methods to RL problems in practice.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exam, Assignments
CO2	Lecture, Q/A	Exam, Assignments
CO3	Lecture, Q/A	Exam, Assignments
CO4	Lecture, Q/A	Exam, Assignments

Textbooks

1. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto.

References

1. Deep Reinforcement Learning by Pieter Abbeel and John Schulman.

DS 4825 Deep Learning for Computer Vision

Prerequisite: None
Credit Hours: 3.0

Computer vision overview; Image Classification with Linear Classifiers; Regularization and Optimization; Neural Networks and Backpropagation; Image Classification with Convolutional Neural Networks(CNN); CNN Architectures; Training Neural Networks; Recurrent Neural Networks; Attention and Transformers; Understanding Video; Object Detection and Image Segmentation; Visualizing and Understanding; Self-supervised Learning; Robot Learning; Generative Models; 3D vision; Human-Centered Artificial Intelligence.

Course Outcomes

CO1 Read and understand research papers in the computer-vision literature.
CO2 Build computer vision systems to solve real-world problems.
CO3 Properly formulate problems with the appropriate mathematical and computational tools.
CO4 Understand the process by which images are formed and represented.
CO5 Understand the building blocks of modern computer vision techniques.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1							x	
CO2			x					
CO3	x							
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. Computer Vision: Algorithms and Applications by Richard Szeliski.

References

1. Deep Learning for Computer Vision by Rajalingappaa Shanmugamani.

DS 4921 Special Topic - I

Prerequisite: None
Credit Hours: 3.0

Course designed on recent topics from Advanced Data Science and Computing. Syllabus should be approved prior to the commencement of the term. In each term only one such course title under this course number can be offered. Furthermore one student can take such course only once.

DS 4111 Genomic Data Analysis

Prerequisite: None
Credit Hours: 3.0

Central Dogma of Molecular Biology; Modern genomics and the experimental tools; Next-generation sequencing: DNA, RNA, and epigenetic patterns; Galaxy project: Using Python; ChIP-Sequence Analysis with MACS; Algorithms for DNA sequencing, assembly; Command line tools; Tools from Bioconductor project: Using R; Statistics for Genomic data: clustering, dimensionality reduction, regression, inference; Working with Genomic data.

Course Outcomes

CO1 Analyze genomic data appropriately considering the sequencing technique and molecular biology.
CO2 Perform sequence alignment and genome assembling.
CO3 Align and quantitate a) DNA sequence reads of various platforms, b) RNA sequence reads of various platforms, c) Microbial DNA and RNA sequence reads, and d) ChIP-seq and CLIP-seq reads.
CO4 Analyze microbial genomics, metagenomics, metatranscriptomics, operons and transcription units taxonomic mapping, microbial abundance, interactions, and pathways.
CO5 Compare and contrast computational methods for performing peak calling and benchmarking and for analyzing ChIP-seq, CLIP-seq, and post-transcriptional regulation.
CO6 Analyze diverse datasets, including small RNA sequencing, polyA sequencing, and protein occupancy profiling.
CO7 Evaluate genetic and somatic variation, differences among variant calling approaches, expression quantitative trait loci identification, and related issues and considerations.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3		x						
CO4	x							
CO5			x					
CO6			x					
CO7			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Assignments, Exams
CO2	Lecture, Q/A	Assignments, Exams
CO3	Lecture, Q/A	Assignments, Exams
CO4	Lecture, Q/A	Assignments, Exams
CO5	Lecture, Q/A	Assignments, Exams
CO6	Lecture, Q/A	Assignments, Exams
CO7	Lecture, Q/A	Assignments, Exams

Textbooks

1. Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools by Vince Buffalo

References

1. Bioconductor Case Studies edited by Florian Hahne, Wolfgang Huber, Robert Gentleman, and Seth Falcon.

DS 4113 Spatial Analytics

Prerequisite: None
Credit Hours: 3.0

Introduction to Spatial Data Science; Importance issues: DBMS problems, topology, spatial indexing, and spatial big data; Spatial autocorrelation, map projection, uncertainty, and modifiable areal unit problem; Open source software: QGIS, PostgreSQL and PostGIS and Hadoop; Spatial Data Science Problems; Geographic Information System (GIS); Layers of GIS: spatial reference framework, spatial data model, spatial data acquisition systems, spatial data analysis, and geo-visualization; Steps of formulation of physical earth, geoid, ellipsoid, datum, and map projections; Coordinate transformation between different map projections; Spatial data acquisition systems; Spatial data analysis; Geovisualization and information delivery; Spatial DBMS; Spatial big data processing using Hadoop MapReduce; Spatial data analysis: Proximity and Accessibility, Spatial Autocorrelation, Spatial Interpolation, Spatial Categorization, Hotspot Analysis; Practical Applications of Spatial Data Science.

Course Outcomes

CO1 Understand the geographical concepts of distance, adjacency and interaction and how fundamental they are in performing spatial data analysis.
CO2 Understand and apply different approaches to spatial data exploration.
CO3 Understand spatial statistics, assumptions and how they are used to explain spatial patterns and processes.
CO4 Demonstrate competency in the use of spatial data analysis tools.
CO5 Interpret and communicate effectively the results of spatial data analysis.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2			x					
CO3	x							
CO4			x					
CO5				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. Spatial Data Science by Robert J. Hijmans.

References

1. QGIS Tutorials and Tips (www.qgistutorials.com)

DS 4115 Marketing Analytics

Prerequisite: None
Credit Hours: 3.0

Introduction to Business Analytics; Predictive Analytics: lending analytics, financial analytics; Prescriptive Analytics: retail analytics, sales-force analytics, portfolio analytics; Supply Chain analytics and Decision Support System; Linear Regression; Time Series Analysis; Data Mining: Cluster Analysis, Market Basket Analysis; Spreadsheet Models; Linear Optimization: Integer Linear Optimization, Nonlinear Optimization; Monte Carlo Simulation; Decision Analysis; Supervised Learning.

Course Outcomes

CO1 Demonstrate the use of analytical tools in marketing.
CO2 Choose appropriate data sources and analytical tools to assess marketing performance.
CO3 Apply analytics tools to a variety of data collected by marketers.
CO4 Translate the results of quantitative analyses into managerial insights for marketing decision-making.
CO5 Explain and illustrate how marketing analytics are used in an integrated manner to solve strategic marketing problems.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4		x						
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. Marketing Analytics: Data-Driven Techniques with Microsoft Excel by Wayne L. Winston.

References

1.

DS 4117 Computational Finance

Prerequisite: None
Credit Hours: 3.0

Financial algorithms used in decision analysis, risk management, data mining and market analysis, and other modern business processes; Background on probabilistic methods used for financial decision making and their application in number of fields such as financial modeling, venture capital decision making, operational risk measurement and investment science; Number of financial applications and algorithms are being presented for portfolio risk analysis, modeling real options, venture capital decision making, etc; Algorithms for financial risk assessment and presents the security concepts and challenges of financial information systems.

Course Outcomes

CO1 Understand fundamental mechanics of derivative markets and the economic impacts of derivative products in risk management.
CO2 Apply the general principle of no-arbitrage asset pricing to evaluate structured products and to design related hedging strategies.
CO3 Perform implementations of basic numerical procedures for asset evaluation.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2			x					
CO3			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments

Textbooks

1. Numerical Methods in Finance with C++ by Maciej J. Capinski and Tomasz Zastawniak.

References

1. Computational Finance (Coursera)

DS 4119 Health Informatics

Prerequisite: None
Credit Hours: 3.0

Historical, technological and theoretical framework for health informatics; Exploration of critical issues and challenges; Potential applications, benefits, and opportunities using information technology; Development of virtual and interactive healthcare; Interoperability, standardization, safety, and risks associated with the implementation of the electronic health record; Professional roles and responsibilities related to managing health information technology; Technical advances, medical connectivity, enabling technologies, education, health policy and regulation and biomedical and health services research dealing with clinical effectiveness, efficacy and safety of telemedicine.

Course Outcomes

CO1 Identify opportunities for healthcare informatics interventions.
CO2 Apply a structured framework for articulating the components of decision support.
CO3 Design knowledge acquisition for decision support.
CO4 Outline a health informatics solution for decision support.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Project, Exams
CO2	Lecture, Q/A	Project, Exams
CO3	Lecture, Q/A	Project, Exams
CO4	Lecture, Q/A	Project, Exams

Textbooks

1. Health Informatics: An Interprofessional Approach by Ramona Nelson, Nancy Staggers, and Kathryn J. Hannah.

References

1. Introduction to Health Informatics (Coursera)

DS 4121 Introduction to Actuarial Science

Prerequisite: None
Credit Hours: 3.0

The theory of rates of interest and discount; annuities and sinking funds with practical applications to mortgage and bond questions. Yield rates; The future lifetime random variable: probability and survival functions; force of mortality; complete and curtate expectation of life; Makeham and Gompertz mortality laws. Life tables: characteristics of population and insurance life tables; selection; fractional age assumptions. Life insurance payments and annuity payments: present value random variables; expected present values; higher moments; actuarial notation. Annual, 1/mthly and continuous cases. Relationships between insurance and annuity functions. Premiums: expense loadings. Present value of future loss random variables and distribution, net and gross cases. Equivalence principle. Portfolio percentile principle. Extra risks; Policy Values: Annual, 1/mthly, and continuous cases. Thiele's equation. Modified premium policy values. Multiple state models: applications in life contingencies; assumptions; Kolmogorov equations; premiums, policy values, multiple decrement models; Joint life models: valuation of insurance benefits on joint lives, dependent and independent cases.

Course Outcomes

CO1 Describe some basic financial fixed income instruments.
CO2 Explain the use of compound interest and discounting in determining the time value of money.
CO3 Apply discounted cash flow techniques for investment project appraisal.
CO4 Analyse some commonly used derivative instruments.
CO5 Describe and analyse the term structure of interest rates.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3			x					
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1		
CO2		
CO3		
CO4		
CO5		

Textbooks

1. Actuarial Mathematics for Life Contingent Risks by David C. M. Dickson, Mary R. Hardy, and Howard R. Waters.

References

1. Society of Actuaries (SOA) (www.soa.org)

DS 4123 Human Computer Interaction

Prerequisite: None
Credit Hours: 3.0

Foundations of human computer interaction: understanding and conceptualizing interaction; Understanding users: human perception, ergonomics, cognition, psychology; Task Analysis; User Interface Design, interface programming, graphical user interfaces, user survey, user journey and experience, mobile devices, multimodal interfaces and ubiquitous computing, user centered system development and evaluation, user- centered software development and evaluation; Prototyping; Interaction design for new environments; Affective and social computing; Assistive and augmentative communication, assistive technology and rehabilitation; Human machine interface, brain computer interface; Experimental research ethics.

Course Outcomes

CO1 Outline and discuss usability goals and user experience goals for designing an interactive product.
CO2 Identify suitable methods for evaluating interactive technologies.
CO3 Identify suitable methods for establishing requirements.
CO4 Discuss the conceptual, practical, and ethical issues involved in evaluation.
CO5 iscuss the advantages and disadvantages of low-fidelity and hi-fidelity prototypes.
CO6 Produce simple prototypes of interactive products.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4		x						
CO5		x						
CO6			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exam, Assignments
CO2	Lecture, Q/A	Exam, Assignments
CO3	Lecture, Q/A	Exam, Assignments
CO4	Lecture, Q/A	Exam, Assignments
CO5	Lecture, Q/A	Exam, Assignments
CO6	Lecture, Q/A	Exam, Project, Assignments

Textbooks

1. The Design of Everyday Things by Donald A. Norman.

References

1. Interaction Design Foundation (www.interaction-design.org)

DS 4125 Medical Image and Signal Processing

Prerequisite: None
Credit Hours: 3.0

Biomedical Signals and Images: ECG, Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications; Speech Signals: The source-filter model of speech production, spectrographic analysis of speech; Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders; Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT; MRI: Physics and signal processing for magnetic resonance imaging; Surgical Applications: A survey of surgical applications of medical image processing; Fundamentals of Deterministic Signal and Image Processing; Data Acquisition: Sampling in time, aliasing, interpolation, and quantization; Digital Filtering: Difference equations, FIR and IIR filters, basic properties of discrete-time systems, convolution; DIFT; DFT; Sampling and spectral analysis; Image Segmentation and Registration.

Course Outcomes

CO1 Apply mathematical methods of signal and image processing to acquired medical signals and images.

CO2 Analyse multidimensional time and frequency domain signals.
CO3 Apply the principles underlying the operation of medical imaging devices.
CO4 Analyse the strengths and weaknesses of medical imaging and sensing devices and how these impact upon their common clinical applications.
CO5 Generate mathematical models by applying their understanding of how medical images are constructed and processed in hardware.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Exams, Assignments
CO2	Lecture, Q/A	Exams, Assignments
CO3	Lecture, Q/A	Exams, Assignments
CO4	Lecture, Q/A	Exams, Assignments
CO5	Lecture, Q/A	Exams, Assignments

Textbooks

1. Biomedical Signal and Image Processing by Kayvan Najarian and Robert Splinter.

References

1. Medical Image Analysis (www.medicalimageanalysis.net)

DS 4127 Computational Epidemiology

Prerequisite: None
Credit Hours: 3.0

Introduction, models, and disease dynamics. What is epidemiology? What is computational epidemiology? Historical overview of epidemiology and computational epidemiology. The importance of understanding and controlling disease-spread. Mass action disease models. Networked computational epidemiology. Dynamics of disease-spread in mass action models and on contact network models; Inference, prediction, and forecasting problems. Given noisy and sparse disease incidence data, how to infer disease model parameters such as transmission probability, period of infectivity, and reproduction number? How to infer infection source and most likely cascades? How to infer latent spreaders? How to predict future cases, forecast future epidemics? Infection surveillance and control problems. Given contact network model and disease model, how to design low-cost disease surveillance and infection control policies? Surveillance includes placing data collection sites in clinics, performing extra testing on selected patients, swabbing selected surfaces in a hospital, etc. Infection control policies include vaccination, prescribing antibiotics and antivirals, quarantining, sequestering, etc; Additional Topics. Sources of disease data: UIHC databases, CDC MMWR, Healthcare Cost and Utilization Project (HCUP) datasets, Truven Health Analytics datasets, MIMIC dataset, other publicly available datasets for research. Deployment and use of technology for gathering contact and behavior data. High-performance computing for large-scale simulations. Game-theory of vaccination.

Course Outcomes

CO1 Understand the interdisciplinary nature of Computational Epidemiology.
CO2 Understand the principles of Epidemiology and its challenges to identify the cause of outbreaks
CO3 Understand the fundamentals of mathematical outbreak models and their interpretation.
CO4 Understand the basics of computational modeling and simulation
CO5 Learn the fundamental study designs in epidemiology.
CO6 Understand the difficulties of communicating among researchers in an interdisciplinary setting.
CO7 Learn to present Public Health related information and study results.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2	x							
CO3	x							
CO4	x							
CO5	x							
CO6	x							
CO7				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Presentation, Exams, Field Study
CO2	Lecture, Q/A	Presentation, Exams, Field Study
CO3	Lecture, Q/A	Presentation, Exams, Field Study
CO4	Lecture, Q/A	Presentation, Exams, Field Study
CO5	Lecture, Q/A	Presentation, Exams, Field Study
CO6	Lecture, Q/A	Presentation, Exams, Field Study
CO7	Lecture, Q/A	Presentation, Exams, Field Study

Textbooks

1. Modeling Infectious Diseases in Humans and Animals by Matt J. Keeling and Pejman Rohani.

References

1. Computational Epidemiology Lab at Boston Children's Hospital (http://rcwww.rc.fas.harvard.edu/cepi/)

DS 4129 Remote Sensing of Environment

Prerequisite: None
Credit Hours: 3.0

Introduction to the principles, characteristics and applications of environmental remote sensing; concepts and foundations of remote sensing, photographic systems and interpretation, thermal and multispectral scanning, radar systems, satellite remote sensing, and digital image processing.

Course Outcomes

CO1 Demonstrate knowledge of theory of remote sensing and GIS including sensor systems, basic radiative transfer, cartographic projections and display, and spatial databases, and of fundamental concepts in geospatial analysis and modeling techniques.

CO2 Quantitatively analyze data to evaluate scientific hypotheses and arguments in remote sensing and geographic information science.

CO3 Communicate effectively, both verbally and in writing, advanced concepts in remote sensing and geographic information systems.

CO4 Demonstrate understanding of the broader impacts and applications of remote sensing and GIS for natural sciences, social sciences, and for society at large.

CO5 Apply a range of geospatial analysis techniques using remote sensing and GIS tools toward solving quantitative problems in one or more core disciplinary areas such as geography, ecology, environmental sciences, biogeosciences, urban planning or natural resources management.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	x							
CO2		x						
CO3		x						
CO4		x						
CO5			x					

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Demonstration, Q/A	Exams, Assignments
CO2	Lecture, Demonstration, Q/A	Exams, Assignments
CO3	Lecture, Demonstration, Q/A	Exams, Assignments
CO4	Lecture, Demonstration, Q/A	Exams, Assignments
CO5	Lecture, Demonstration, Q/A	Exams, Assignments

Textbooks

1. Remote Sensing of the Environment: An Earth Resource Perspective by John R. Jensen.

References

1.

DS 4131 Precision Agriculture

Prerequisite: None
Credit Hours: 3.0

Introduction; Technology in precision agriculture: CAN bus, GNSS, displays; Autoguidance Swaths, components; Yield Monitoring; Water Management; Smart Irrigation; Digital pasture management; Soil health, field productivity zoning; Blockchain and farm trade; Telematics and Software; Drones.

Course Outcomes

CO1 Demonstrate advanced theoretical and practical knowledge of precision agricultural technologies and model the skills and application expected in a professional career.
CO2 Demonstrate ability to review, analyse, consolidate and synthesise PA knowledge to identify and provide solutions to complex problems.
CO3 Critically evaluate physical and economic factors affecting a given scenario and use Precision Agricultural tools to synthesise an appropriate solution.
CO4 Present a clear and coherent exposition of, the objectives and specific applications of precision agriculture for various farming systems to a variety of audiences.
CO5 Make high level, independent evaluation of sources of data for precision agriculture and provide an evaluation of the integration of multiple systems of precision agriculture in the form of a technical report.

Mapping between course outcomes and program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1		x						
CO2			x					
CO3			x					
CO4				x				
CO5				x				

Mapping between course outcomes and assessment strategy

CO	Teaching Strategy	Assessment
CO1	Lecture, Q/A	Presentation, Report, Exams
CO2	Lecture, Q/A	Presentation, Report, Exams
CO3	Lecture, Q/A	Presentation, Report, Exams
CO4	Lecture, Q/A	Presentation, Report, Exams
CO5	Lecture, Q/A	Presentation, Report, Exams

Textbooks

1. Precision Agriculture Basics by Ancha Srinivasan, David E. Clay, and John F. Shanahan.

References

1.

DS 4923 Special Topic - II

Prerequisite: None
Credit Hours: 3.0

Course designed on recent topics from Application Area of Data Science. Syllabus should be approved prior to the commencement of the term. In each term only one such course title under this course number can be offered. Furthermore one student can take such course only once.

DS 4000 A Capstone Project - I

Prerequisite: None
Credit Hours: 2.0

A capstone project designed in the field of data science.

DS 4000B Capstone Project - II

Prerequisite: DS 4000A
Credit Hours: 2.0

In this course the students will partially implement the project proposal that is accepted in the course DS 4000A.

DS 4000C Capstone Project - III

Prerequisite: DS 4000B
Credit Hours: 2.0

In this course the students will implement the project that is partially implemented in DS 4000B.