VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

CURRICULUM AND SYLLABI

(2023-2024)

B. Tech. Computer Science and Engineering (Data Science)

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VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

To be a world-renowned centre of education, research and service in computing and allied domains.

MISSION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

- To offer computing education programs with the goal that the students become technically competent and develop lifelong learning skill.
- To undertake path-breaking research that creates new computing technologies and solutions for industry and society at large.
- To foster vibrant outreach programs for industry, research organizations, academia and society.

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B.Tech-CSE (Data Science)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems.
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry.
3. Graduates will function in their profession with social awareness and responsibility.
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country.
5. Graduates will be successful in pursuing higher studies in engineering or management.
6. Graduates will pursue career paths in teaching or research.

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B.Tech-CSE (Data Science)

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having a clear understanding of the subject related concepts and of contemporary issues and apply them to identify, formulate and analyse complex engineering problems.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_09: Having cross cultural competency exhibited by working as a member or in teams

PO_10: Having a good working knowledge of communicating in English – communication with engineering community and society

PO_11: Having a good cognitive load management skills related to project management and finance

PO_12: Having interest and recognise the need for independent and lifelong learning

Category Credit Detail			
Sl.No.	**Description**	**Credit**	**Maximum Credit**
1	FC - Foundation Core	53	53
2	DLES - Discipline-linked Engineering Sciences	12	12
3	DC - Discipline Core	47	47
4	SPE - Specialization Elective	21	21
5	PI - Projects and Internship	9	9
6	OE - Open Elective	9	9
7	BC - Bridge Course	0	0
8	NGCR - Non-graded Core Requirement	11	11
Total Credits		162	

Foundation Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	BCHY101L	Engineering Chemistry	Theory Only	1.0	3	0	0	0	3.0
2	BCHY101P	Engineering Chemistry Lab	Lab Only	1.0	0	0	2	0	1.0
3	BCSE101E	Computer Programming: Python	Embedded Theory and Lab	1.0	1	0	4	0	3.0
4	BCSE102L	Structured and Object-Oriented Programming	Theory Only	1.0	2	0	0	0	2.0
5	BCSE102P	Structured and Object-Oriented Programming Lab	Lab Only	1.0	0	0	4	0	2.0
6	BCSE103E	Computer Programming: Java	Embedded Theory and Lab	1.0	1	0	4	0	3.0
7	BEEE102L	Basic Electrical and Electronics Engineering	Theory Only	1.0	3	0	0	0	3.0
8	BEEE102P	Basic Electrical and Electronics Engineering Lab	Lab Only	1.0	0	0	2	0	1.0
9	BENG101L	Technical English Communication	Theory Only	1.0	2	0	0	0	2.0
10	BENG101P	Technical English Communication Lab	Lab Only	1.0	0	0	2	0	1.0
11	BENG102P	Technical Report Writing	Lab Only	1.0	0	0	2	0	1.0
12	BFLE200L	B.Tech. Foreign Language - 2021onwards	Basket	1.0	0	0	0	0	2.0
13	BHSM200L	B.Tech. HSM Elective - 2021 onwards	Basket	1.0	0	0	0	0	3.0
14	BMAT101L	Calculus	Theory Only	1.0	3	0	0	0	3.0
15	BMAT101P	Calculus Lab	Lab Only	1.0	0	0	2	0	1.0
16	BMAT102L	Differential Equations and Transforms	Theory Only	1.0	3	1	0	0	4.0
17	BMAT201L	Complex Variables and Linear Algebra	Theory Only	1.0	3	1	0	0	4.0
18	BMAT202L	Probability and Statistics	Theory Only	1.0	3	0	0	0	3.0
19	BMAT202P	Probability and Statistics Lab	Lab Only	1.0	0	0	2	0	1.0
20	BPHY101L	Engineering Physics	Theory Only	1.0	3	0	0	0	3.0
21	BPHY101P	Engineering Physics Lab	Lab Only	1.0	0	0	2	0	1.0
22	BSTS101P	Quantitative Skills Practice I	Soft Skill	1.0	0	0	3	0	1.5
23	BSTS102P	Quantitative Skills Practice II	Soft Skill	1.0	0	0	3	0	1.5
24	BSTS201P	Qualitative Skills Practice I	Soft Skill	1.0	0	0	3	0	1.5
25	BSTS202P	Qualitative Skills Practice II	Soft Skill	1.0	0	0	3	0	1.5

Discipline-linked Engineering Sciences									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	BECE102L	Digital Systems Design	Theory Only	1.0	3	0	0	0	3.0
2	BECE102P	Digital Systems Design Lab	Lab Only	1.0	0	0	2	0	1.0
3	BECE204L	Microprocessors and Microcontrollers	Theory Only	1.0	3	0	0	0	3.0
4	BECE204P	Microprocessors and Microcontrollers Lab	Lab Only	1.0	0	0	2	0	1.0
5	BMAT205L	Discrete Mathematics and Graph Theory	Theory Only	1.0	3	1	0	0	4.0

Discipline Core									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	BCSE202L	Data Structures and Algorithms	Theory Only	1.0	3	0	0	0	3.0
2	BCSE202P	Data Structures and Algorithms Lab	Lab Only	1.0	0	0	2	0	1.0
3	BCSE203E	Web Programming	Embedded Theory and Lab	1.0	1	0	4	0	3.0
4	BCSE204L	Design and Analysis of Algorithms	Theory Only	1.0	3	0	0	0	3.0
5	BCSE204P	Design and Analysis of Algorithms Lab	Lab Only	1.0	0	0	2	0	1.0
6	BCSE205L	Computer Architecture and Organization	Theory Only	1.0	3	0	0	0	3.0
7	BCSE301L	Software Engineering	Theory Only	1.0	3	0	0	0	3.0
8	BCSE301P	Software Engineering Lab	Lab Only	1.0	0	0	2	0	1.0
9	BCSE302L	Database Systems	Theory Only	1.0	3	0	0	0	3.0
10	BCSE302P	Database Systems Lab	Lab Only	1.0	0	0	2	0	1.0
11	BCSE303L	Operating Systems	Theory Only	1.0	3	0	0	0	3.0
12	BCSE303P	Operating Systems Lab	Lab Only	1.0	0	0	2	0	1.0
13	BCSE304L	Theory of Computation	Theory Only	1.0	3	0	0	0	3.0
14	BCSE305L	Embedded Systems	Theory Only	1.0	3	0	0	0	3.0
15	BCSE306L	Artificial Intelligence	Theory Only	1.0	3	0	0	0	3.0
16	BCSE307L	Compiler Design	Theory Only	1.0	3	0	0	0	3.0
17	BCSE307P	Compiler Design Lab	Lab Only	1.0	0	0	2	0	1.0
18	BCSE308L	Computer Networks	Theory Only	1.0	3	0	0	0	3.0
19	BCSE308P	Computer Networks Lab	Lab Only	1.0	0	0	2	0	1.0
20	BCSE309L	Cryptography and Network Security	Theory Only	1.0	3	0	0	0	3.0
21	BCSE309P	Cryptography and Network Security Lab	Lab Only	1.0	0	0	2	0	1.0

Specialization Elective									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	BCSE206L	Foundations of Data Science	Theory Only	1.0	3	0	0	0	3.0
2	BCSE207L	Programming for Data Science	Theory Only	1.0	2	0	0	0	2.0
3	BCSE207P	Programming for Data Science Lab	Lab Only	1.0	0	0	2	0	1.0

Specialization Elective									
4	BCSE208L	Data Mining	Theory Only	1.0	2	0	0	0	2.0
5	BCSE208P	Data Mining Lab	Lab Only	1.0	0	0	2	0	1.0
6	BCSE209L	Machine Learning	Theory Only	1.0	3	0	0	0	3.0
7	BCSE209P	Machine Learning Lab	Lab Only	1.0	0	0	2	0	1.0
8	BCSE331L	Exploratory Data Analysis	Theory Only	1.0	2	0	0	0	2.0
9	BCSE331P	Exploratory Data Analysis Lab	Lab Only	1.0	0	0	2	0	1.0
10	BCSE332L	Deep Learning	Theory Only	1.0	3	0	0	0	3.0
11	BCSE332P	Deep Learning Lab	Lab Only	1.0	0	0	2	0	1.0
12	BCSE333L	Statistical Inference	Theory Only	1.0	2	0	0	0	2.0
13	BCSE333P	Statistical Inference Lab	Lab Only	1.0	0	0	2	0	1.0
14	BCSE334L	Predictive Analytics	Theory Only	1.0	3	0	0	0	3.0
15	BCSE335L	Healthcare Data Analytics	Theory Only	1.0	3	0	0	0	3.0
16	BCSE336L	Financial Data Analytics	Theory Only	1.0	2	0	0	0	2.0
17	BCSE336P	Financial Data Analytics Lab	Lab Only	1.0	0	0	2	0	1.0

Projects and Internship									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	BCSE399J	Summer Industrial Internship	Project	1.0	0	0	0	0	1.0
2	BCSE497J	Project - I	Project	1.0	0	0	0	0	3.0
3	BCSE498J	Project - II / Internship	Project	1.0	0	0	0	0	5.0
4	BCSE499J	One Semester Internship	Project	1.0	0	0	0	0	14.0

Open Elective									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credit
1	BCSE355L	AWS Solutions Architect	Theory Only	1.0	3	0	0	0	3.0
2	BECE201L	Electronic Materials and Devices	Theory Only	1.0	3	0	0	0	3.0
3	BECE203L	Circuit Theory	Theory Only	1.0	3	1	0	0	4.0
4	BHUM201L	Mass Communication	Theory Only	1.0	3	0	0	0	3.0
5	BHUM202L	Rural Development	Theory Only	1.0	3	0	0	0	3.0
6	BHUM203L	Introduction to Psychology	Theory Only	1.0	3	0	0	0	3.0
7	BHUM204L	Industrial Psychology	Theory Only	1.0	3	0	0	0	3.0
8	BHUM205L	Development Economics	Theory Only	1.0	3	0	0	0	3.0
9	BHUM206L	International Economics	Theory Only	1.0	3	0	0	0	3.0
10	BHUM207L	Engineering Economics	Theory Only	1.0	3	0	0	0	3.0
11	BHUM208L	Economics of Strategy	Theory Only	1.0	3	0	0	0	3.0
12	BHUM209L	Game Theory	Theory Only	1.0	3	0	0	0	3.0
13	BHUM210E	Econometrics	Embedded Theory and Lab	1.0	2	0	2	0	3.0
14	BHUM211L	Behavioral Economics	Theory Only	1.0	3	0	0	0	3.0

Open Elective									
15	BHUM212L	Mathematics for Economic Analysis	Theory Only	1.0	3	0	0	0	3.0
16	BHUM213L	Corporate Social Responsibility	Theory Only	1.0	3	0	0	0	3.0
17	BHUM214L	Political Science	Theory Only	1.0	3	0	0	0	3.0
18	BHUM215L	International Relations	Theory Only	1.0	3	0	0	0	3.0
19	BHUM216L	Indian Culture and Heritage	Theory Only	1.0	3	0	0	0	3.0
20	BHUM217L	Contemporary India	Theory Only	1.0	3	0	0	0	3.0
21	BHUM218L	Financial Management	Theory Only	1.0	3	0	0	0	3.0
22	BHUM219L	Principles of Accounting	Theory Only	1.0	3	0	0	0	3.0
23	BHUM220L	Financial Markets and Institutions	Theory Only	1.0	3	0	0	0	3.0
24	BHUM221L	Economics of Money, Banking and Financial Markets	Theory Only	1.0	3	0	0	0	3.0
25	BHUM222L	Security Analysis and Portfolio Management	Theory Only	1.0	3	0	0	0	3.0
26	BHUM223L	Options , Futures and other Derivatives	Theory Only	1.0	3	0	0	0	3.0
27	BHUM224L	Fixed Income Securities	Theory Only	1.0	3	0	0	0	3.0
28	BHUM225L	Personal Finance	Theory Only	1.0	3	0	0	0	3.0
29	BHUM226L	Corporate Finance	Theory Only	1.0	3	0	0	0	3.0
30	BHUM227L	Financial Statement Analysis	Theory Only	1.0	3	0	0	0	3.0
31	BHUM228L	Cost and Management Accounting	Theory Only	1.0	3	0	0	0	3.0
32	BHUM229L	Mind, Embodiment and Technology	Theory Only	1.0	3	0	0	0	3.0
33	BHUM230L	Health Humanities in Biotechnological Era	Theory Only	1.0	3	0	0	0	3.0
34	BHUM231L	Reproductive Choices for a Sustainable Society	Theory Only	1.0	3	0	0	0	3.0
35	BHUM232L	Introduction to Sustainable Aging	Theory Only	1.0	3	0	0	0	3.0
36	BHUM233L	Environmental Psychology	Theory Only	1.0	3	0	0	0	3.0
37	BHUM234L	Indian Psychology	Theory Only	1.0	3	0	0	0	3.0
38	BHUM235E	Psychology of Wellness	Embedded Theory and Lab	1.0	2	0	2	0	3.0
39	BHUM236L	Taxation	Theory Only	1.0	3	0	0	0	3.0
40	BITE202L	Digital Logic and Microprocessors	Theory Only	1.0	3	0	0	0	3.0
41	BITE202P	Digital Logic and Microprocessors Lab	Lab Only	1.0	0	0	2	0	1.0
42	BMGT108L	Entrepreneurship	Theory Only	1.0	3	0	0	0	3.0
43	BMGT109L	Introduction to Intellectual Property	Theory Only	1.0	3	0	0	0	3.0
44	BPHY201L	Optics	Theory Only	1.0	3	0	0	0	3.0
45	BPHY202L	Classical Mechanics	Theory Only	1.0	3	0	0	0	3.0
46	BPHY203L	Quantum Mechanics	Theory Only	1.0	3	0	0	0	3.0
47	BPHY301E	Computational Physics	Embedded Theory and Lab	1.0	2	0	2	0	3.0
48	BPHY302P	Physics Lab	Lab Only	1.0	0	0	2	0	1.0
49	BPHY401L	Solid State Physics	Theory Only	1.0	3	0	0	0	3.0
50	BPHY402L	Electromagnetic Theory	Theory Only	1.0	3	0	0	0	3.0
51	BPHY403L	Atomic and Nuclear Physics	Theory Only	1.0	3	0	0	0	3.0
52	BPHY404L	Statistical Mechanics	Theory Only	1.0	3	0	0	0	3.0
53	BSTS301P	Advanced Competitive Coding - I	Soft Skill	1.0	0	0	3	0	1.5
54	BSTS302P	Advanced Competitive Coding - II	Soft Skill	1.0	0	0	3	0	1.5
55	CFOC105M	Emotional Intelligence	Online Course	1.0	0	0	0	0	2.0
56	CFOC133M	E-Business	Online Course	1.0	0	0	0	0	3.0

Open Elective									
57	CFOC168M	Switching Circuits and Logic Design	Online Course	1.0	0	0	0	0	3.0
58	CFOC191M	Forests and their Management	Online Course	1.0	0	0	0	0	3.0
59	CFOC227M	GPU Architectures and Programming	Online Course	1.0	0	0	0	0	3.0
60	CFOC332M	Fundamentals of Automotive Systems	Online Course	1.0	0	0	0	0	3.0
61	CFOC384M	Entrepreneurship Essentials	Online Course	1.0	0	0	0	0	3.0
62	CFOC391M	Effective Writing	Online Course	1.0	0	0	0	0	1.0
63	CFOC469M	Financial Mathematics	Online Course	1.0	0	0	0	0	3.0
64	CFOC497M	Financial Statement Analysis and Reporting	Online Course	1.0	0	0	0	0	3.0
65	CFOC599M	Leadership and Team Effectiveness	Online Course	1.0	0	0	0	0	3.0
66	CFOC642M	Conservation Economics	Online Course	1.0	0	0	0	0	3.0
67	CFOC647M	Air pollution and Control	Online Course	1.0	0	0	0	0	3.0
68	CFOC648M	Centre-State Relations in India	Online Course	1.0	0	0	0	0	2.0
69	CFOC649M	Energy Resources, Economics, and Sustainability	Online Course	1.0	0	0	0	0	2.0
70	CFOC650M	Human Physiology	Online Course	1.0	0	0	0	0	3.0
71	CFOC651M	Psychology of Stress, Health and Well-being	Online Course	1.0	0	0	0	0	3.0
72	CFOC652M	Signal Processing Techniques and its Applications	Online Course	1.0	0	0	0	0	3.0
73	CFOC653M	Strength & Conditioning for the Indian Population	Online Course	1.0	0	0	0	0	3.0
74	CFOC654M	The Evolution of the Earth and Life	Online Course	1.0	0	0	0	0	3.0
75	CFOC655M	United Nations Sustainable Development Goals (UN SDGs)	Online Course	1.0	0	0	0	0	3.0

Bridge Course									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	BENG101N	Effective English Communication	Lab Only	1.0	0	0	4	0	2.0

Non-graded Core Requirement									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credit**
1	BCHY102N	Environmental Sciences	Online Course	1.0	0	0	0	0	2.0
2	BCSE101N	Introduction to Engineering	Project	1.0	0	0	0	0	1.0
3	BEXC100N	Extracurricular Activities / Co-Curricular Activities - B.Tech. Programmes	Basket	1.0	0	0	0	0	2.0
4	BHUM101N	Ethics and Values	Online Course	1.0	0	0	0	0	2.0
5	BSSC101N	Essence of Traditional Knowledge	Online Course	1.0	0	0	0	0	2.0
6	BSSC102N	Indian Constitution	Online Course	1.0	0	0	0	0	2.0

FOUNDATION CORE

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

Foundation Core

BCHY101L	Engineering Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To enable students to have fundamental understanding of the basic concepts of different disciplines of chemistry.
2. To provide avenues for learning advanced concepts from school to university
3. To empower students with emerging concepts in applied chemistry to be useful in addressing societal needs
4. To integrate analytical and computational ability with experimental skills to create individuals competent in basic science and its by-product of its application.
5. To offer opportunities to create pathways for self-reliant in terms of knowledge and higher learning

Course Outcomes :

1. Understand the fundamental concepts in organic, inorganic, physical, and analytical chemistry.
2. Analyze the principles of applied chemistry in solving the societal issues.
3. Apply chemical concepts for the advancement of materials.
4. Appreciate the fundamental principles of spectroscopy and the related applications.
5. Design new materials, energy conversion devices and new protective coating techniques.

Module:1	**Chemical thermodynamics and kinetics**	**6 hours**

Laws of thermodynamics - entropy change (selected processes) – spontaneity of a chemical reaction and Gibbs free energy - heat transfer; Kinetics - Concept of activation energy and energy barrier - Arrhenius equation- effect of catalysts (homo and heterogeneous) – Enzyme catalysis (Michaelis-Menten Mechanism).

Module:2	**Metal complexes and organometallics**	**6 hours**

Inorganic complexes - structure, bonding and application; Organometallics – introduction, stability, structure and applications of metal carbonyls, ferrocene and Grignard reagent; Metals in biology (haemoglobin, chlorophyll- structure and property).

Module:3	**Organic intermediates and reaction transformations**	**6 hours**

Organic intermediates - stability and structure of carbocations, carbanions and radicals; Aromatics (aromaticity) and heterocycles (3, 4, 5, 6 membered and fused systems); Organic transformations for making useful drugs for specific disease targets (two examples) and dyes (addition, elimination, substitution and cross coupling reactions).

Module:4	**Energy devices**	**6 hours**

Electrochemical and electrolytic cells – electrode materials with examples (semi-conductors), electrode-electrolyte interface- chemistry of Li ion secondary batteries, supercapacitors; Fuel cells: H_2-O_2 and solid oxide fuel cell (SOFC); Solar cells - photovoltaic cell (silicon based), photoelectrochemical cells and dye-sensitized cells.

Module:5	**Functional materials**	**7 hours**

Oxides of AB, AB_2, ABO_3 type (specific examples); Composites - types and properties; Polymers - thermosetting and thermoplastic polymers – synthesis and application (TEFLON, BAKELITE); Conducting polymers- polyacetylene and effect of doping – chemistry of display devices specific to OLEDs; Nano materials – introduction, bulk *vs* nano (quantum dots), top-down and bottom-up approaches for synthesis, and properties of nano Au.

Module:6	**Spectroscopic, diffraction and microscopic techniques**	**5 hours**

Fundamental concepts in spectroscopic and instrumental techniques; Principle and applications of UV-Visible and XRD techniques (numericals); Overview of various techniques such as AAS, IR, NMR, SEM and TEM.

Module:7	**Industrial applications**	**7 hours**

Water purification methods - zeolites, ion-exchange resins and reverse osmosis; Fuels and combustion -LCV, HCV, Bomb calorimeter (numericals), anti-knocking agents); Protective coatings for corrosion control: cathodic and anodic protection - PVD technique; Chemical sensors for environmental monitoring - gas sensors; Overview of computational methodologies: energy minimization and conformational analysis.				
Module:8	**Contemporary topics**			**2 hours**
Guest lectures from Industry and, Research and Development Organizations				
	Total Lecture hours:			**45 hours**
Textbook				
1.	Theodore E. Brown, H Eugene, LeMay Bruce E. Bursten, Catherine Murphy, Patrick Woodward, Matthew E. Stoltzfus, Chemistry: The Central Science, 2017, 14th edition, Pearson Publishers, 2017. UK			
Reference Books				
1.	Peter Vollhardt, Neil Schore, Organic Chemistry: Structure and Function, 2018, 8th ed. WH Freeman, London			
2.	Atkins' Physical Chemistry: International, 2018, Eleventh edition, Oxford University Press; UK			
3.	Colin Banwell, Elaine McCash, Fundamentals for Molecular Spectroscopy, 4th Edition, McGraw Hill, US			
4.	Solid State Chemistry and its Applications, Anthony R. West. 2014, 2nd edition, Wiley, UK.			
5.	AngÃ¨le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic solar energy: From fundamentals to Applications, 2017, Wiley publishers, UK.			
6.	Lawrence S. Brown and Thomas Holme, Chemistry for engineering students, 2018, 4th edition – *Open access version*			
Mode of Evaluation: CAT, Written assignment, Quiz and FAT				
Recommended by Board of Studies	28.06.2021			
Approved by Academic Council	No. 63	Date	23.09.2021	

BCHY101P	Engineering Chemistry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objective

To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcome :

At the end of the course the student will be able to

1. Understand the importance and hands-on experience on analysis of metal ions by means of experiments.
2. Get practical experience on synthesis and characterization of the organic molecules and nanomaterials in the laboratory.
3. Apply their knowledge in thermodynamic functions, kinetics and molecular geometries through the experiments.

Indicative Experiments	
1.	Thermodynamics functions from EMF measurements : Zinc – Copper system
2.	Determination of reaction rate, order and molecularity of ethylacetate hydrolysis
3.	Colorimetric estimation of Ni^{2+} using conventional and smart phone digital-imaging methods
4.	Laboratory scale preparation of important drug intermediate - para aminophenol for the synthesis for acetaminophen
5.	Magnesium-sea water activated cell – Effect of salt concentration on voltage generation
6.	Analysis of iron in an alloy sample by potentiometry
7.	Preparation of tin oxide by sol- gel method and its characterization
8.	Size dependent colour variation of Cu_2O nanoparticles by spectrophotometer
9.	Determination of hardness of water sample by complexometric titration before and after ion-exchange process
10.	Computational Optimization of molecular geometry using Avogadro software
	Total Laboratory Hours **30 hours**

Mode of assessment: Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BCSE101E	Computer Programming: Python	L	T	P	C
		1	0	4	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To provide exposure to basic problem-solving techniques using computers.
2. To inculcate the art of logical thinking abilities and propose novel solutions for real world problems through programming language constructs.

Course Outcome

1. Classify various algorithmic approaches, categorize the appropriate data representation, and demonstrate various control constructs.
2. Choose appropriate programming paradigms, interpret and handle data using files to propose solution through reusable modules; idealize the importance of modules and packages.

Module:1	**Introduction to Problem Solving**	**1 hour**
Problem Solving: Definition and Steps, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode.		
Module:2	**Python Programming Fundamentals**	**2 hours**
Introduction to python – Interactive and Script Mode – Indentation – Comments – Variables – Reserved Words – Data Types – Operators and their precedence – Expressions – Built-in Functions – Importing from Packages.		
Module:3	**Control Structures**	**2 hours**
Decision Making and Branching: if, if-else, nested if, multi-way if-elif statements – Looping: while loop, for loop – else clauses in loops, nested loops – break, continue and pass statements.		
Module:4	**Collections**	**3 hours**
Lists: Create, Access, Slicing, Negative indices, List methods, List comprehensions – Tuples: Create, Indexing and slicing, Operations on tuples – Dictionary: Create, add, and replace values, Operations on dictionaries – Sets: Creation and operations.		
Module:5	**Strings and Regular Expressions**	**2 hours**
Strings: Comparison, Formatting, Slicing, Splitting, Stripping – Regular Expressions: Matching, Search and replace, Patterns.		
Module:6	**Functions and Files**	**3 hours**
Functions – Parameters and Arguments: Positional arguments, Keyword arguments, Parameters with default values – Local and Global scope of variables – Functions with Arbitrary arguments – Recursive Functions – Lambda Function. Files: Create, Open, Read, Write, Append and Close – tell and seek methods.		
Module:7	**Modules and Packages**	**2 hours**
Built-in modules – User-Defined modules – Overview of Numpy and Pandas packages.		
	Total Lecture hours:	**15 hours**

Text Book(s)

1. Eric Matthes, Python Crash Course: A Hands-On, Project-Based Introduction to Programming, 2nd Edition, No starch Press, 2019

Reference Books

1. Martic C Brown, Python: The Complete Reference, 4th Edition, McGraw Hill Publishers, 2018.
2. John V. Guttag, Introduction to computation and programming using python: with applications to understanding data. 2nd Edition, MIT Press, 2016.

Mode of Evaluation: No separate evaluation for theory component.				
Indicative Experiments				
1.	Problem Analysis Chart, Flowchart and Pseudocode Practices.			
2.	Sequential Constructs using Python Operators, Expressions.			
3.	Branching (if, if-else, nested if, multi-way if-elif statements) and Looping (for, while, nested looping, break, continue, else in loops).			
4.	List, Tuples, Dictionaries & Sets.			
5.	Strings, Regular Expressions.			
6.	Functions, Lambda, Recursive Functions and Files.			
7.	Modules and Packages (NumPy and Pandas)			
Total Laboratory Hours				**60 hours**
Text Book(s)				
1.	Mariano Anaya, Clean Code in Python: Develop maintainable and efficient code, 2nd Edition, Packt Publishing Limited, 2021.			
Reference Books				
1.	Harsh Bhasin, Python for beginners, 1st Edition, New Age International (P) Ltd., 2019,			
	Mode of assessment: Continuous assessments and FAT			
Recommended by Board of Studies		03.07.2021		
Approved by Academic Council		No. 63	Date	23.09.2021

BCSE102L	Structured and Object-Oriented Programming	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart the basic constructs in structured programming and object-oriented programming paradigms.
2. To inculcate the insights and benefits in accessing memory locations by implementing real world problems.
3. To help solving real world problems through appropriate programming paradigms.

Course Outcome

At the end of the course, students should be able to:

1. Understand different programming language constructs and decision-making statements; manipulate data as a group.
2. Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers.
3. Comprehend various elements of object-oriented programing paradigm; propose solutions through inheritance and polymorphism; identify the appropriate data structure for the given problem and devise solution using generic programming techniques.

Module:1	**C Programming Fundamentals**	**2 hours**

Variables - Reserved words – Data Types – Operators – Operator Precedence - Expressions - Type Conversions - I/O statements - Branching and Looping: if, if-else, nested if, if-else ladder, switch statement, goto statement - Loops: for, while and do…while – break and continue statements.

Module:2	**Arrays and Functions**	**4 hours**

Arrays: One Dimensional array - Two-Dimensional Array – Strings and its operations. User Defined Functions: Declaration – Definition – call by value and call by reference - Types of Functions - Recursive functions - Storage Classes - Scope, Visibility and Lifetime of Variables.

Module:3	**Pointers**	**4 hours**

Declaration and Access of Pointer Variables, Pointer arithmetic – Dynamic memory allocation – Pointers and arrays - Pointers and functions.

Module:4	**Structure and Union**	**2 hours**

Declaration, Initialization, Access of Structure Variables - Arrays of Structure - Arrays within Structure - Structure within Structures - Structures and Functions – Pointers to Structure -

Module:5	**Overview of Object-Oriented Programming**	**5 hours**

Features of OOP - Classes and Objects - "this" pointer - Constructors and Destructors - Static Data Members, Static Member Functions and Objects - Inline Functions – Call by reference - Functions with default Arguments - Functions with Objects as Arguments - Friend Functions and Friend Classes.

Module:6	**Inheritance**	**5 hours**

Inheritance - Types of Inheritance: Single inheritance, Multiple Inheritance, Multi-level

Inheritance, Hierarchical Inheritance - Multipath Inheritance - Inheritance and constructors.		
Module:7	**Polymorphism**	**4 hours**
Function Overloading - Operator Overloading – Dynamic Polymorphism - Virtual Functions - Pure virtual Functions - Abstract Classes.		
Module:8	**Generic Programming**	**4 hours**
Function templates and class templates, Standard Template Library.		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Herbert Schildt, C: The Complete Reference, 4th Edition, McGraw Hill Education, 2017
2.	Herbert Schildt, C++: The Complete Reference, 4th Edition, McGraw Hill Education, 2017.
Reference Books	
1.	Yashavant Kanetkar, Let Us C: 17th Edition, BPB Publicaitons, 2020.
2.	Stanley Lippman and Josee Lajoie, C++ Primer, 5th Edition, Addison-Wesley publishers, 2012.

Mode of Evaluation: CAT / Written Assignment / Quiz / FAT / Project.			
Recommended by Board of Studies	03.07.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BCSE102P	Structured and Object-Oriented Programming Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart the basic constructs in structured programming and object-oriented programming paradigms.
2. To inculcate the insights and benefits in accessing memory locations by implementing real world problems.
3. To solve real world problems through appropriate programming paradigms.

Course Outcome

At the end of the course, students should be able to:

1. Understand different programming language constructs and decision-making statements; manipulate data as a group.
2. Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers.
3. Comprehend various elements of object-oriented programing paradigm; propose solutions through inheritance and polymorphism; identify the appropriate data structure for the given problem and devise solution using generic programming techniques.

Indicative Experiments

1.	Programs using basic control structures, branching and looping
2.	Experiment the use of 1-D, 2-D arrays and strings and Functions
3.	Demonstrate the application of pointers
4.	Experiment structures and unions
5.	Programs on basic Object-Oriented Programming constructs.
6.	Demonstrate various categories of inheritance
7.	Program to apply kinds of polymorphism.
8.	Develop generic templates and Standard Template Libraries.
	Total Laboratory Hours: 60 hours

Text Book(s)

1. Robert C. Seacord, Effective C: An Introduction to Professional C Programming, 1st Edition, No Starch Press, 2020.

Reference Book(s)

1. Vardan Grigoryan and Shunguang Wu, Expert C++: Become a proficient programmer by learning coding best practices with C++17 and C++20's latest features, 1st Edition, Packt Publishing Limited, 2020.

Mode of assessment: Continuous assessments and FAT.

Recommended by Board of Studies	03.07.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BCSE103E	Computer Programming : Java	L	T	P	C
		1	0	4	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To introduce the core language features of Java and understand the fundamentals of Object -Oriented programming in Java.
2. To develop the ability of using Java to solve real world problems.

Course Outcome:

At the end of this course, students should be able to:

1. Understand basic programming constructs; realize the fundamentals of Object Orientated Programming in Java; apply inheritance and interface concepts for enhancing code reusability.
2. Realize the exception handling mechanism; process data within files and use the data structures in the collection framework for solving real world problems.

Module:1	**Java Basics**	**2 hours**

OOP Paradigm - Features of Java Language - JVM - Bytecode - Java program structure – Basic programming constructs - data types - variables – Java naming conventions – operators.

Module:2	**Looping Constructs and Arrays**	**2 hours**

Control and looping constructs - Arrays – one dimensional and multi-dimensional – enhanced for loop – Strings - Wrapper classes.

Module:3	**Classes and Objects**	**2 hours**

Class Fundamentals – Access and non-access specifiers - Declaring objects and assigning object reference variables – array of objects – constructors and destructors – usage of "this" and "static" keywords.

Module:4	**Inheritance and Polymorphism**	**3 hours**

Inheritance – types –- use of "super" – final keyword - Polymorphism – Overloading and Overriding - abstract class – Interfaces.

Module:5	**Packages and Exception Handling**	**2 hours**

Packages: Creating and Accessing - Sub packages.
Exception Handling - Types of Exception - Control Flow in Exceptions - Use of try, catch, finally, throw, throws in Exception Handling - User defined exceptions.

Module:6	**IO Streams and Files**	**2 hours**

Java I/O streams – FileInputStream & FileOutputStream – FileReader & FileWriter- DataInputStream & DataOutputStream – BufferedInputStream & BufferedOutputStream – PrintOutputStream - Serialization and Deserialization.

Module:7	**Collection Framework**	**2 hours**

Generic classes and methods - Collection framework: List and Map.

	Total Lecture hours:	**15 hours**

Text Book(s)

1.	Y. Daniel Liang, "Introduction to Java programming" - comprehensive version-11th Edition, Pearson publisher, 2017.

Reference Books

1.	Herbert Schildt , The Complete Reference -Java, Tata McGraw-Hill publisher, 10th Edition, 2017.
2	Cay Horstmann,"Big Java", 4th edition, John Wiley & Sons publisher, 5th edition, 2015
3	E.Balagurusamy, "Programming with Java", Tata McGraw-Hill publishers, 6th edition, 2019

Mode of Evaluation: No separate evaluation for theory component.			
Indicative Experiments			
1.	Programs using sequential and branching structures.		
2.	Experiment the use of looping, arrays and strings.		
3.	Demonstrate basic Object-Oriented programming elements.		
4.	Experiment the use of inheritance, polymorphism and abstract classes.		
5.	Designing packages and demonstrate exception handling.		
6.	Demonstrate the use of IO streams, file handling and serialization.		
7.	Program to discover application of collections.		
	Total Laboratory Hours	**60 hours**	
Text Book(s)			
1.	Marc Loy, Patrick Niemeyer and Daniel Leuck, Learning Java, O'Reilly Media, Inc., 5th Edition, 2020.		
Reference Books			
1.	Dhruti Shah, 100+ Solutions in Java: A Hands-On Introduction to Programming in Java, BPB Publications, 1st Edition, 2020.		
Mode of assessment: Continuous assessments and FAT			
Recommended by Board of Studies		03.07.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

Course Code	Course Title	L	T	P	C
BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Familiarize with various laws and theorems to solve electric and electronic circuits
2. Provide an overview on working principle of machines
3. Excel the concepts of semiconductor devices, op-amps and digital circuits

Course Outcomes

On completion of the course, the students will be able to:

1. Evaluate DC and AC circuit parameters using various laws and theorems
2. Comprehend the parameters of magnetic circuits
3. Classify and compare various types of electrical machines and its applications
4. Design basic combinational circuits in digital system
5. Analyze the characteristics and applications of semiconductor devices

Module:1	**DC Circuits**	**7 hours**

Basic circuit elements and sources; Ohms law; Kirchhoff's laws; Series and Parallel connection of circuit elements; Star-delta transformation; Mesh current analysis; Node voltage analysis; Theorems: Thevenin's, Maximum power transfer and Superposition theorem.

Module:2	**AC Circuits**	**8 hours**

Alternating voltages and currents, RMS, average, maximum values, Single Phase RL, RC, RLC series circuits, Power in AC circuits, Power Factor, Three phase balanced systems, Star and delta Connections, Electrical Safety, Fuses and Earthing.

Module:3	**Magnetic Circuits**	**7 hours**

Magnetic field; Toroidal core: Flux density, Flux linkage; Magnetic circuit with airgap; Reluctance in series and parallel circuits; Self and mutual inductance; Transformer: turn ratio determination.

Module:4	**Electrical Machines**	**7 hours**

Construction, working principle and applications of DC Machines, Transformers, Three phase Induction motors, synchronous generators, single phase induction motors, special machines stepper motor, universal motor and BLDC motor.

Module:5	**Digital Systems**	**7 hours**

Binary arithmetic; Number base conversion; Boolean algebra: simplification of Boolean functions using K-maps; Logic gates; Design of basic combinational circuits: adders, multiplexers, de-multiplexers.

Module:6	**Semiconductor Devices and Applications**	**7 hours**

Characteristics: PN junction diode, Zener diode, BJT, MOSFET; Applications: Rectifier, Voltage regulator, Operational amplifier.

Module:7	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Books

1	Allan R. Hambley, "Electrical Engineering -Principles & Applications", 2019, 6th Edition, Pearson Education
2	V. D. Toro, Electrical Engineering Fundamentals, 2nd edition. PHI, 2014

Reference Books

1	R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, 11th edition.

	Pearson, 2012			
2	DP Kothari & Nagrath, “Basic Electric Engineering”, 2019, Tata McGraw Hill			
Recommended by Board of Studies		28-05-2022		
Approved by Academic Council		No. 67	Date	08-08-2022

Course code	Course Title	L	T	P	C
BEEE102P	Basic Electrical and Electronics Engineering Lab	0	0	2	1
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objective

1. Design and solve the fundamental electrical and electronics circuits

Course Outcomes

1. Identify appropriate method of solving the fundamental electrical and electronics circuits
2. Design and conduct experiments on electrical and electronics circuits

Experiments (Indicative)	
1	Verification of Kirchoff's law
2	Verification of Maximum Power Transfer Theorem
3	Staircase wiring circuit layout for multi storage building
4	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars.
5	Measurement of Earth resistance using Megger
6	Sinusoidal steady state response of RLC circuits
7	Three phase power measurement for ac loads
8	Design of half-adder and full-adder digital circuits
9	Synthesis of 8x1 multiplexer and 1x8 de-multiplexers
10	Characteristics of PN diode and acts as switch
11	Realization of single-phase rectifier
12	Design of regulated power supply using Zener diode.
13	Characteristics of MOSFET
14	Characteristics of BJT
15	Measurement of energy using single-phase energy meter
16	Measurement of power in a 1-phase circuit by using CTs and PTs

Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment, FAT			
Recommended by Board of Studies	28-05-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

BENG101L	Technical English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

1. To develop LSRW skills for effective communication in professional situations
2. To enhance knowledge of grammar and vocabulary for meaningful communication
3. To understand information from diverse texts for effective technical communication

Course Outcomes:

1. Use grammar and vocabulary appropriately while writing and speaking
2. Apply the concepts of communication skills in formal and informal situations
3. Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences
4. Write clearly and significantly in academic and general contexts

Module:1	**Introduction to Communication**	**4 hours**
Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications		
Module:2	**Grammatical Aspects**	**4 hours**
Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection		
Module:3	**Written Correspondence**	**4 hours**
Job Application Letters - Resume Writing - Statement of Purpose		
Module:4	**Business Correspondence**	**4 hours**
Business Letters: Calling for Quotation, Complaint & Sales Letter – Memo - Minutes of Meeting - Describing products and processes		
Module:5	**Professional Writing**	**4 hours**
Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal – Recommendations		
Module:6	**Team Building & Leadership Skills**	**4 hours**
Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Management		
Module:7	**Research Writing**	**4 hours**
Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencing		
Module:8	**Guest Lecture from Industry and R&D organizations**	**2 hours**
Contemporary Issues		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Raman, Meenakshi & Sangeeta Sharma. (2015). *Technical Communication: Principles and Practice*, (3rd Edition). India: Oxford University Press.

Reference Books

1. Taylor, Shirley & Chandra .V. (2010). *Communication for Business A Practical Approach* 4th Edition. India: Pearson Longman.
2. Kumar, Sanjay & Pushpalatha. (2018). *English Language and Communication Skills for Engineers*. India: Oxford University Press.
3. Koneru Aruna. (2020). *English Language Skills for Engineers*. India: McGraw Hill Education.
4. Rizvi, M. Ashraf. (2018). *Effective Technical Communication* 2nd Edition. Chennai: McGraw Hill Education.
5. Mishra, Sunitha & Muralikrishna,C. (2014). *Communication Skills for Engineers*. India: Pearson Education.

6.	Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*. India: Cambridge University Press.			
Mode of Evaluation : CAT / Assignment / Quiz / FAT / Group Discussion				
Recommended by Board of Studies		28.06.2021		
Approved by Academic Council		No. 63	Date	23.09.2021

BENG101P	Technical English Communication Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To use appropriate grammatical structures in professional communication
2. To improve English communication skills for better employability
3.To enhance meaningful communication skills in writing and public speaking

Course Outcomes:

1.Demonstrate professional rhetoric and articulate ideas effectively
2. Interpret material on technology and deliver eloquent presentations
3. Apply receptive and productive skills in real life situations and develop workplace communication

Indicative Experiments

1.	**Grammar & Vocabulary** Error Detection **Activity:** -Worksheets
2.	**Listening to Narratives** Interviews of eminent personalities & Ted Talks **Activity:** Listening Comprehension / Summarising
3.	**Video Resume** SWOT Analysis & digital resume techniques **Activity:** Preparing a digital résumé for mock interview
4.	**Product & Process Description** Describing and Sequencing **Activity:** Demonstration of product and process
5.	**Mock Meetings** Types of meetings and meeting etiquette **Activity: Conduct of meetings and drafting minutes of the meeting**
6.	**Reading research article** Scientific and Technical articles **Activity:** Writing Literature review
7.	**Analytical Reading** Case Studies on Communication, Team Building and Leadership **Activity:** Group Discussion
8.	**Presentations** Preparing Conference/Seminar paper **Activity:** Individual/ Group presentations
9.	**Intensive Listening** Scientific documentaries **Activity:** Note taking and Summarising
10.	**Interview Skills** Interview questions and techniques **Activity:** Mock Interviews

Total Laboratory Hours | **30 hours**

Mode of Assessment: Continuous Assessment / FAT / Written Assignments / Quiz/ Oral Presentation and Group Activity.

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BENG102P	Technical Report Writing	I L I T I P I C I o I o 2 11
Pre-requisite	Technical English Communication	**Syllabus version** 1.0

Course Objectives:

1. To augment specific writing skills for preparing technical reports
2. To think critically, evaluate, analyse general and complex technical information
3. To acquire proficiency in writing and presenting reports

Course Outcomes:

1.Write error free sentences using appropriate grammar, vocabulary and style
2. Synthesize information and concepts in preparing reports
3. Demonstrate the ability to write and present reports on diverse topics

Indicative Experiments

1.	**Advanced Grammar, Vocabulary and Editing** Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary - Abbreviations - Mechanics of Editing: Punctuation and Proof Reading **Activity:** Worksheets
2.	**Research and Analyses** Synchronise Technical Details from Newspapers - Magazines - Articles and e-content **Activity:** Writing introduction and literature review
3.	**Systematisation of Information** Techniques to Converge Objective-Oriented data in Diverse Technical Reports **Activity:** Preparing Questionnaire
4.	**Data Visualisation** Interpreting Data - Graphs - Tables- Charts - Imagery - Infographics **Activity:** Transcoding
5.	**Introduction to Reports** Meaning - Definition - Purpose - Characteristics and Types of Reports **Activity:** Worksheets on Types of reports
6.	**Structure of Reports** Title- Preface- Acknowledgement - AbstracUSummary- Introduction - Materials and Methods- Results- Discussion - Conclusion - Suggestions/Recommendations **Activity:** Identifying the structure of report
7.	**Report Writing** Data Collection - Draft an Outline and Organize Information **Activity:** Drafting reports
8.	**Supplementary Texts** Appendix- Index- Glossary- References- Bibliography - Notes **Activity:** Organizing supplementary texts
9.	**Review of Final Reports** Structure- Content- Style - Layout and Referencing **Activity:** Examining clarity and coherence in final reports
10.	**Presentation** Presenting Technical Reports **Activity:** Planning, creating and digital presentation of reports
	Total Laboratory Hours 30 hours

Mode of assessment: Continuous Assessment/ FAT/ Assignments/ Quiz/ Presentations/ Oral examination

Recommended by Board of Studies	28.06.2021		
Aooroved by Academic Council	No. 63	Date	23.09.2021

BMAT101L	Calculus	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. Enhance to use technology to model the physical situations into mathematical problems, experiment, interpret results, and verify conclusions.

Course Outcomes

At the end of the course the student should be able to:
1. Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
3. Evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
4. Use special functions to evaluate various types of integrals.
5. Understand gradient, directional derivatives, divergence, curl, Green's, Stokes and Gauss Divergence theorems.

Module:1	**Single Variable Calculus**	**8 hours**

Differentiation- Extrema on an Interval Rolle's Theorem and the Mean value theorem-Increasing and decreasing functions.-First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution.

Module:2	**Multivariable Calculus**	**5 hours**

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.

Module:3	**Application of Multivariable Calculus**	**5 hours**

Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.

Module:4	**Multiple integrals**	**8 hours**

Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates.

Module:5	**Special Functions**	**6 hours**

Beta and Gamma functions–interrelation between beta and gamma functions-evaluation of multiple integrals using gamma and beta functions. Dirichlet's integral -Error functions complementary error functions.

Module:6	**Vector Differentiation**	**5 hours**

Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials. Statement of vector identities-simple problems.

Module:7	**Vector Integration**	**6 hours**

Line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.

Module:8	**Contemporary Topics**	**2 hours**

Guest lectures from Industry and, Research and Development Organizations

	Total Lecture hours:	**45 hours**

Text Book

1. George B.Thomas, D.Weir and J. Hass, Thomas Calculus, 2014, 13th edition, Pearson

Reference Books				
1.	Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India			
2.	B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers			
3.	John Bird, Higher Engineering Mathematics, 2017, 6th Edition, Elsevier Limited.			
4.	James Stewart, Calculus: Early Transcendental, 2017, 8th edition, Cengage Learning.			
5.	K.A.Stroud and Dexter J. Booth, Engineering Mathematics, 2013, 7th Edition, Palgrave Macmillan.			
Mode of Evaluation: CAT, Assignment, Quiz and FAT				
Recommended by Board of Studies		24.06.2021		
Approved by Academic Council		No. 63	Date	23.09.2021

BMAT101P	**Calculus Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences
2. To visualize mathematical functions and its related properties.
3. To evaluate single and multiple integrals and understand it graphically.

Course Outcomes

At the end of the course the student should be able to:

1. Demonstrate MATLAB code for challenging problems in engineering
2. Using plots/displays, interpret and illustrate elementary mathematical functions and procedures.

Indicative Experiments

1.	Introduction to MATLAB through matrices and general Syntax
2.	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB
3.	Evaluating Extremum of a single variable function
4.	Understanding integration as Area under the curve
5.	Evaluation of Volume by Integrals (Solids of Revolution)
6.	Evaluating maxima and minima of functions of two variables
7.	Applying Lagrange multiplier optimization method
8.	Evaluating Volume under surfaces
9.	Evaluating triple integrals
10.	Evaluating gradient, curl and divergence
11.	Evaluating line integrals in vectors
12.	Applying Green's theorem to real world problems
	Total Laboratory Hours **30 hours**

Text Book

1.	Brian H. Hahn, Daniel T. Valentine, Essential MATLAB for Engineers and Scientists, Academic Press, 7th edition, 2019.

Reference Books

1.	Amos Gilat, MATLAB: An Introduction with Applications, Wiley, 6/e, 2016.
2	Maritn Brokate, Pammy Manchanda, Abul Hasan Siddiqi, Calculus for Scientists and Engineers, Springer, 2019

Mode of assessment: DA and FAT

Recommended by Board of Studies	24.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BMAT102L	Differential Equations and Transforms	L	T	P	C
		3	1	0	4
Pre-requisite	**BMAT101L, BMAT101P**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart the knowledge of Laplace transform, an important transform techniques for Engineers which requires knowledge of integration.
2. Presenting the elementary notions of Fourier series, this is vital in practical harmonic analysis.
3. Enriching the skills in solving initial and boundary value problems.
4. Impart the knowledge and application of difference equations and the Z-transform in discrete systems that are inherent in natural and physical processes.

Course Outcomes

At the end of the course the student should be able to:

1. Find solution for second and higher order differential equations, formation and solving partial differential equations.
2. Understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution.
3. Employ the tools of Fourier series and Fourier transforms.
4. Know the techniques of solving differential equations and partial differential equations.
5. Know the Z-transform and its application in population dynamics and digital signal processing.

Module:1	**Ordinary Differential Equations (ODE)**	**6 hours**

Second order non- homogenous differential equations with constant coefficients- Differential equations with variable coefficients- method of undetermined coefficients-method of Variation of parameters-Solving Damped forced oscillations and LCR circuit theory problems.

Module:2	**Partial Differential Equations (PDE)**	**5 hours**

Formation of partial differential equations – Singular integrals — Solutions of standard types of first order partial differential equations – Lagrange's linear equation-Method of separation of variables

Module:3	**Laplace Transform**	**7 hours**

Definition- Properties of Laplace transform-Laplace transform of standard functions - Laplace transform of periodic functions-Unit step function-Impulse function. Inverse Laplace transform-Partial fractions method and by Convolution theorem..

Module:4	**Solution to ODE and PDE by Laplace transform**	**7 hours**

Solution of ODE's – Non-homogeneous terms involving Heaviside function, Impulse function - Solving Non-homogeneous system using Laplace transform - solution to First order PDE by Laplace transform.

Module:5	**Fourier Series**	**6 hours**

Fourier series - Euler's formulae- Dirichlet's conditions - Change of interval - Half range series – RMS value – Parseval's identity.

Module:6	**Fourier Transform**	**6 hours**

Complex Fourier transform - properties - Relation between Fourier and Laplace Transforms- Fourier sine and cosine transforms – Parseval's identity- Convolution Theorem and simple applications to solve PDE.

Module:7	**Z-Transform**	**6 hours**

Definition of Z-transform and Inverse Z-transform - Standard functions - Partial fractions and

convolution method. Difference equation - first and second order difference equations with constant coefficients - solution of simple difference equations using Z-transform.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours: **Total Tutorial hours :**	**45 hours** **15 hours**

Text Book(s)

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, John Wiley India.
2. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers.

Reference Books

1. Michael D. Greenberg, Advanced Engineering Mathematics, 2006, 2nd Edition, Pearson Education, Indian edition.
2. A First Course in Differential Equations with Modelling Applications, Dennis Zill, 2018, 11th Edition, Cengage Publishers.

Mode of Evaluation: CAT, written assignment, Quiz, FAT

Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BMAT201L	Complex Variables and Linear Algebra	L	T	P	C
		3	1	0	4
Pre-requisite	**BMAT102L**	**Syllabus version**			
		1.0			

Course Objectives

1. To present comprehensive, compact, and integrated treatment of one of the most important branches of applied mathematics namely Complex variables to the engineers and the scientists.
2. To present comprehensive, compact, and integrated treatment of another most important branches of applied mathematics namely Linear Algebra to the engineers and the scientists.
3. To provide students with a framework of the concepts that will help them to analyse deeply about many complex problems.

Course Outcomes

At the end of the course the student should be able to

1. Construct analytic functions and find complex potential of fluid flow and electric fields.
2. Find the image of straight lines by elementary transformations and to express analytic functions in power series.
3. Evaluate real integrals using techniques of contour integration.
4. Use the power of inner product and norm for analysis.
5. Use matrices and transformations for solving engineering problems.

Module:1	**Analytic Functions**	**7hours**

Complex variable - Analytic functions and Cauchy – Riemann equations; Laplace equation and Harmonic functions; Construction of Harmonic conjugate and analytic functions; Applications of analytic functions to fluid-flow and electric field problems.

Module:2	**Conformal and Bilinear transformations**	**7 hours**

Conformal mapping - Elementary transformations; Translation, Magnification, Rotation, Inversion; Exponential and Square transformations ($w = e^z$, z^2); Bilinear transformation; Cross-ratio-Images of the regions bounded by straight lines under the above transformations;

Module:3	**Complex Integration**	**7 hours**

Functions given by Power Series - Taylor and Laurent series-Singularities - Poles – Residues; Integration of a complex function along a contour; Statements of Cauchy-Goursat theorem- Cauchy's integral formula-Cauchy's residue theorem-Evaluation of real integrals-Indented contour integral.

Module:4	**Vector Spaces**	**6 hours**

Vector space – subspace; linear combination - span - linearly dependent – Independent – bases; Dimensions; Finite dimensional vector space. Row and column spaces; Rank and nullity.

Module:5	**Linear Transformations**	**6 hours**

Linear transformations – Basic properties; Invertible linear transformation; Matrices of linear transformations; Vector space of linear transformations; Change of bases; Similarity.

Module:6	**Inner Product Spaces**	**5 hours**

Dot products and inner products; Lengths and angles of vectors; Matrix representations of inner products; Gram - Schmidt – Orthogonalization.

Module:7	**Matrices and System of Equations**	**5 hours**

Eigenvalues and Eigen vectors; Properties of Eigenvalues and Eigen vectors; Cayley-Hamilton theorem; System of linear equations; Gaussian elimination and Gauss Jordan methods.

Module:8	**Contemporary issues:**	**2 hours**

	Total Lecture hours:	**45 hours**
	Total Tutorial hours :	**15 hours**

Text Book(s)

1. G. Dennis Zill, Patrick D. Shanahan, A first course in complex analysis with applications, 2013, 3rd Edition, Jones and Bartlett Publishers Series in Mathematics.
2. Jin Ho Kwak, Sungpyo Hong, Linear Algebra, 2004, Second edition, Springer.

Reference Books

1. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, John Wiley & Sons (Wiley student Edition).
2. Michael, D. Greenberg, Advanced Engineering Mathematics, 2006, 2nd Edition, Pearson Education.
3. Bernard Kolman, David, R. Hill, Introductory Linear Algebra - An applied first course, 2011, 9th Edition Pearson Education.
4. Gilbert Strang, Introduction to Linear Algebra, 2015, 5th Edition, Cengage Learning
5. B.S. Grewal, Higher Engineering Mathematics, 2020, 44th Edition, Khanna Publishers.

Mode of Evaluation: Digital Assignments(Solutions by using soft skill), Quiz, Continuous Assessments, Final Assessment Test.

Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BMAT202L	Probability and Statistics	L	T	P	C
		3	0	0	3
Pre-requisite	BMAT101L, BMAT101P	**Syllabus version**			
		1.0			

Course Objectives :

1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
2. To analyze distributions and relationship of real-time data.
3. To apply estimation and testing methods to make inference and modelling techniques for decision making.

Course Outcome :

At the end of the course the student should be able to:

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analyzing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analyzing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.

Module:1	**Introduction to Statistics**	**6 hours**

Statistics and data analysis; Measures of central tendency; Measure of Dispersion, Moments-Skewness-Kurtosis (Concepts only).

Module:2	**Random variables**	**8 hours**

Random variables- Probability mass function, distribution and density functions-Joint probability distribution and Joint density functions; Marginal, Conditional distribution and Density functions- Mathematical expectation and its properties- Covariance, Moment generating function.

Module:3	**Correlation and Regression**	**4 hours**

Correlation and Regression – Rank Correlation; Partial and Multiple correlation; Multiple regression.

Module:4	**Probability Distributions**	**7 hours**

Binomial distribution; Poisson distributions; Normal distribution; Gamma distribution; Exponential distribution; Weibull distribution.

Module:5	**Hypothesis Testing-I**	**4 hours**

Testing of hypothesis –Types of errors - Critical region, Procedure for testing of hypothesis- Large sample tests- Z test for Single Proportion- Difference of Proportion- Mean and difference of means.

Module:6	**Hypothesis Testing-II**	**9 hours**

Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – One way-Two way-Three way classifications - CRD-RBD- LSD.

Module:7	**Reliability**	**5 hours**

Basic concepts- Hazard function-Reliabilities of series and parallel systems- System

Reliability - Maintainability-Preventive and repair maintenance- Availability.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book:

1. R. E. Walpole, R. H. Myers, S. L. Mayers, K. Ye, Probability and Statistics for engineers and scientists, 2012, 9th Edition, Pearson Education.

Reference Books

1. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, 2016, 6th Edition, John Wiley & Sons.
2. E. Balagurusamy, Reliability Engineering, 2017, Tata McGraw Hill, Tenth reprint.
3. J. L. Devore, Probability and Statistics, 2012, 8th Edition, Brooks/Cole, Cengage Learning.
4. R. A. Johnson, Miller Freund's, Probability and Statistics for Engineers, 2011, 8th edition, Prentice Hall India.
5. Bilal M. Ayyub, Richard H. McCuen, Probability, Statistics and Reliability for Engineers and Scientists, 2011, 3rd edition, CRC press.

Mode of Evaluation: Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.

Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BMAT202P	Probability and Statistics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**BMAT101L, BMAT101P**	**Syllabus version**			
		1.0			

Course Objectives:

1. To enable the students for having experimental knowledge of basic concepts of statistics using R programming.
2. To study the relationship of real-time data and decision making through testing methods using R.
3. To make students capable to do experimental research using statistics in various engineering problems.

Course Outcomes:

At the end of the course the student should be able to:

1. Demonstrate R programming for statistical data.
2. Carry out appropriate analysis of statistical methods through experimental techniques using R.

Indicative Experiments

1.	Introduction: Understanding Data types; importing/exporting data	Total Laboratory hours: 30
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations	
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination	
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficients of determination	
5.	Fitting the probability distributions: Binomial distribution	
6.	Normal distribution, Poisson distribution	
7.	Testing of hypothesis for one sample mean and proportion from real time problems	
8.	Testing of hypothesis for two sample means and proportion from real time problems	
9.	Applying the t-test for independent and dependent samples	
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design, Latin square Design	

Text Book

1. Statistical analysis with R by Joseph Schmuller, John wiley and sons Inc., New Jersey 2017.

Reference Books:

1. The Book of R: A First course in Programming and Statistics, by Tilman M Davies, William Pollock, 2016.
2. R for Data Science, by Hadley Wickham and Garrett Grolemund, O' Reilly Media Inc., 2017.

Mode of assessment: Continuous assessment, FAT / Oral examination and others

Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

Course Code	Course Title	L	T	P	C
BPHY101L	Engineering Physics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To explain the dual nature of radiation and matter.
2. To apply Schrödinger's equation to solve finite and infinite potential problems and apply quantum ideas at the nanoscale.
3. To understand the Maxwell's equations for electromagnetic waves and apply the concepts to semiconductors for engineering applications.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the phenomenon of waves and electromagnetic waves.
2. Understand the principles of quantum mechanics.
3. Apply quantum mechanical ideas to subatomic domain.
4. Appreciate the fundamental principles of a laser and its types.
5. Design a typical optical fiber communication system using optoelectronic devices.

Module:1	**Introduction to waves**	**7 hours**
Waves on a string - Wave equation on a string (derivation) - Harmonic waves- reflection and transmission of waves at a boundary (Qualitative) - Standing waves and their eigenfrequencies.		
Module:2	**Electromagnetic waves**	**7 hours**
Physics of divergence - gradient and curl - Qualitative understanding of surface and volume integral - Maxwell Equations (Qualitative) - Displacement current - Electromagnetic wave equation in free space - Plane electromagnetic waves in free space - Hertz's experiment.		
Module:3	**Elements of quantum mechanics**	**6 hours**
Need for Quantum Mechanics: Idea of Quantization (Planck and Einstein) - Compton effect (Qualitative) – de Broglie hypothesis - - Davisson-Germer experiment - Wave function and probability interpretation - Heisenberg uncertainty principle - Schrödinger wave equation (time dependent and time independent).		
Module:4	**Applications of quantum mechanics**	**5 hours**
Eigenvalues and eigenfunction of particle confined in one dimensional box - Basics of nanophysics - Quantum confinement and nanostructures - Tunnel effect (qualitative) and scanning tunneling microscope.		
Module:5	**Lasers**	**6 hours**
Laser characteristics - spatial and temporal coherence - Einstein coefficients and their significance - Population inversion - two, three and four level systems - Pumping schemes - threshold gain coefficient - Components of a laser - He-Ne, Nd:YAG and CO2 lasers and their engineering applications.		
Module:6	**Propagation of EM waves in optical fibers**	**6 hours**
Introduction to optical fiber communication system - light propagation through fibers - Acceptance angle - Numerical aperture - V-parameter - Types of fibers – Attenuation - Dispersion-intermodal and intramodal. Application of fiber in medicine - Endoscopy.		
Module:7	**Optoelectronic devices**	**6 hours**
Introduction to semiconductors - direct and indirect bandgap – Sources: LED and laser diode, Photodetectors: PN and PIN.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Textbook(s)	
1.	H. D. Young and R. A. Freedman, University Physics with Modern Physics, 2020, 15th Edition, Pearson, USA.
2.	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011, 1st Edition, Pearson, USA
Reference Books	
1.	H. J. Pain, The Physics of vibrations and waves, 2013, 6th Edition, Wiley Publications, India.
2.	R. A. Serway, J. W. Jewett, Jr, Physics for Scientists and Engineers with Modern Physics, 2019, 10th Edition, Cengage Learning, USA.
3.	K. Krane, Modern Physics, 2020, 4th Edition, Wiley Edition, India.
4.	M.N.O. Sadiku, Principles of Electromagnetics, 2015, 6th Edition, Oxford University Press, India.
5.	W. Silfvast, Laser Fundamentals, 2012, 2nd Edition, Cambridge University Press, India.
Mode of Evaluation: Written assignment, Quiz, CAT and FAT	

Recommended by Board of Studies	26-06-2021		
Approved by Academic Council	No. 63	Date	23-09-2021

BPHY101P	**Engineering Physics Lab**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
Pre-requisite	**12th or equivalent**	**Syllabus version**			
		1.0			

Course Objectives

To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the dual nature of radiation and matter by means of experiments.
2. Get hands-on experience on the topics of quantum mechanical ideas in the laboratory.
3. Apply low power lasers in optics and optical fiber related experiments.

Indicative Experiments	
1.	To determine the dependence of fundamental frequency with the length and tension of a stretched string using sonometer.
2.	To determine the characteristics of EM waves using Hertz experiment
3.	To determine the wavelength of laser source (He-Ne laser and diode lasers of different wavelengths) using diffraction grating
4.	To demonstrate the wave nature of electron by diffraction through graphite sheet
5.	To determine the Planck's constant using electroluminescence process
6.	To numerically demonstrate the discrete energy levels and the wavefunctions using Schrödinger equation (e.g., particle in a box problem can be given as an assignment)
7.	To determine the refractive index of a prism using spectrometer (angle of prism will be given)
8.	To determine the efficiency of a solar cell
9.	To determine the acceptance angle and numerical aperture of an optical fiber
10.	To demonstrate the phase velocity and group velocity (simulation)
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous assessment / FAT / Oral examination

Recommended by Board of Studies	26.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BSTS101P	Quantitative Skills Practice I	L	T	P	C
		0	0	3	1.5
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. To enhance the logical reasoning skills of the students and help them improve problem-solving abilities
2. To acquire skills required to solve quantitative aptitude problems
3. To boost the verbal ability of the students for academic and professional purposes

Course Outcomes:

1. Exhibit sound knowledge to solve problems of Quantitative Aptitude
2. Demonstrate ability to solve problems of Logical Reasoning
3. Display the ability to tackle questions of Verbal Ability

Module:1	**Logical Reasoning**	**5 hours**

Word group categorization questions
Puzzle type class involving students grouping words into right group orders of logical sense
Cryptarithmetic

Module:2	**Data arrangements and Blood relations**	**6 hours**

Linear Arrangement - Circular Arrangement - Multi-dimensional Arrangement - Blood Relations

Module:3	**Ratio and Proportion**	**6 hours**

Ratio - Proportion - Variation - Simple equations - Problems on Ages - Mixtures and alligations

Module:4	**Percentages, Simple and Compound Interest**	**6 hours**

Percentages as Fractions and Decimals - Percentage Increase / Decrease - Simple Interest - Compound Interest - Relation Between Simple and Compound Interest

Module:5	**Number System**	**6 hours**

Number system- Power cycle - Remainder cycle - Factors, Multiples - HCF and LCM

Module:6	**Essential grammar for Placement**	**7 hours**

- Prepositions
- Adjectives and Adverbs
- Tense
- Speech and Voice
- Idioms and Phrasal Verbs
- Collocations, Gerunds and Infinitives
- Definite and Indefinite Articles
- Omission of Articles
- Prepositions
- Compound Prepositions and Prepositional Phrases
- Interrogatives

Module:7	**Reading Comprehension for Placement**	**3 hours**

Types of questions - Comprehension strategies - Practice exercises

Module:8	**Vocabulary for Placement**	**6 hours**

Exposure to questions related to Synonyms – Antonyms – Analogy - Confusing words - Spelling correctness

	Total Lecture hours:	**45 hours**

Text Book(s)

1. SMART. (2018). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2. Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd (Ed.). New Delhi: S. Chand Publishing.

3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.			
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.			
Reference Books				
1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.			
Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)				
Recommended by Board of Studies		28.06.2021		
Approved by Academic Council		No. 63	Date	23.09.2021

BSTS102P	Quantitative Skills Practice II	L	T	P	C
		0	0	3	1.5
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. Help to trigger the students' logical thinking skills and apply it in real-life scenarios
2. Learn to deploy the strategies of solving quantitative ability problems
3. To expand the verbal ability of students
4. Assist to run the gamut of employability skills

Course Outcomes:

1. Become proficient in interacting and using decision making models effectively
2. Help to understand the given concepts expressly to deliver an impactful presentation
3. Acquire knowledge of solving quantitative aptitude and verbal ability questions effortlessly

Module:1	**Logical Reasoning puzzles - Advanced**	**2 hours**

Advanced puzzles:

- Sudoku
- Mind-bender style word statement puzzles
- Anagrams
- Rebus puzzles

Module:2	**Logical connectives, Syllogism and Venn diagrams**	**2 hours**

Logical Connectives - Advanced Syllogisms - 4, 5, 6 and other multiple statement problems - Challenging Venn Diagram questions: Set theory

Module:3	**Permutation, Combination and Probability - Advanced**	**4 hours**

Fundamental Counting Principle- Permutation and Combination - Computation of Permutation - Advanced problems - Circular Permutations - Computation of Combination - Advanced problems -Advanced probability

Module:4	**Quantitative Aptitude**	**6 hours**

Logarithms, Progressions, Geometry and Quadratic equations - Advanced

- Logarithm
- Arithmetic Progression
- Geometric Progression
- Geometry
- Mensuration
- Coded inequalities
- Quadratic Equations

Concepts followed by advanced questions of CAT level

Module:5	**Image interpretation**	**2 hours**

Image interpretation: Methods - Exposure to image interpretation questions through brainstorming and practice

Module:6	**Critical Reasoning - Advanced**	**3 hours**

Concepts of Critical Reasoning - Exposure to advanced questions of GMAT level

Module:7	**Recruitment Essentials**	**8 hours**

Mock interviews

Cracking other kinds of interviews

Skype/ Telephonic interviews Panel interviews Stress interviews **Guesstimation** 1. Best methods to approach Guesstimation questions 2. Practice with impromptu interview on Guesstimation questions **Case studies/ situational interview** 1. Scientific strategies to answer case study and situational interview questions 2. Best ways to present cases 3. Practice on presenting cases and answering situational interviews asked in recruitment rounds		
Module:8	**Problem solving and Algorithmic skills**	**18 hours**
Logical methods to solve problem statements in Programming - Basic algorithms introduced		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	SMART. (2018). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2.	Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd (Ed.). New Delhi: S. Chand Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.

Reference Books

1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

Course Code	Course Title	L	T	P	C
BSTS201P	Qualitative Skills Practice - I	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To enhance the logical reasoning skills of students and improve problem-solving abilities
2. To strengthen the ability of solving quantitative aptitude problems
3. To enrich the verbal ability of the students for academic purposes

Course Outcomes:

1. Become experts in solving problems of quantitative Aptitude
2. Learn to defend and critique concepts of logical reasoning
3. Integrate and display verbal ability effectively

Module:1	**Lessons on excellence**	**2 hours**

Skill introspection - Skill acquisition - consistent practice

Module:2	**Thinking Skill**	**6 hours**

- Problem Solving
- Critical Thinking
- Lateral Thinking

Rebus puzzles, and word-link builder questions

Module:3	**Logical Reasoning**	**6 hours**

- Coding and Decoding
- Series
- Analogy
- Odd Man Out
- Visual Reasoning

Module:4	**Sudoku puzzles**	**3 hours**

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Module:5	**Attention to detail**	**3 hours**

Picture and word driven Qs to develop attention to detail as a skill

Module:6	**Quantitative Aptitude**	**14 hours**

Speed Maths

- Addition and Subtraction of bigger numbers
- Square and square roots
- Cubes and cube roots
- Vedic maths techniques
- Multiplication Shortcuts
- Multiplication of 3 and higher digit numbers
- Simplifications
- Comparing fractions
- Shortcuts to find HCF and LCM
- Divisibility tests shortcuts

Algebra and functions		
Module:7	**Verbal Ability**	**6 hours**
Grammar challenge A practice paper with sentence based and passage-based questions on grammar discussed - Nouns and Pronouns, Verbs, Subject-Verb Agreement, Pronoun-Antecedent Agreement, Punctuations **Verbal reasoning**		
Module:8	**Recruitment Essentials**	**5 hours**
Looking at an engineering career through the prism of an effective resume • Importance of a resume - the footprint of a person's career achievements • Designing an effective resume • An effective resume vs. a poor resume • Skills you must build starting today the requisite? • How does one build skills **Impression Management** Getting it right for the interview: • Grooming, dressing • Body Language and other non-verbal signs • Displaying the right behaviour		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	SMART. (2018). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2.	Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd (Ed.). New Delhi: S. Chand Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt.Ltd.
Reference Books	
1.	Sharma Arun. (2016). *Quantitative Aptitude*, 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
BSTS202P	Qualitative Skills Practice - II	0	0	3	1.5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To apply critical thinking skills to related to their subject matter
2. To demonstrate competency in verbal, quantitative and reasoning aptitude
3. To produce good written skills for effective communication

Course Outcomes:

1. Apply critical thinking skills to problems solving related to their subject matter
2. Demonstrate competency in verbal, quantitative and reasoning aptitude
3. Display good written skills for use in academic and professional scenarios

Module:1	Logical Reasoning	5 hours

- Clocks
- Calendars
- Direction Sense
- Cubes

Practice on advanced problems

Module:2	Data interpretation and Data sufficiency - Advanced	5 hours

- Advanced Data Interpretation and Data Sufficiency questions of CAT level
- Multiple chart problems
- Caselet problems

Module:3	Time and work– Advanced	5 hours

- Work with different efficiencies
- Pipes and cisterns: Multiple pipe problems
- Work equivalence
- Division of wages
- Advanced application problems with complexity in calculating total work

Module:4	Time, Speed and Distance - Advanced	5 hours

- Relative speed
- Advanced Problems based on trains
- Advanced Problems based on boats and streams
- Advanced Problems based on races

Module:5	Profit and loss, Partnerships and averages - Advanced	5 hours

- Partnership
- Averages
- Weighted average
- Advanced problems discussed

Module:6	Number system - Advanced	4 hours

Advanced application problems on Numbers involving HCF, LCM, divisibility tests, remainder and power cycles.		
Module:7	**Verbal Ability**	**13hours**

Sentence Correction - Advanced

- Subject-Verb Agreement
- Modifiers
- Parallelism
- Pronoun-Antecedent Agreement
- Verb Time Sequences
- Comparisons
- Prepositions
- Determiners

Quick introduction to 8 types of errors followed by exposure to GMAT level questions

Sentence Completion and Para-jumbles - Advanced

- Pro-active thinking
- Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues)
- Fixed jumbles
- Anchored jumbles

Practice on advanced GRE/ GMAT level questions

Reading Comprehension – Advanced

Exposure to RCs of the level of GRE/ GMAT relating to a wide variety of subjects

Module:8	**Writing skills for Placement**	**3 hours**

Essay writing

- Idea generation for topics
- Best practices
- Practice and feedback

	Total Lecture hours:	**45 hours**

Text Book(s)

1.	SMART. (2018). *Place Mentor* 1st (Ed.). Chennai: Oxford University Press.
2.	Aggarwal R.S. (2017). *Quantitative Aptitude for Competitive Examinations* 3rd (Ed.). New Delhi: S. Chand Publishing.
3.	FACE. (2016). *Aptipedia Aptitude Encyclopedia* 1st (Ed.). New Delhi: Wiley Publications.
4.	ETHNUS. (2016). *Aptimithra,*1st (Ed.) Bangalore: McGraw-Hill Education Pvt. Ltd.

Reference Books

1.	Sharma Arun. (2016). *Quantitative Aptitude,* 7th(Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Mode of evaluation: CAT, Assessments and FAT (Computer Based Test)			
Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

DISCIPLINE-LINKED ENGINEERING SCIENCES

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

Discipline Linked Engineering Sciences

Course Code	Course Title	L	T	P	C
BECE102L	Digital Systems Design	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. Provide an understanding of Boolean algebra and logic functions.
2. Develop the knowledge of combinational and sequential logic circuit design.
3. Design and model the data path circuits for digital systems.
4. Establish a strong understanding of programmable logic.
5. Enable the student to design and model the logic circuits using Verilog HDL.

Course Outcome

At the end of the course the student will be able to

1. Optimize the logic functions using and Boolean principles and K-map.
2. Model the Combinational and Sequential logic circuits using Verilog HDL.
3. Design the various combinational logic circuits and data path circuits.
4. Analyze and apply the design aspects of sequential logic circuits.
5. Analyze and apply the design aspects of Finite state machines.
6. Examine the basic architectures of programmable logic devices.

Module:1	Digital Logic	8 hours

Boolean Algebra: Basic definitions, Axiomatic definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Simplification of Boolean functions. Gate-Level Minimization: The Map Method (K-map up to 4 variable), Product of Sums and Sum of Products Simplification, NAND and NOR Implementation. Logic Families: Digital Logic Gates, TTL and CMOS logic families.

Module:2	Verilog HDL	5 hours

Lexical Conventions, Ports and Modules, Operators, Dataflow Modelling, Gate Level Modelling, Behavioural Modeling, Test Bench.

Module:3	Design of Combinational Logic Circuits	8 hours

Design Procedure, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Decoders, Encoders, Multiplexers, De-multiplexers, Parity generator and checker, Applications of Decoder, Multiplexer and De-multiplexer. Modeling of Combinational logic circuits using Verilog HDL.

Module:4	Design of data path circuits	6 hours

N-bit Parallel Adder/Subtractor, Carry Look Ahead Adder, Unsigned Array Multiplier, Booth Multiplier, 4-Bit Magnitude comparator. Modeling of data path circuits using Verilog HDL.

Module:5	Design of Sequential Logic Circuits	8 hours

Latches, Flip-Flops - SR, D, JK & T, Buffer Registers, Shift Registers - SISO, SIPO, PISO, PIPO, Design of synchronous sequential circuits: state table and state diagrams, Design of counters: Modulo-n, Johnson, Ring, Up/Down, Asynchronous counter. Modeling of sequential logic circuits using Verilog HDL.

Module:6	Design of FSM	4 hours

Finite state Machine(FSM):Mealy FSM and Moore FSM , Design Example : Sequence detection, Modeling of FSM using Verilog HDL.

Module:7	Programmable Logic Devices	4 hours

Types of Programmable Logic Devices: PLA, PAL, CPLD, FPGA Generic Architecture.

Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Textbook(s)	
1.	M. Morris Mano and Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL and System Verilog, 2018, 6th Edition, Pearson Pvt. Ltd.
Reference Books	
1.	Ming-Bo Lin, Digital Systems Design and Practice: Using Verilog HDL and FPGAs, 2015, 2nd Edition, Create Space Independent Publishing Platform.
2.	Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2009, 2nd edition, Prentice Hall of India Pvt. Ltd.
3.	Stephen Brown and ZvonkoVranesic, Fundamentals of Digital Logic with Verilog Design, 2013, 3rd Edition, McGraw-Hill Higher Education.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	14-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BECE102P	Digital Systems Design Lab	0	0	2	1
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objective

- To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcome

At the end of the course the student will be able to

1. Design, simulate and synthesize combinational logic circuits, data path circuits and sequential logic circuits using Verilog HDL.
2. Design and implement FSM on FPGA.
3. Design and implement small digital systems on FPGA.

Indicative Experiments

1.	Characteristics of Digital ICs, Realization of Boolean expressions	**2 hours**
2.	Design and Verilog modeling of Combinational Logic circuits	**4 hours**
3.	Design and Verilog modeling of various data path elements - Adders	**2 hours**
4.	Design and Verilog modeling of various data path elements - Multipliers	**2 hours**
5.	Implementation of combinational circuits – (FPGA / Trainer Kit)	**2 hours**
6.	Implementation of data path circuit - (FPGA / Trainer Kit)	**2 hours**
7.	Design and Verilog modeling of simple sequential circuits like Counters and Shift registers	**2 hours**
8.	Design and Verilog modeling of complex sequential circuits	**2 hours**
9.	Implementation of Sequential circuits - (FPGA / Trainer Kit)	**2 hours**
10.	Design and Verilog modeling of FSM based design – Serial Adder	**2 hours**
11.	Design and Verilog modeling of FSM based design – Traffic Light Controller / Vending Machine	**4 hours**
12.	Design of ALU	**4 hours**
	Total Laboratory Hours	**30 hours**

Mode of Assessment: Continuous Assessment and Final Assessment Test

Recommended by Board of Studies	14-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BECE204L	Microprocessors and Microcontrollers	3	0	0	3
Pre-requisite	BECE102L	Syllabus version			
		1.0			

Course Objectives:

1. To acquaint students with architectures of Intel microprocessors, microcontroller and ARM processors.
2. To familiarize the students with assembly language programming in 8051 microcontroller and ARM processor.
3. To interface peripherals and I/O devices with the 8051 microcontroller.

Course Outcome:

At the end of the course, the student should be able to

1. Comprehend the various microprocessors including Intel Pentium Processors
2. Infer the architecture and Programming of Intel 8086 Microprocessor.
3. Comprehend the architectures and programming of 8051 microcontroller.
4. Deploy the implementation of various peripherals such as general purpose input/ output, timers, serial communication, LCD, keypad and ADC with 8051 microcontroller
5. Infer the architecture of ARM Processor
6. Develop the simple application using ARM processor.

Module:1	Overview of Microprocessors	3 hours

Introduction to Microprocessors, 8-bit/16-bit Microprocessor, Overview of Intel Pentium, I (i3, i5, i7) Series Processor.

Module:2	Microprocessor Architecture and Interfacing: Intel x86	8 hours

16-bit Microprocessor: 8086 - Architecture and Addressing modes, Memory Segmentation, Instruction Set, Assembly Language Processing, Programming with DOS and BIOS function calls, minimum and maximum mode configuration, Programmable Peripheral Interface (8255), Programmable Timer Controller (8254), Memory Interface to 8086.

Module:3	Microcontroller Architecture: Intel 8051	7 hours

Microcontroller 8051 - Organization and Architecture, RAM-ROM Organization, Machine Cycle, Instruction set: Addressing modes, Data Processing - Stack, Arithmetic, Logical; Branching – Unconditional and Conditional, Assembly programming.

Module:4	Microcontroller 8051 Peripherals	5 hours

I/O Ports, Timers-Counters, Serial Communication and Interrupts.

Module:5	I/O interfacing with Microcontroller 8051	7 hours

LCD, LED, Keypad, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Sensor with Signal Conditioning Interface.

Module:6	ARM Processor Architecture	5 hours

ARM Design Philosophy; Overview of ARM architecture; States [ARM, Thumb, Jazelle]; Registers, Modes; Conditional Execution; Pipelining; Vector Tables; Exception handling.

Module:7	ARM Instruction Set	8 hours

ARM Instruction- data processing instructions, branch instructions, load store instructions, SWI Instruction, Loading instructions, conditional Execution, Assembly Programming.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	A.K. Ray, K.M. Bhurchandi, Advanced Microprocessor and Peripherals, 2012, 2nd Edition, Tata McGraw-Hill, India.	
2.	Mohammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems, 2014, 2nd Edition, Pearson, India.	
Reference Books		
1.	Muhammad Ali Mazidi, ARM Assembly Language Programming & Architecture: 1, 2016, 2nd Edition, Microdigitaled.com	
2.	A. Nagoor Kani, 8086 Microprocessors and its Applications, 2017, Second Edition, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, India.	
3.	Joseph Yiu, The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors, 2015, 2nd Edition, Elsevier Science & Technology, UK	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies	14-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
BECE204P	Microprocessors and Microcontrollers Lab	0	0	2	1
Pre-requisite	BECE102L	Syllabus version			
		1.0			

Course Objectives

1. To familiarize the students with assembly language programming using microprocessor and microcontroller.
2. To familiarize the students with Embedded C language programming using microcontroller.
3. To interface peripherals and I/O devices with the microcontroller and microprocessor.

Course Outcome

Student will be able to

1. Showcase the skill, knowledge and ability of programming microcontroller and microprocessor using its instruction set.
2. Expertise with microcontroller and interfaces including general purpose input/ output, timers, serial communication, LCD, keypad and ADC.

Indicative Experiments [Experiments using 8086/8051/ARM]

1	Assembly language programming of Arithmetic/logical operations.	**6 hours**
2	Assembly language programming of memory operations.	**4 hours**
3	Assembly language programming/ Embedded C programming for interfacing the peripherals: General purpose input/ output, timers, serial communication, LCD, keypad and ADC.	**10 hours**
4	Hardware implementation of peripheral interfacing: General purpose input/ output, timers, serial communication, LCD, keypad and ADC.	**10 hours**
	Total Laboratory Hours	**30 hours**

Mode of Assessment: Continuous Assessment and Final Assessment Test

Recommended by Board of Studies	14-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

BMAT205L	Discrete Mathematics and Graph Theory	L	T	P	C
		3	1	0	4
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives:

1. To address the challenges of the relevance of lattice theoryand algebraic structures to computer science and engineering problems.
2. To use Counting techniques, in particular recurrence relations to computer science problems.
3. To understand the concepts of graph theory and related algorithm concepts.

Course Outcomes:

At the end of this course, students are expected to

1. Learn proof techniques and concepts of inference theory
2. Use algebraic structures in applications
3. Counting techniques in engineering problems.
4. Use lattice and Boolean algebra properties in Digital circuits.
5. Solve Science and Engineering problems using Graph theory.

Module:1	**Mathematical Logic**	**7 hours**

Statements and Notation-Connectives–Tautologies-Equivalence - Implications–Normal forms - The Theory of Inference for the Statement Calculus - Predicate Calculus - Inference Theory of the Predicate Calculus

Module:2	**Algebraic Structures**	**6 hours**

Semigroups and Monoids - Groups – Subgroups – Lagrange's Theorem Homomorphism – Properties-Group Codes.

Module:3	**Counting Techniques**	**6 hours**

Basics of counting - Pigeonhole principle - Permutations and combinations - Inclusion-exclusion principle - Recurrence relations - Solving recurrence relations - Generating functions-Solution to recurrence relations.

Module:4	**Lattices and Boolean algebra**	**6 hours**

Partially Ordered Relations -Lattices as Posets – Hasse Digram – Properties of Lattices – Boolean algebra-Properties of Boolean Algebra-Boolean functions.

Module:5	**Fundamentals of Graphs**	**6hours**

Basic Concepts of Graph Theory – Planar and Complete graph - Matrix representation of Graphs – Graph Isomorphism – Connectivity–Cut sets-Euler and Hamilton Paths–Shortest Path algorithms

Module:6	**Trees, Fundamental circuits, Cut sets**	**6 hours**

Trees – properties of trees – distance and centres in tree – Spanning trees – Spanning tree algorithms- Tree traversals- Fundamental circuits and cut-sets

Module:7	**Graph colouring, covering, Partitioning**	**6 hours**

Bipartite graphs - Chromatic number – Chromatic partitioning – Chromatic polynomial - matching – Covering– Four Colour problem.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
	Total Tutorial hours:	**15 hours**

Text Books:

1. Discrete Mathematical Structures with Applications to Computer Science, J .P. Trembley and R. Manohar, Tata McGraw Hill-35th reprint, 2017.
2. Graph theory with application to Engineering and Computer Science, NarasingDeo,

Prentice Hall India 2016.			
Reference Books:			
1. Discrete Mathematics and its applications, Kenneth H. Rosen, 8th Edition, Tata McGraw Hill, 2019. 2. Discrete Mathematical Structures, Kolman, R.C.Busby and S.C.Ross, 6th Edition, PHI, 2018. 3. Discrete Mathematics, Richard Johnsonbaugh, 8th Edition, Prentice Hall, 2017. 4. Discrete Mathematics, S. Lipschutz and M. Lipson, McGraw Hill Education (India) 2017. 5. Elements of Discrete Mathematics–A Computer Oriented Approach, C.L.Liu, Tata McGraw Hill, Special Indian Edition, 2017. 6.Introduction to Graph Theory, D. B. West, 3rd Edition, Prentice-Hall, Englewood Cliffs, NJ, 2015.			
Mode of Evaluation: CAT, Quizzes, Digital Assignments, FAT			
Recommended by Board of Studies	15.02.2022		
Approved by Academic Council	No. 65	Date	17-03-2022

DISCIPLINE CORE

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

BCSE202L	Data Structures and Algorithms	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart basic concepts of data structures and algorithms.
2. To differentiate linear, non-linear data structures and their operations.
3. To comprehend the necessity of time complexity in algorithms.

Course Outcomes

On completion of this course, students should be able to:

1. Understand the fundamental analysis and time complexity for a given problem.
2. Articulate linear, non-linear data structures and legal operations permitted on them.
3. Identify and apply suitable algorithms for searching and sorting.
4. Discover various tree and graph traversals.
5. Explicate hashing, heaps and AVL trees and realize their applications.

Module:1	**Algorithm Analysis**	**8 hours**

Importance of algorithms and data structures - Fundamentals of algorithm analysis: Space and time complexity of an algorithm, Types of asymptotic notations and orders of growth - Algorithm efficiency – best case, worst case, average case - Analysis of non-recursive and recursive algorithms - Asymptotic analysis for recurrence relation: Iteration Method, Substitution Method, Master Method and Recursive Tree Method.

Module:2	**Linear Data Structures**	**7 hours**

Arrays: 1D and 2D array- Stack - Applications of stack: Expression Evaluation, Conversion of Infix to postfix and prefix expression, Tower of Hanoi – Queue - Types of Queue: Circular Queue, Double Ended Queue (deQueue) - Applications – List: Singly linked lists, Doubly linked lists, Circular linked lists- Applications: Polynomial Manipulation.

Module:3	**Searching and Sorting**	**7 hours**

Searching: Linear Search and binary search – Applications.
Sorting: Insertion sort, Selection sort, Bubble sort, Counting sort, Quick sort, Merge sort - Analysis of sorting algorithms.

Module:4	**Trees**	**6 hours**

Introduction - Binary Tree: Definition and Properties - Tree Traversals- Expression Trees:- Binary Search Trees - Operations in BST: insertion, deletion, finding min and max, finding the k^{th} minimum element.

Module:5	**Graphs**	**6 hours**

Terminology – Representation of Graph – Graph Traversal: Breadth First Search (BFS), Depth First Search (DFS) - Minimum Spanning Tree: Prim's, Kruskal's - Single Source Shortest Path: Dijkstra's Algorithm.

Module:6	**Hashing**	**4 hours**

Hash functions - Separate chaining - Open hashing: Linear probing, Quadratic probing, Double hashing - Closed hashing - Random probing – Rehashing - Extendible hashing.

Module:7	**Heaps and AVL Trees**	**5 hours**

Heaps - Heap sort- Applications -Priority Queue using Heaps. AVL trees: Terminology, basic operations (rotation, insertion and deletion).

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1. Mark A. Weiss, Data Structures & Algorithm Analysis in C++, 4^{th} Edition, 2013, Pearson Education.

Reference Books			
1.	Alfred V. Aho, Jeffrey D. Ullman and John E. Hopcroft, Data Structures and Algorithms, 1983, Pearson Education.		
2.	Horowitz, Sahni and S. Anderson-Freed, Fundamentals of Data Structures in C, 2008, 2nd Edition, Universities Press.		
3.	Thomas H. Cormen, C.E. Leiserson, R L. Rivest and C. Stein, Introduction to Algorithms, 2009, 3rd Edition, MIT Press.		
Mode of Evaluation: CAT, Assignment, Quiz and FAT			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE202P	Data Structures and Algorithms Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart basic concepts of data structures and algorithms.
2. To differentiate linear, non-linear data structures and their operations.
3. To comprehend the necessity of time complexity in algorithms.

Course Outcomes

On completion of this course, students should be able to:

1. Apply appropriate data structures to find solutions to practical problems.
2. Identify suitable algorithms for solving the given problems.

Indicative Experiments

1.	Implementation of stack data structure and its applications
2.	Implementation of queue data structure and its applications
3.	Implementation linked list and its application
4.	Implementation of searching algorithms
5.	Implementation of sorting algorithms
6.	Binary Tree Traversal implementation
7.	Binary Search Tree implementation
8.	Graph Traversal – Depth First Search and Breadth First Search algorithm
9.	Minimum Spanning Tree – Prim's and Kruskal's algorithm
10.	Single Source Shortest Path Algorithm - Dijkstra's algorithm
	Total Laboratory Hours 30 hours

Text Book

1.	Mark A. Weiss, Data Structures & Algorithm Analysis in C++, 2013, 4th Edition, Pearson.

Reference Books

1.	Alfred V. Aho, Jeffrey D. Ullman and John E. Hopcroft, Data Structures and Algorithms, 1983, Pearson Education.
2.	Horowitz, Sahni and S. Anderson-Freed, Fundamentals of Data Structures in C, 2008, 2nd Edition, Universities Press.
3.	Thomas H. Cormen, C.E. Leiserson, R L. Rivest and C. Stein, Introduction to Algorithms, 2009, 3rd Edition, MIT Press.

Mode of assessment: Continuous assessments and FAT.

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
BCSE203E	Web Programming	1	0	4	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To convey the Internet and Its Application in Real world.
2. To introduce the fundamentals of web programming through HTML and CSS.
3. To establish the application of Javascript in designing interactive web pages.
4. To investigate various elements of ReactJS and design user interfaces to deploy in the real time.

Course Outcomes

At the end of this course students will be able to:

1. Apply various elements of HTML and CSS.
2. Design interactive web pages using JavaScript.
3. Create Dynamic Web Applications using ReactJS.
4. Deploy and host web applications in Local Servers or Cloud platforms.

Module:1	**Introduction**	**2 hours**

World wide web and its evolution - E-mail, Telnet, FTP, E–commerce, Cloud Computing, Video conferencing - Internet service providers, IP Address, URL, Domain Name Servers - Web Browsers, Search Engine -Web Server vs Application Server.

Module:2	**Hypertext Markup Language**	**2 hours**

HTML Tags, Structure, HTML Coding Conventions - Block Elements, Text Elements, Code-Related Elements, Character References - Lists, Images, section, article, and aside Elements - nav and a Elements - header and footer Elements.

Module:3	**Cascading Style Sheets**	**2 hours**

CSS Overview - CSS Rules, CSS Syntax and Style - Class Selectors, ID Selectors, span and div Elements - Cascading, style Attribute, style Container, External CSS Files - CSS Properties: Color Properties, Font Properties, line-height Property, Text Properties, Border Properties. Element Box, padding Property, margin Property - Hosting a Website and GIT.

Module:4	**JavaScript**	**3 hours**

Hello World Web Page - Buttons, Functions, Variables, Identifiers - Assignment Statements and Objects - Document Object Model, Forms: form Element, Controls, Text Control Accessing a Form's Control Values, reset and focus Methods – Event Handler Attributes: onchange, onmouseover, onmouseout.

Module:5	**Advanced JavaScript**	**2 hours**

While Loop, External JavaScript Files, do Loop, Radio Buttons, Checkboxes, for Loop - fieldset and legend Elements- Manipulating CSS with JavaScript- Using z-index to Stack Elements-Textarea Controls - Pull-Down Menus- List Boxes- Canvas and Drawing - Event Handler and Listener.

Module:6	**ReactJS**	**2 hours**

React Environment Setup - ReactJS Basics - React JSX - React Components: React Component API - React Component Life Cycle - React Constructors - React Dev Tools - React Native vs ReactJS.

Module:7	**Advanced ReactJS**	**2 hours**

React Dataflow: React State - React Props - React Props Validation - Styling React - Hooks and Routing - Deploying React - Case Studies for building dynamic web applications.

	Total Lecture hours:	**15 hours**

Text Book(s)

1. Dean, J., Web Programming with HTML5, CSS, and JavaScript. Jones & Bartlett Learning, 2018.

2.	Minnick, C. Beginning ReactJS foundations building user interfaces with ReactJS: An Approachable Guide, OReillly, 2022.
Reference Books	
1.	Harvey M Deitel, Paul J Deitel and Tem R Nieto, Internet and World Wide Web How to Program, Pearson, 6th Edition, 2020.
2.	Rebah, H.B., Boukthir, H. and Chedebois, A., Website Design and Development with HTML5 and CSS3. John Wiley & Sons, 2022.
Mode of Evaluation: Written Assignment, Quiz.	
Indicative Experiments	
1.	Explore various terminologies related to Internet (ISP, Email, Telnet, FTP, Web browsers, Search Engines)
2.	Experiment the use of basic HTML elements.
3.	Demonstrate the applications of Lists, Tables, Images, Section, article and aside elements.
4.	Investigate the various components of CSS.
5.	Develop web pages using HTML and various elements of CSS.
6	Designing simple dynamic webpages using Javascript.
7.	Build web pages using While Loop, External JavaScript Files, do Loop, Radio Buttons, Checkboxes, for Loop - fieldset and legend Elements.
8.	Manipulating CSS with JavaScript- Using z-index to Stack Elements-Textarea Controls - Pull-Down Menus- List Boxes- Canvas and Drawing - Event Handler and Listener.
9.	React Environment Setup - ReactJS Basics - React JSX - React Components: React Component API.
10.	Understand React Component Life Cycle and apply React Constructors - React Dev Tools - React Native vs ReactJS.
11.	Envisage React Dataflow: React State - React Props - React Props Validation - Styling React - Hooks and Routing.
12.	Deploying React - Case Studies for building dynamic web applications.
Total Laboratory Hours	**60 hours**
Text Book	
1.	Laura Lemay, Rafe Colburn and Jennifer Kyrnin, Mastering HTML, CSS and Javascript Web Publishing, BPB Publication, 1st Edition, 2016.
Reference Books	
1.	Alex Banks and Eve Porcello, Learning React: Functional Web Development with React and Redux, O'Reilly Publishers, 1st Edition, 2017.
Mode of assessment: Continuous Assessments, FAT	

Recommended by Board of Studies		26-07-2022	
Approved by Academic Council	No. 67	Date	08-08-2022

BCSE204L	Design and Analysis of Algorithms	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To provide mathematical foundations for analyzing the complexity of the algorithms
2. To impart the knowledge on various design strategies that can help in solving the real world problems effectively
3. To synthesize efficient algorithms in various engineering design situations

Course Outcomes

On completion of this course, student should be able to:

1. Apply the mathematical tools to analyze and derive the running time of the algorithms
2. Demonstrate the major algorithm design paradigms.
3. Explain major graph algorithms, string matching and geometric algorithms along with their analysis.
4. Articulating Randomized Algorithms.
5. Explain the hardness of real-world problems with respect to algorithmic efficiency and learning to cope with it.

Module:1	**Design Paradigms: Greedy, Divide and Conquer Techniques**	**6 hours**

Overview and Importance of Algorithms - Stages of algorithm development: Describing the problem, Identifying a suitable technique, Design of an algorithm, Derive Time Complexity, Proof of Correctness of the algorithm, Illustration of Design Stages - Greedy techniques: Fractional Knapsack Problem, and Huffman coding - Divide and Conquer: Maximum Subarray, Karatsuba faster integer multiplication algorithm.

Module:2	**Design Paradigms: Dynamic Programming, Backtracking and Branch & Bound Techniques**	**10 hours**

Dynamic programming: Assembly Line Scheduling, Matrix Chain Multiplication, Longest Common Subsequence, 0-1 Knapsack, TSP- Backtracking: N-Queens problem, Subset Sum, Graph Coloring- Branch & Bound: LIFO-BB and FIFO BB methods: Job Selection problem, 0-1 Knapsack Problem

Module:3	**String Matching Algorithms**	**5 hours**

Naïve String-matching Algorithms, KMP algorithm, Rabin-Karp Algorithm, Suffix Trees.

Module:4	**Graph Algorithms**	**6 hours**

All pair shortest path: Bellman Ford Algorithm, Floyd-Warshall Algorithm - Network Flows: Flow Networks, Maximum Flows: Ford-Fulkerson, Edmond-Karp, Push Re-label Algorithm – Application of Max Flow to maximum matching problem

Module:5	**Geometric Algorithms**	**4 hours**

Line Segments: Properties, Intersection, sweeping lines - Convex Hull finding algorithms: Graham's Scan, Jarvis' March Algorithm.

Module:6	**Randomized algorithms**	**5 hours**

Randomized quick sort - The hiring problem - Finding the global Minimum Cut.

Module:7	**Classes of Complexity and Approximation Algorithms**	**7 hours**

The Class P - The Class NP - Reducibility and NP-completeness – SAT (Problem Definition and statement), 3SAT, Independent Set, Clique, Approximation Algorithm – Vertex Cover, Set Cover and Travelling salesman

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**

Text Book

1. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009.

Reference Books				
1.	Jon Kleinberg and ÉvaTardos, Algorithm Design, Pearson Education, 1st Edition, 2014.			
2.	Rajeev Motwani, Prabhakar Raghavan; Randomized Algorithms, Cambridge University Press, 1995 (Online Print – 2013)			
3.	Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, Network Flows: Theory, Algorithms, and Applications, 1st Edition, Pearson Education, 2014.			
Mode of Evaluation: CAT, Written assignments, Quiz, FAT.				
Recommended by Board of Studies		04-03-2022		
Approved by Academic Council		No. 65	Date	17-03-2022

BCSE204P	Design and Analysis of Algorithms Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To provide mathematical foundations for analyzing the complexity of the algorithms
2. To impart the knowledge on various design strategies that can help in solving the real world problems effectively
3. Synthesize efficient algorithms in various engineering design situations

Course Outcome

On completion of this course, student should be able to:
1. Demonstrate the major algorithm design paradigms.
2. Explain major graph algorithms, string matching and geometric algorithms along with their analysis.

Indicative Experiments

1.	Greedy Strategy : Activity Selection & Huffman coding
2.	Dynamic Programming : ALS, Matrix Chain Multiplication , Longest Common Subsequence, 0-1 Knapsack
3.	Divide and Conquer : Maximum Subarray and Karatsuba faster integer multiplication algorithm
4.	Backtracking: N-queens
5.	Branch and Bound: Job selection
6	String matching algorithms : Naïve, KMP and Rabin Karp,suffix trees
7	MST and all pair shortest path algorithms
8	Network Flows : Ford –Fulkerson and Edmond - Karp
9	Intersection of line segments &Finding Convexhull, Finding closest pair of points
10	Polynomial time algorithm for verification of NPC problems
11	Approximation and Randomized algorithms
	Total Laboratory Hours 30 Hours

Text Book

1.	Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009.

Reference Books

1.	Jon Kleinberg and ÉvaTardos, Algorithm Design, Pearson Education, 1st Edition, 2014.
2.	Rajeev Motwani, Prabhakar Raghavan; Randomized Algorithms, Cambridge University Press, 1995 (Online Print – 2013)
3.	Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, Network Flows: Theory, Algorithms, and Applications, 1st Edition, Pearson Education, 2014.

Mode of assessment: Continuous assessments, FAT.

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE205L	Computer Architecture and Organization	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives

1. To acquaint students with the basic concepts of fundamental component, architecture, register organization and performance metrics of a computer and to impart the knowledge of data representation in binary and to understand the implementation of arithmetic algorithms in a typical computer.
2. To teach students how to describe machine capabilities and design an effective data path design for instruction execution. To introduce students to syntax and semantics of machine level programming.
3. To make students understand the importance of memory systems, IO interfacing techniques and external storage and their performance metrics for a typical computer. And explore various alternate techniques for improving the performance of a processor.

Course Outcomes

On completion of this course, student should be able to:

1. Differentiate Von Neumann, Harvard, and CISC and RISC architectures. Analyze the performance of machine with different capabilities. Recognize different instruction formats and addressing modes. Validate efficient algorithm for fixed point and floating point arithmetic operations.
2. Explain the importance of hierarchical memory organization. Able to construct larger memories. Analyze and suggest efficient cache mapping technique and replacement algorithms for given design requirements. Demonstrate hamming code for error detection and correction.
3. Understand the need for an interface. Compare and contrast memory mapping and IO mapping techniques. Describe and Differentiate different modes of data transfer. Appraise the synchronous and asynchronous bus for performance and arbitration.
4. Assess the performance of IO and external storage systems. Classify parallel machine models. Analyze the pipeline hazards and solutions.

Module:1	**Introduction To Computer Architecture and Organization**	**5 Hours**

Overview of Organization and Architecture –Functional components of a computer: Registers and register files - Interconnection of components - Overview of IAS computer function - Organization of the von Neumann machine - Harvard architecture - CISC & RISC Architectures.

Module:2	**Data Representation and Computer Arithmetic**	**5 Hours**

Algorithms for fixed point arithmetic operations: Multiplication (Booths, Modified Booths), Division (restoring and non-restoring) - Algorithms for floating point arithmetic operations - Representation of nonnumeric data (character codes).

Module:3	**Instruction Sets and Control Unit**	**9 Hours**

Computer Instructions: Instruction sets, Instruction Set Architecture, Instruction formats, Instruction set categories - Addressing modes - Phases of instruction cycle – ALU - Data-path and control unit: Hardwired control unit and Micro programmed control unit - Performance metrics: Execution time calculation, MIPS, MFLOPS.

Module:4	**Memory System Organization and Architecture**	**7 Hours**

Memory systems hierarchy: Characteristics, Byte Storage methods, Conceptual view of memory cell - Design of scalable memory using RAM's- ROM's chips - Construction of larger size memories - Memory Interleaving - Memory interface address map- Cache memory: principles, Cache memory management techniques, Types of caches, caches misses, Mean

memory access time evaluation of cache.		
Module:5	**Interfacing and Communication**	**5 Hours**
I/O fundamentals: handshaking, buffering, I/O Modules - I/O techniques: Programmed I/O, Interrupt-driven I/O, Direct Memory Access, Direct Cache Access - Interrupt structures: Vectored and Prioritized-interrupt overhead - Buses: Synchronous and asynchronous - Arbitration.		
Module:6	**Subsystems**	**5 Hours**
External storage systems: Solid state drivers - Organization and Structure of disk drives: Electronic- magnetic and optical technologies - Reliability of memory systems - Error detecting and error correcting systems - RAID Levels - I/O Performance		
Module:7	**High Performance Processors**	**7 Hours**
Classification of models - Flynn's taxonomy of parallel machine models (SISD, SIMD, MISD, MIMD) - Pipelining: Two stages, Multi stage pipelining, Basic performance issues in pipelining, Hazards, Methods to prevent and resolve hazards and their drawbacks - Approaches to deal branches - Superscalar architecture: Limitations of scalar pipelines, superscalar versus super pipeline architecture, superscalar techniques, performance evaluation of superscalar architecture - performance evaluation of parallel processors: Amdahl's law, speed-up and efficiency.		
Module:8	**Contemporary Issues**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1	David A. Patterson and John L. Hennessy, Computer Organization and Design -The Hardware / Software Interface 6th Edition, Morgan Kaufmann, 2020
Reference Book(s)	
1	Computer Architecture and Organization-Designing for Performance, William Stallings, Tenth edition, Pearson Education series, 2016
2	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer organization, Mc Graw Hill, Fifth edition, Reprint 2011.
Mode of Evaluation: CAT, Written Assignments, Quiz and FAT.	

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE301L	Software Engineering	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To introduce the essential Software Engineering concepts.
2. To impart concepts and skills for performing analysis, design ,develop, test and evolve efficient software systems of various disciplines and applications
3. To make familiar about engineering practices, standards and metrics for developing software components and products.

Course Outcomes

On completion of this course, student should be able to:

1. Apply and assess the principles of various process models for the software development.
2. Demonstrate various software project management activities that include planning , Estimations, Risk assessment and Configuration Management
3. Perform Requirements modelling and apply appropriate design and testing heuristics to produce quality software systems.
4. Demonstrate the complete Software life cycle activities from requirements analysis to maintenance using the modern tools and techniques.
5. Escalate the use of various standards and metrics in evaluating the process and product.

Module:1	**Overview Of Software Engineering**	**6 hours**

Nature of Software, Software Engineering, Software process, project, product, Process Models

Classical Evolutionary models, Introduction to Agility - Agile Process-Extreme programming - XP Process – Principles of Agile Software Development framework - Overview of System Engineering

Module:2	**Introduction To Software Project Management**	**6 hours**

Planning, Scope, Work break-down structure, Milestones, Deliverables, Cost and Estimates - (Human Resources, Time-scale, Costs), Risk Management, RMMM Plan, CASE TOOLS, Agile Project Management, Managing team dynamics and communication, Metrics and Measurement

Module:3	**Modelling Requirements**	**8 hours**

Software requirements and its types, Requirements Engineering process, Requirement Elicitation, System Modeling – Requirements Specification and Requirement Validation, Requirements Elicitation techniques, Requirements management in Agile.

Module:4	**Software Design**	**8 hours**

Design concepts and principles - Abstraction - Refinement - Modularity Cohesion coupling, Architectural design, Detailed Design Transaction Transformation, Refactoring of designs, Object oriented Design User-Interface Design

Module:5	**Validation And Verification**	**7 hours**

Strategic Approach to Software Testing, Testing Fundamentals Test Plan, Test Design, Test Execution, Reviews, Inspection and Auditing – Regression Testing – Mutation Testing - Object oriented testing - Testing Web based System - Mobile App testing – Mobile test Automation and tools – DevOps Testing – Cloud and Big Data Testing

Module:6	**Software Evolution**	**4 hours**

Software Maintenance, Types of Maintenance, - Software Configuration Management – Overview – SCM Tools. Re-Engineering, Reverse Engineering, Software Reuse		
Module:7	**Quality Assurance**	**4 hours**
Product and Process Metrics, Quality Standards Models ISO, TQM, Six-Sigma, Process improvement Models: CMM & CMMI. Quality Control and Quality Assurance - Quality Management - Quality Factors - Methods of Quality Management		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Ian Somerville, Software Engineering, 10th Edition, Addison-Wesley, 2015
Reference Books	
1.	Roger S. Pressman and Bruce R. Maxim, Software Engineering: A Practitioner's Approach, 10th edition, McGraw Hill Education, 2019
2.	William E. Lewis , Software Testing and Continuous Quality Improvement, Third Edition, Auerbach Publications, 2017

Mode of Evaluation: CAT, Written assignment, Quiz, FAT.			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE301P	Software Engineering Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To introduce the essential Software Engineering concepts.
2. To impart concepts and skills for performing analysis, design ,develop, test and evolve efficient software systems of various disciplines and applications
3. To make familiar about engineering practices, standards and metrics for developing software components and products.

Course Outcome

On completion of this course, student should be able to:

1. Demonstrate the complete Software life cycle activities from requirements analysis to maintenance using the modern tools and techniques.

Indicative Experiments

1.	Analysis and Identification of the suitable process models
2.	Work Break-down Structure (Process Based, Product Based, Geographic Based and Role Based) and Estimations
3.	Requirement modelling using Entity Relationship Diagram(Structural Modeling)
4.	Requirement modelling using Context flow diagram, DFD (Functional Modeling)
5.	Requirement modelling using State Transition Diagram (Behavioral Modeling)
6.	OO design – Use case Model, Class Model
7.	OO design – Interaction Models
8.	OO design – Package, Component and deployment models
9.	Design and demonstration of test cases. Functional Testing and Non- Functional Testing (using any open source tools)
10.	Story Boarding and User Interface design Modelling
	Total Laboratory Hours: 30 hours

Text Book(s)

1.	Ian Somerville, Software Engineering, 10th Edition, Addison-Wesley, 2015

Reference Books

1.	Roger S. Pressman and Bruce R. Maxim, Software Engineering: A Practitioner's Approach, 10th edition, McGraw Hill Education, 2019
2.	William E. Lewis, Software Testing and Continuous Quality Improvement, Third Edition, Auerbach Publications, 2017

Mode of assessment: Continuous assessments, FAT.

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE302L	Database Systems	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To understand the concepts of File system and structure of the database; Designing an Entity-Relationship model for a real-life application and Mapping a database schema from the ER model.
2. To differentiate various normal forms, evaluate relational schemas for design qualities and optimize a query.
3. To impart the working methodologies of transaction management, understand concurrency control, recovery, indexing, access methods and fundamental view on unstructured data and its management.

Course Outcomes

On completion of this course, student should be able to:

1. Comprehend the role of database management system in an organization and design the structure and operation of the relational data model.
2. Develop a database project depending on the business requirements, considering various design issues.
3. List the concepts of indexing and accessing methods.
4. Explain the concept of a database transaction processing and comprehend the concept of database facilities including concurrency control, backup and recovery.
5. Review the fundamental view on unstructured data and describe other emerging database technologies.

Module:1	**Database Systems Concepts and Architecture**	**4 hours**

Need for database systems – Characteristics of Database Approach – Advantages of using DBMS approach - Actors on the Database Management Scene: Database Administrator - Classification of database management systems - Data Models - Schemas and Instances - Three-Schema Architecture - The Database System Environment - Centralized and Client/Server Architectures for DBMSs – Overall Architecture of Database Management Systems

Module:2	**Relational Model and E-R Modeling**	**6 hours**

Relational Model: Candidate Keys, Primary Keys, Foreign Keys - Integrity Constraints - Handling of Nulls - Entity Relationship Model: Types of Attributes, Relationships, Structural Constraints, Relational model Constraints – Mapping ER model to a relational schema – Extended ER Model - Generalization – Specialization – Aggregations.

Module:3	**Relational Database Design**	**6 hours**

Database Design – Schema Refinement - Guidelines for Relational Schema - Functional dependencies - Axioms on Functional Dependencies- Normalization: First, Second and Third Normal Forms - Boyce Codd Normal Form, Multi-valued dependency and Fourth Normal form - Join dependency and Fifth Normal form

Module:4	**Physical Database Design and Query Processing**	**8 hours**

File Organization - Indexing: Single level indexing, multi-level indexing, dynamic multilevel Indexing - B+ Tree Indexing – Hashing Techniques: Static and Dynamic Hashing – Relational Algebra - Translating SQL Queries into Relational Algebra - Query Processing – Query Optimization: Algebraic Query Optimization, Heuristic query optimization Rules, Join Query Optimization using Indexing and Hashing - Tuple Relational Calculus.

Module:5	**Transaction Processing and Recovery**	**8 hours**

Introduction to Transaction Processing – Transaction concepts: ACID Properties of Transactions, Transaction States - Serial and Serializable Schedules - Schedules based on recoverability – Schedules based on Serializability - Conflict Serializabilty - Recovery Concepts: Log Based Recovery Protocols, Recovery based on deferred update, Recovery techniques based on immediate update – Shadow Paging Algorithm		
Module:6	**Concurrency Control In Transaction Processing**	**8 hours**
Concurrent Transactions – Lost Update Problem - Concurrency Control Techniques: Time Stamp Based Protocols, Thomas Write Rule, Lock Based Protocols, Lock Compatibility Matrix, - Two-Phase Locking Protocol - Lock Conversions - Graph Based Protocols for Concurrency Control - Tree Protocol for Concurrency Control – Deadlocks Based on Locks in Transactions – Deadlock Handling Techniques – Transaction Deadlock Detection Techniques – Transaction Deadlock Prevention Techniques – Multi-Granularity Locking for avoiding Transaction Deadlocks		
Module:7	**NOSQL Database Management**	**3 hours**
Introduction, Need of NoSQL, CAP Theorem, different NoSQL data bases: Key-value data stores, Columnar families, Document databases, Graph databases		
Module:8	**Contemporary Issues**	**2 Hours**
	Total Lecture hours:	**45 hours**

Text Book	
1.	R. Elmasri & S. B. Navathe, Fundamentals of Database Systems, Addison Wesley, 7th Edition, 2016
Reference Books	
1.	A. Silberschatz, H. F. Korth & S. Sudarshan, Database System Concepts, McGraw Hill, 7th Edition 2019.
2.	Raghu Ramakrishnan, Database Management Systems, Mcgraw-Hill, 4th Edition, 2018
3.	C.J.Date, A.Kannan, S.Swamynathan," An Introduction to Database Systems", Pearson, Eighth Edition, 2006.
4.	Gerardus Blokdyk, NoSQL Databases A Complete Guide, 5STARCooks, 2021
Mode of Evaluation: CAT, Written assignments, Quiz and FAT.	

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE302P	Database Systems Lab	L	T	P	C
		0	0	2	1
Pre-requisite		**Syllabus version**			
		1.0			

Course Objectives

1. Basic ability to understand the concepts of File system and structure of the database; Designing an Entity-Relationship model for a real-life application and Mapping a database schema from the ER model.
2. Differentiate various normal forms, evaluate relational schemas for design qualities and optimize a query.
3. Explain the working methodologies of transaction management and give a solution during a transaction failure. Understand the basic concepts on concurrency control, recovery, indexing, access methods and fundamental view on unstructured data and its management.

Course Outcome

On completion of this course, student should be able to:

1. Design the structure and operation of the relational data model.
2. Examine the data requirements of the real world and design a database management system.

Indicative Experiments	
1.	Data Definition and Data Manipulation Language
2.	Constraints
3.	Single row functions
4.	Operators and group functions
5.	Sub query, views and joins
6.	High Level Language Extensions - Procedures, Functions, Cursors and Triggers
	Total Laboratory Hours 30 hours

Text Book

1. R. Elmasri & S. B. Navathe, Fundamentals of Database Systems, Addison Wesley, 7th Edition, 2016

Reference Books

1. A. Silberschatz, H. F. Korth & S. Sudarshan, Database System Concepts, McGraw Hill, 7th Edition 2019.
2. Raghu Ramakrishnan, Database Management Systems, Mcgraw-Hill, 4th Edition, 2018
3. C.J.Date, A.Kannan, S.Swamynathan," An Introduction to Database Systems", Pearson, Eighth Edition, 2006.
4. Gerardus Blokdyk, NoSQL Databases A Complete Guide, 5STARCooks, 2021

Mode of assessment: Continuous assessments, FAT

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE303L	Operating Systems	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To introduce the operating system concepts, designs and provide skills required to implement the services.
2. To describe the trade-offs between conflicting objectives in large scale system design.
3. To develop the knowledge for application of the various design issues and services.

Course Outcomes

On completion of this course, student should be able to:

1. Interpret the evolution of OS functionality, structures, layers and apply various types of system calls of various process states.
2. Design scheduling algorithms to compute and compare various scheduling criteria.
3. Apply and analyze communication between inter process and synchronization techniques.
4. Implement page replacement algorithms, memory management problems and segmentation.
5. Differentiate the file systems for applying different allocation, access technique, representing virtualization and providing protection and security to OS.

Module:1	**Introduction**	**3 hours**

Introduction to OS: Functionality of OS - OS design issues - Structuring methods (monolithic, layered, modular, micro-kernel models) - Abstractions, processes, resources - Influence of security, networking, and multimedia.

Module:2	**OS Principles**	**4 hours**

System calls, System/Application Call Interface – Protection: User/Kernel modes - Interrupts -Processes - Structures (Process Control Block, Ready List etc.), Process creation, management in Unix – Threads: User level, kernel level threads and thread models.

Module:3	**Scheduling**	**9 hours**

Processes Scheduling - CPU Scheduling: Pre-emptive, non-pre-emptive - Multiprocessor scheduling – Deadlocks - Resource allocation and management - Deadlock handling mechanisms: prevention, avoidance, detection, recovery.

Module:4	**Concurrency**	**8 hours**

Inter-process communication, Synchronization - Implementing synchronization primitives (Peterson's solution, Bakery algorithm, synchronization hardware) - Semaphores – Classical synchronization problems, Monitors: Solution to Dining Philosophers problem – IPC in Unix, Multiprocessors and Locking - Scalable Locks - Lock-free coordination.

Module:5	**Memory Management**	**7 hours**

Main memory management, Memory allocation strategies, Virtual memory: Hardware support for virtual memory (caching, TLB) – Paging - Segmentation - Demand Paging - Page Faults - Page Replacement -Thrashing - Working Set.

Module:6	**Virtualization and File System Management**	**6 hours**

Virtual Machines - Virtualization (Hardware/Software, Server, Service, Network - Hypervisors - Container virtualization - Cost of virtualization - File system interface (access methods, directory structures) - File system implementation (directory implementation, file allocation methods) - File system recovery - Journaling - Soft updates - Log-structured file system - Distributed file system.

Module:7	**Storage Management, Protection and Security**	**6 hours**

Disk structure and attachment – Disk scheduling algorithms (seek time, rotational latency based)- System threats and security – Policy vs mechanism - Access vs authentication -

System protection: Access matrix – Capability based systems - OS: performance, scaling, future directions in mobile OS.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Book		
1.	Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts", 2018, 10th Edition, Wiley, United States.	
Reference Books		
1.	Andrew S. Tanenbaum, "Modern Operating Systems", 2016, 4th Edition, Pearson, United Kingdom.	
2.	William Stallings, "Operating Systems: Internals and Design Principles", 2018, 9th Edition, Pearson, United Kingdom.	
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT		
Recommended by Board of Studies	04-03-2022	
Approved by Academic Council	No. 65	Date 17-03-2022

BCSE303P	Operating Systems Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To introduce the operating system concepts, designs and provide skills required to implement the services.
2. To describe the trade-offs between conflicting objectives in large scale system design.
3. To develop the knowledge for application of the various design issues and services.

Course Outcome

On completion of this course, student should be able to:

1. Interpret the evolution of OS functionality, structures, layers and apply various types of system calls of various process states.
2. Design scheduling algorithms to compute and compare various scheduling criteria.
3. Apply and analyze communication between inter process and synchronization techniques.
4. Implement page replacement algorithms, memory management problems and segmentation.
   Differentiate the file systems for applying different allocation, access technique, representing virtualization and providing protection and security to OS.

Indicative Experiments

1.	Study of Basic Linux Commands
2.	Implement your own bootloader program that helps a computer to boot an OS.
3.	Shell Programming (I/O, Decision making, Looping, Multi-level branching)
4.	Creating child process using fork () system call, Orphan and Zombie process creation
5.	Simulation of CPU scheduling algorithms (FCFS, SJF, Priority and Round Robin)
6.	Implement process synchronization using semaphores / monitors.
7.	Simulation of Banker s algorithm to check whether the given system is in safe state or not. Also check whether addition resource requested can be granted immediately
8.	Parallel Thread management using Pthreads library. Implement a data parallelism using multi-threading
9.	Dynamic memory allocation algorithms - First-fit, Best-fit, Worst-fit algorithms
10.	Page Replacement Algorithms FIFO, LRU and Optimal
11.	Implement a file locking mechanism.
12.	Virtualization Setup: Type-1, Type-2 Hypervisor (Detailed Study Report)
	Total Laboratory Hours 30 hours

Text Book

1. Fox, Richard, "Linux with Operating System Concepts", 2022, 2nd Edition, Chapman and Hall/CRC, UK.

Reference Books

1. Love, Robert, "Linux System Programming: talking directly to the kernel and C library", 2013, 2nd Edition, O'Reilly Media, Inc, United States.
2. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts", 2018, 10th Edition, Wiley, United States.

Mode of Assessment: Continuous Assessments, FAT

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE304L	Theory of Computation	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. Types of grammars and models of automata.
2. Limitation of computation: What can be and what cannot be computed.
3. Establishing connections among grammars, automata and formal languages.

Course Outcome

On completion of this course, student should be able to:
1. Compare and analyse different computational models
2. Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
3. Identify limitations of some computational models and possible methods of proving them.
4. Represent the abstract concepts mathematically with notations.

Module:1	**Introduction to Languages and Grammars**	**4 hours**
Recall on Proof techniques in Mathematics - Overview of a Computational Models - Languages and Grammars - Alphabets - Strings - Operations on Languages, Overview on Automata		
Module:2	**Finite State Automata**	**8 hours**
Finite Automata (FA) - Deterministic Finite Automata (DFA) - Non-deterministic Finite Automata (NFA) - NFA with epsilon transitions – NFA without epsilon transition, conversion of NFA to DFA, Equivalence of NFA and DFA – minimization of DFA		
Module:3	**Regular Expressions and Languages**	**7 hours**
Regular Expression - FA and Regular Expressions: FA to regular expression and regular expression to FA - Pattern matching and regular expressions - Regular grammar and FA - Pumping lemma for regular languages - Closure properties of regular languages		
Module:4	**Context Free Grammars**	**7 hours**
Context-Free Grammar (CFG) – Derivations - Parse Trees - Ambiguity in CFG - CYK algorithm – Simplification of CFG – Elimination of Useless symbols, Unit productions, Null productions - Normal forms for CFG: CNF and GNF - Pumping Lemma for CFL - Closure Properties of CFL		
Module:5	**Pushdown Automata**	**5 hours**
Definition of the Pushdown automata - Languages of a Pushdown automata – Power of Non-Deterministic Pushdown Automata and Deterministic pushdown automata		
Module:6	**Turing Machine**	**6 hours**
Turing Machines as acceptor and transducer - Multi head and Multi tape Turing Machines – Universal Turing Machine - The Halting problem - Turing-Church thesis		
Module:7	**Recursive and Recursively Enumerable Languages**	**6 hours**
Recursive and Recursively Enumerable Languages, Language that is not Recursively Enumerable (RE) – computable functions – Chomsky Hierarchy – Undecidable problems - Post's Correspondence Problem		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1.	J.E. Hopcroft, R. Motwani and J.D. Ullman, "Introduction to Automata Theory, Languages and Computation", Third Edition, Pearson Education, India 2008. ISBN: 978-8131720479

Reference Books

1.	Peter Linz, "An Introduction to Formal Languages and Automata", Sixth Edition, Jones & Bartlett, 2016. ISBN: 978-9384323219		
2.	K. Krithivasan and R. Rama, "Introduction to Formal Languages, Automata and Computation", Pearson Education, 2009. ISBN: 978-8131723562		
Mode of Evaluation: CAT, Assignment, Quiz, FAT.			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE305L	Embedded Systems	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To expose students to various challenges and constraints of special purpose computing systems in terms of resources and functional requirements.
2. To introduce students to various components of typical embedded systems viz., sensors and actuators, data converters, UART etc., their interfacing, programming environment for developing any smart systems and various serial communication protocols for optimal components interfacing and communication.
3. To make students understand the importance of program modeling, optimization techniques and debugging tools for product development and explore various solutions for real time scheduling issues in terms of resources and deadline.

Course Outcomes

On completion of this course, students should be able to:

1. Identify the challenges in designing an embedded system using various microcontrollers and interfaces.
2. To summaries the functionality of any special purpose computing system, and to propose smart solutions to engineering challenges at the prototype level.
3. To examine the working principle and interface of typical embedded system components, create programme models, apply various optimization approaches including simulation environment and demonstration using debugging tools.
4. To evaluate the working principle of serial communication protocols and their proper use, as well as to analyze the benefits and drawbacks of real-time scheduling algorithms and to recommend acceptable solutions for specific challenges.

Module:1	**Introduction**	**5 hours**
Overview of Embedded Systems, Design challenges, Embedded processor technology, Hardware Design, Micro-controller architecture -8051, PIC, and ARM.		
Module:2	**I/O Interfacing Techniques**	**8 hours**
Memory interfacing, A/D, D/A, Timers, Watch-dog timer, Counters, Encoder & Decoder, UART, Sensors and actuators interfacing.		
Module:3	**Architecture of Special Purpose Computing System**	**6 hours**
ATM, Handheld devices, Data Compressor, Image Capturing Devices–Architecture and Requirements, Challenges & Constraints of special purpose computing system.		
Module:4	**Programming Tools**	**7 hours**
Evolution of embedded programming tools, Modelling programs, Code optimization, Logic analyzers, Programming environment.		
Module:5	**Real Time Operating System**	**8 hours**
Classification of Real time system, Issues & challenges in RTS, Real time scheduling schemes- EDF-RMS & Hybrid techniques, eCOS, POSIX, Protothreads.		
Module:6	**Embedded Networking Protocols**	**5 hours**
Inter Integrated Circuits (I2C), Controller Area Network, Embedded Ethernet Controller, RS232, Bluetooth, Zigbee, Wifi.		
Module:7	**Applications of Embedded Systems**	**4 hours**
Introduction to embedded system applications using case studies – Role in Agriculture sector, Automotive electronics, Consumer Electronics, Industrial controls, Medical Electronics.		
Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:		**45 hours**
Text Book			
1.	Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Fourth Edition, Morgan Kaufman Publishers, 2016.		
Reference Books			
1.	Embedded Systems Architecture, Programming and Design, by Raj Kamal, McGraw Hill Education, 3e, 2015.		
2.	Embedded System Design A Unified Hardware/Sofware Introduction, by Vahid G Frank and Givargis Tony, John Wiley & Sons, 2009.		
Mode of Evaluation: CAT, written assignment, Quiz, FAT.			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE306L	Artificial Intelligence	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart artificial intelligence principles, techniques and its history.
2. To assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving engineering problems
3. To develop intelligent systems by assembling solutions to concrete computational problems

Course Outcomes

On completion of this course, student should be able to:

1. Evaluate Artificial Intelligence (AI) methods and describe their foundations.
2. Apply basic principles of AI in solutions that require problem-solving, inference, perception, knowledge representation and learning.
3. Demonstrate knowledge of reasoning, uncertainty, and knowledge representation for solving real-world problems
4. Analyse and illustrate how search algorithms play a vital role in problem-solving

Module:1	**Introduction**	**6 hours**
Introduction- Evolution of AI, State of Art -Different Types of Artificial Intelligence- Applications of AI-Subfields of AI-Intelligent Agents- Structure of Intelligent Agents- Environments		
Module:2	**Problem Solving based on Searching**	**6 hours**
Introduction to Problem Solving by searching Methods-State Space search, Uninformed Search Methods – Uniform Cost Search, Breadth First Search- Depth First Search-Depth-limited search, Iterative deepening depth-first, Informed Search Methods- Best First Search, A* Search		
Module 3	**Local Search and Adversarial Search**	**5 hours**
Local Search algorithms – Hill-climbing search, Simulated annealing, Genetic Algorithm, Adversarial Search: Game Trees and Minimax Evaluation, Elementary two-players games: tic-tac-toe, Minimax with Alpha-Beta Pruning.		
Module:4	**Logic and Reasoning**	**8 hours**
Introduction to Logic and Reasoning -Propositional Logic-First Order Logic-Inference in First Order Logic- Unification, Forward Chaining, Backward Chaining, Resolution.		
Module:5	**Uncertain Knowledge and Reasoning**	**5 hours**
Quantifying Uncertainty- Bayes Rule -Bayesian Belief Network- Approximate Inference in Bayesian networks		
Module:6	**Planning**	**7 hours**
Classical planning, Planning as State-space search, Forward search, backward search, Planning graphs, Hierarchical Planning, Planning and acting in Nondeterministic domains – Sensor-less Planning, Multiagent planning		
Module:7	**Communicating, Perceiving and Acting**	**6 hours**
Communication-Fundamentals of Language -Probabilistic Language Processing -Information Retrieval- Information Extraction-Perception-Image Formation- Object Recognition.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd Edition, Prentice Hall.

Reference Books			
1.	K. R. Chowdhary, Fundamentals of Artificial Intelligence, Springer, 2020.		
2	Alpaydin, E. 2010. Introduction to Machine Learning. 2nd Edition, MIT Press.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE307L	Compiler Design	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To provide fundamental knowledge of various language translators.
2. To make students familiar with lexical analysis and parsing techniques.
3. To understand the various actions carried out in semantic analysis.
4. To make the students get familiar with how the intermediate code is generated.
5. To understand the principles of code optimization techniques and code generation.
6. To provide foundation for study of high-performance compiler design.

Course Outcomes

1. Apply the skills on devising, selecting, and using tools and techniques towards compiler design
2. Develop language specifications using context free grammars (CFG).
3. Apply the ideas, the techniques, and the knowledge acquired for the purpose of developing software systems.
4. Constructing symbol tables and generating intermediate code.
5. Obtain insights on compiler optimization and code generation.

Module:1	**INTRODUCTION TO COMPILATION AND LEXICAL ANALYSIS**	**7 hours**

Introduction to LLVM - Structure and Phases of a Compiler-Design Issues-Patterns-Lexemes-Tokens-Attributes-Specification of Tokens-Extended Regular Expression- Regular expression to Deterministic Finite Automata (Direct method) - Lex - A Lexical Analyzer Generator.

Module:2	**SYNTAX ANALYSIS**	**8 hours**

Role of Parser- Parse Tree - Elimination of Ambiguity – Top Down Parsing - Recursive Descent Parsing - LL (1) Grammars – Shift Reduce Parsers- Operator Precedence Parsing - LR Parsers, Construction of SLR Parser Tables and Parsing- CLR Parsing- LALR Parsing.

Module:3	**SEMANTICS ANALYSIS**	**5 hours**

Syntax Directed Definition – Evaluation Order - Applications of Syntax Directed Translation - Syntax Directed Translation Schemes - Implementation of L-attributed Syntax Directed Definition.

Module:4	**INTERMEDIATE CODE GENERATION**	**5 hours**

Variants of Syntax trees - Three Address Code- Types – Declarations - Procedures - Assignment Statements - Translation of Expressions - Control Flow - Back Patching- Switch Case Statements.

Module:5	**CODE OPTIMIZATION**	**6 hours**

Loop optimizations- Principal Sources of Optimization -Introduction to Data Flow Analysis - Basic Blocks - Optimization of Basic Blocks - Peephole Optimization- The DAG Representation of Basic Blocks -Loops in Flow Graphs - Machine Independent Optimization- Implementation of a naïve code generator for a virtual Machine- Security checking of virtual machine code.

Module:6	**CODE GENERATION**	**5 hours**

Issues in the design of a code generator- Target Machine- Next-Use Information - Register Allocation and Assignment- Runtime Organization- Activation Records.

Module:7	**PARALLELISM**	**7 hours**

Parallelization- Automatic Parallelization- Optimizations for Cache Locality and Vectorization- Domain Specific Languages-Compilation- Instruction Scheduling and Software Pipelining- Impact of Language Design and Architecture Evolution on Compilers-Static Single Assignment

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:			**45 hours**
Text Book(s)				
1.	A. V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, Compilers: Principles, techniques, & tools, 2007, Second Edition, Pearson Education, Boston.			
Reference Books				
1.	Watson, Des. A Practical Approach to Compiler Construction. Germany, Springer International Publishing, 2017.			
Mode of Evaluation: CAT, Quiz, Written assignment and FAT				
Recommended by Board of Studies	04-03-2022			
Approved by Academic Council	No. 65	Date	17-03-2022	

BCSE307P	Compiler Design Lab	L	T	P	C
		0	0	2	1
Pre-requisite		**Syllabus version**			
		1.0			

Course Objectives

1. To provide fundamental knowledge of various language translators.
2. To make students familiar with phases of compiler.
3. To provide foundation for study of high-performance compiler design.

Course Outcome

1. Apply the skills on devising, selecting and using tools and techniques towards compiler design
2. Develop language specifications using context free grammars (CFG).
3. Apply the ideas, the techniques, and the knowledge acquired for the purpose of developing software systems.
4. Constructing symbol tables and generating intermediate code.
5. Obtain insights on compiler optimization and code generation.

Indicative Experiments	
1.	Implementation of LEXR using LLVM.
2.	Implementation of handwritten parser using LLVM
3.	Generating code with the LLVM backend.
4.	Defining a real programming language.
5.	Write a recursive descent parser for the CFG language and implement it using LLVM.
6.	Write a LR parser for the CFG language and implement it in the using LLVM.
7.	Intro to Flex and Bison Modify the scanner and parser so that terminating a statement with "; b" instead of ";" results in the output being printed in binary.
8.	Using LLVM-style RTTI for the AST and Generating IR from the AST.
9.	Converting types from an AST description to LLVM types.
10.	Emitting assembler text and object code.
	Total Laboratory Hours **30 hours**

Mode of assessment: CAT, FAT

Text Book(s)

1	Learn LLVM 12: A beginner's guide to learning LLVM compiler tools and core libraries with C++

Reference Books

1.	Watson, Des. A Practical Approach to Compiler Construction. Germany, Springer International Publishing, 2017.

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE308L	Computer Networks	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To build an understanding among students about the fundamental concepts of computer networking, protocols, architectures, and applications.
2. To help students to acquire knowledge in design, implement and analyze performance of OSI and TCP-IP based Architectures.
3. To identify the suitable application layer protocols for specific applications and its respective security mechanisms.

Course Outcomes

On completion of this course, student should be able to:

1. Interpret the different building blocks of Communication network and its architecture.
2. Contrast different types of switching networks and analyze the performance of network
3. Identify and analyze error and flow control mechanisms in data link layer.
4. Design sub-netting and analyze the performance of network layer with various routing protocols.
5. Compare various congestion control mechanisms and identify appropriate transport layer protocol for real time applications with appropriate security mechanism.

Module:1	**Networking Principles and Layered Architecture**	**6 hours**
Data Communications and Networking: A Communications Model – Data Communications - Evolution of network, Requirements , Applications, Network Topology (Line configuration, Data Flow), Protocols and Standards, Network Models (OSI, TCP/IP)		
Module:2	**Circuit and Packet Switching**	**7 hours**
Switched Communications Networks – Circuit Switching – Packet Switching – Comparison of Circuit Switching and Packet Switching – Implementing Network Software, Networking Parameters(Transmission Impairment, Data Rate and Performance)		
Module:3	**Data Link Layer**	**8 hours**
Error Detection and Correction – Hamming Code , CRC, Checksum- Flow control mechanism – Sliding Window Protocol - GoBack - N - Selective Repeat - Multiple access Aloha - Slotted Aloha - CSMA, CSMA/CD – IEEE Standards(IEEE802.3 (Ethernet), IEEE802.11(WLAN))- RFID- Bluetooth Standards		
Module:4	**Network Layer**	**8 hours**
IPV4 Address Space – Notations – Classful Addressing – Classless Addressing – Network Address Translation – IPv6 Address Structure – IPv4 and IPv6 header format		
Module:5	**Routing Protocols**	**6 hours**
Routing-Link State and Distance Vector Routing Protocols- Implementation-Performance Analysis- Packet Tracer		
Module:6	**Transport Layer**	**5 hours**
TCP and UDP-Congestion Control-Effects of Congestion-Traffic Management-TCP Congestion Control-Congestion Avoidance Mechanisms-Queuing Mechanisms-QoS Parameters		
Module:7	**Application layer**	**3 hours**
Application layer-Domain Name System-Case Study : FTP-HTTP-SMTP-SNMP		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1.	Behrouz A. Forouzan, Data communication and Networking, 5th Edition, 2017,

	McGraw Hill Education.		
Reference Books			
1.	James F. Kurose and Keith W.Ross, Computer Networking: A Top-Down Approach, 6th Edition, 2017, Pearson Education.		
2.	William Stallings, "Data and Computer Communication", 10th Edition, 2017, Pearson, United Kingdom.		
Mode of Evaluation: CAT, Written Assignment, Quiz, FAT			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE308P	Computer Networks Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To build an understanding among students about the fundamental concepts of computer networking, protocols, architectures, and applications.
2. To help students to acquire knowledge in design, implement and analyze performance of OSI and TCP-IP based Architectures.
3. To identify the suitable application layer protocols for specific applications and its respective security mechanisms

Course Outcome

On completion of this course, student should be able to:

1. Interpret the different building blocks of Communication network and its architecture.
2. Contrast different types of switching networks and analyze the performance of network
3. Identify and analyze error and flow control mechanisms in data link layer.
4. Design sub-netting and analyze the performance of network layer with various routing protocols.
5. Compare various congestion control mechanisms and identify appropriate transport layer protocol for real time applications with appropriate security mechanism.

Indicative Experiments

1.	Study of Basic Network Commands, Demo session of all networking hardware and Functionalities
2.	Error detection and correction mechanisms
3.	Flow control mechanisms
4.	IP addressing Classless addressing
5.	Observing Packets across the network and Performance Analysis of Routing protocols
6.	Socket programming(TCP and UDP) - Some challenging experiments can be given on Socket programming
7.	Simulation of unicast routing protocols
8.	Simulation of Transport layer Protocols and analysis of congestion control techniques in network
9.	Develop a DNS client server to resolve the given host name or IP address
	Total Laboratory Hours 30 hours

Text book

1	W.Richard Stevens, Uix Network Programming, 2ndEdition, Pearson Education, 2015.

Mode of assessment: Continuous assessment, FAT

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE309L	Cryptography and Network Security	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To explore the concepts of basic number theory and cryptographic techniques.
2. To impart concept of Hash and Message Authentication, Digital Signatures and authentication protocols.
3. To reveal the basics of transport layer security, Web Security and various types of System Security.

Course Outcomes

On completion of this course, students should be able to:

1. To know the fundamental mathematical concepts related to security.
2. To understand concept of various cryptographic techniques.
3. To apprehend the authentication and integrity process of data for various applications
4. To know fundamentals of Transport layer security, web security, E-Mail Security and IP Security

Module:1	**Fundamentals of Number Theory**	**5 hours**
Finite Fields and Number Theory: Modular arithmetic, Euclidian Algorithm, Primality Testing: Fermats and Eulers theorem, Chinese Reminder theorem, Discrete Logarithms.		
Module:2	**Symmetric Encryption Algorithms**	**7 hours**
Symmetric key cryptographic techniques: Introduction to Stream cipher, Block cipher: DES, AES,IDEA, Block Cipher Operation, Random Bit Generation and RC4		
Module:3	**Asymmetric Encryption Algorithm and Key Exchange**	**8 hours**
Asymmetric key cryptographic techniques: principles, RSA, ElGamal, Elliptic Curve cryptography, Homomorphic Encryption and Secret Sharing, Key distribution and Key exchange protocols, Diffie-Hellman Key Exchange, Man-in-the-Meddle Attack		
Module:4	**Message Digest and Hash Functions**	**5 hours**
Requirements for Hash Functions, Security of Hash Functions, Message Digest (MD5), Secure Hash Function (SHA),Birthday Attack, HMAC		
Module:5	**Digital Signature and Authentication Protocols**	**7 hours**
Authentication Requirements, Authentication Functions, Message Authentication Codes, Digital Signature Authentication, Authentication Protocols, Digital Signature Standards, RSA Digital Signature, Elgamal based Digital Signature, Authentication Applications: Kerberos, X.509 Authentication Service, Public Key Infrastructure (PKI)		
Module:6	**Transport Layer Security and IP Security**	**4 hours**
Transport-Layer Security, Secure Socket Layer(SSL),TLS, IP Security: Overview: IP Security Architecture, Encapsulating Payload Security		
Module:7	**E-mail, Web and System Security**	**7 hours**
Electronic Mail Security, Pretty Good Privacy (PGP), S/MIME, Web Security: Web Security Considerations, Secure Electronic Transaction Protocol Intruders, Intrusion Detection, Password Management, Firewalls: Firewall Design Principles, Trusted Systems.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1.	Cryptography and Network Security-Principles and Practice, 8th Edition, by Stallings

	William, published by Pearson, 2020		
Reference Books			
1.	Cryptography and Network Security, 3rd Edition, by Behrouz A Forouzan and Depdeep Mukhopadhyay, published by McGrawHill, 2015		
Mode of Evaluation: CAT, written assignment, Quiz, and FAT			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE309P	Cryptography and Network Security Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. Understand various Private and Public Key cryptographic algorithms.
2. To learn about hash functions and digital signature algorithms
3. Acquire knowledge in various network security models

Course Outcome

On completion of this course, students should be able to:

1. Implement various cipher techniques without using standard cryptographic library functions
2. Develop the various hash functions and digital signature algorithms for different applications
3. Develop various secured networking-based application

Indicative Experiments

1.	Consider a sender and receiver who need to exchange data confidentially using symmetric encryption. Write program that implements DES encryption and decryption using a 64 bit key size and 64 bit block size
2.	Consider a sender and receiver who need to exchange data confidentially using symmetric encryption. Write program that implements AES encryption and decryption using a 64/128/256 bits key size and 64 bit block size.
3	Develop an chipper scheme by using RSA
4.	Develop a MD5 hash algorithm that finds the Message Authentication Code (MAC)
5	Find a Message Authentication Code (MAC) for given variable size message by using SHA-128 and SHA-256 Hash algorithm Measure the Time consumptions for varying message size for both SHA-128 and SHA-256.
6	Develop the Digital Siganture standard(DSS)for verifying the legal communicating parties
7	Design a Diffie Hellman multiparty key exchange protocol and perform Man-in-the-Middle Attack.
8	Develop a simple client and server application using SSL socket communication
9	Develop a simple client server model using telnet and capture the packets transmitted with tshark Analyze the pcap file and get the transmitted data (plain text) using any packet capturing library. Implement the above scenario using SSH and observe the data
10	Develop a web application that implements JSON web token
	Total Laboratory Hours 30 hours

Mode of assessment: Continuous Assessment, FAT

Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

SPECIALIZATION ELECTIVE

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

Course code	Course Title	L	T	P	C
BCSE206L	Foundations of Data Science	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide fundamental knowledge on data science with querying and analytics required for the field of data science.
2. To understand the process of handling heterogeneous data, pre-process and visualize them for better understanding.
3. To gain the fundamental knowledge on data science tools and gain basic skill set to solve real-time data science problems.

Course Outcome

Upon completion of the course the student will be able to

1. Ability to obtain fundamental knowledge on data science.
2. Demonstrate proficiency in data analytics.
3. Apply advanced tools to work on dimensionality reduction and mathematical operations.
4. Handle various types of data and visualize them using through programming for knowledge representation.
5. Demonstrate numerous open source data science tools to solve real-world problems through industrial case studies.

Module:1	**Data Science Context**	**5 hours**

Need for Data Science – What is Data Science - Data Science Process – Business Intelligence and Data Science – Prerequisites for a Data Scientist – Tools and Skills required.

Module:2	**Databases for Data Science**	**7 hours**

Structured Query Language (SQL): Basic Statistics, Data Munging, Filtering, Joins, Aggregation, Window Functions, Ordered Data, preparing No-SQL: Document Databases, Wide-column Databases and Graphical Databases.

Module:3	**Data Science Methodology**	**8 hours**

Analytics for Data Science – Examples of Data Analytics – Data Analytics Lifecycle: Data Discovery, Data Preparation, Model Planning, Model Building, Communicate Results.

Module:4	**Data Analytics on Text**	**7 hours**

Major Text Mining Areas – Information Retrieval – Data Mining – Natural Language Processing NLP) – Text analytics tasks: Cleaning and Parsing, Searching, Retrieval, Text Mining, Part-of-Speech Tagging, Stemming, Text Analytics Pipeline. NLP: Major components of NLP, stages of NLP, and NLP applications.

Module:5	**Platform for Data Science**	**6 hours**

Python for Data Science –Python Libraries – Data Frame Manipulation with numpy and pandas – Exploration Data Analysis – Time Series Dataset – Clustering with Python – Dimensionality Reduction. Python integrated Development Environments (IDE) for Data Science.

Module:6	**GNU Octave for Mathematical Operations**	**6 hours**

Handling Vectors and Matrices: Multiplication, Transpose, Random Matrix creation, Eigen Vectors and Eigen Values, Determinants. Arithmetic Operations – Set Operations – Plotting Data.

Module:7	**Tableau**	**4 hours**

Tableau Introduction – Dimensions, Measures, Descriptive Statistics, Basic Charts, Dashboard Design Principles, Special Chart Types, Integrate Tableau with Google Sheets.

Module:8	**Contemporary Issues**	**2 hours**

	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, 'Fundamentals of Data Science, CRC Press, 1st Edition, 2022.	
Reference Books		
1.	Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge University Press, First Edition, 2020.	
2.	Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 1st Edition, 2015.	
3.	Ani Adhikari and John DeNero, 'Computational and Inferential Thinking: The Foundations of Data Science', GitBook, 2019.	
Mode of Evaluation : Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test		
Recommended by Board of Studies	12-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BCSE207L	Programming for Data Science	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide necessary knowledge on data manipulation and to perform analysis on the practical problems using a programming approach.
2. To generate report and visualize the results in graphical form using programming tools.
3. To learn and implement R programs for data science.

Course Outcome

Upon completion of the course, the student will be able to

1. Engrave and use R language to solve problems.
2. Design a suitable form for analysis from real-time data.
3. Formulate insights from the data through statistical inferences.
4. Evaluate and visualize the results, analyze the performance of the models.

Module:1	**Functions in R**	**2 hours**

Programming with R- Running R Code - Including Comments - Defining Variables, Functions -Built-in R Functions - Loading Functions - Writing Functions - Using Conditional Statements.

Module:2	**Vectors and Lists**	**3 hours**

Vector - Vectorized Operations - Vector Indices - Vector Filtering - Modifying Vectors, Lists - Creating Lists - Accessing List Elements - Modifying Lists- Applying Functions to Lists with lapply().

Module:3	**Data Wrangling**	**4 hours**

Understanding Data - The Data Generation Process - Finding Data - Types of Data - Interpreting Data - Using Data to Answer Questions - Data Frames - Working with Data Frames -Working with CSV Data.

Module:4	**Manipulating Data with dplyr and tidyr**	**5 hours**

Data Manipulation - Core dplyr Functions- Performing Sequential Operations -Analyzing Data Frames by Group - Joining Data Frames Together - dplyr in Action: Analyzing Flight Data- Reshaping Data with tidyr -From Columns to Rows: gather() - From Rows to Columns: spread() - tidyr in Action: Exploring Educational Statistics.

Module:5	**Accessing Databases and Web APIs**	**5 hours**

An Overview of Relational Databases -A Taste of SQL-Accessing a Database from R - Accessing Web APIs -RESTful Requests -Accessing Web APIs from R -Processing JSON Data -APIs in Action: Finding Cuban Food in Seattle.

Module:6	**Data Visualization**	**6 hours**

Designing Data Visualizations - The Purpose of Visualization - Selecting Visual Layouts - Choosing Effective Graphical Encodings - Expressive Data Displays - Enhancing Aesthetics - Creating Visualizations with ggplot2- A Grammar of Graphics - Basic Plotting with ggplot2 - Complex Layouts and Customization - Building Maps- ggplot2 in Action: A case study.

Module:7	**Interactive Visualization in R**	**3 hours**

The Plotly Package - The Rbokeh Package - The Leaflet Package - Interactive Visualization in Action: Exploring Changes to the City of Seattle.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Michael Freeman and Joel Ross, Programming Skills for Data Science: Start Writing

	Code to Wrangle, Analyze, and Visualize Data with R, Addison-Wesley, 2018.			
Reference Books				
1.	Benjamin S. Baumer, Daniel T. Kaplan and Nicholas J. Horton, Modern Data Science with R, Chapman and Hall/CRC, 2021.			
2.	John Mount and Nina Zumel, Practical Data Science with R, 2nd edition, Wiley, 2019.			
Mode of Evaluation : Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies	12-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BCSE207P	Programming for Data Science Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide necessary knowledge on data manipulation and to perform analysis on the practical problems using statistical and machine learning approach.
2. To generate report and visualize the results in graphical form using programming tools.
3. To learn and implement R programs for data science.

Course Outcome

Upon completion of the course, the student will be able to

1. Program and use R language to solve problems.
2. Design a suitable form for analysis from real-time data.
3. Formulate insights from the data through statistical inferences.
4. Evaluate and visualize the results, analyze the performance of the models.

Indicative Experiments		
1.	Functions in R	**4 hours**
2.	Vectors and Lists	**2 hours**
3.	Data Frames	**4 hours**
4.	Handling Missing Data	**4 hours**
5.	Manipulating Data with dplyr and tidyr	**2 hours**
6.	Processing JSON Data	**2 hours**
7.	APIs	**3 hours**
8	Data Visualization	**3 hours**
9.	Interactive Visualization in R	**3 hours**
10.	Case Study	**3 hours**
	Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE208L	Data Mining	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the fundamental processes data warehousing and major issues in data mining.
2. To impart the knowledge on various data mining concepts and techniques that can be applied to text mining, web mining etc.
3. To develop the knowledge for application of data mining and social impacts of data mining.

Course Outcome

Upon completion of the course the student will be able to

1. Interpret the contribution of data warehousing and data mining to the decision-support systems.
2. Construct the data needed for data mining using preprocessing techniques.
3. Discover interesting patterns from large amounts of data using Association Rule Mining.
4. Extract useful information from the labeled data using various classifiers and Compile unlabeled data into clusters applying various clustering algorithms.
5. Demonstrate capacity to perform a self-directed piece of practical work that requires the application of data mining techniques.

Module:1	Data Warehousing	4 hours

Introduction to Data warehouse - Data Warehouse models- Data warehouse architecture: Three-tier data warehouse architecture - Data warehouse modeling: Data cube and OLAP – Star and Snowflake Schema.

Module:2	Introduction to Data Mining	3 hours

Introduction to data mining - Data mining functionalities - Steps in data mining process- Classification of data mining systems - Major issues in data mining.

Module:3	Data Preprocessing	3 hours

Data Preprocessing: An overview - Data cleaning - Data integration -Data reduction - Data transformation.

Module:4	Frequent Pattern Mining	4 hours

Frequent Pattern Mining: Basic Concepts and a Road Map - Efficient and scalable frequent item set mining methods: Apriori algorithm, FP-Growth algorithm - Mining frequent item sets using vertical data format.

Module:5	Classification Techniques	5 hours

General approach to classification - Classification by decision tree induction - Bayes classification methods - Model evaluation and selection - Techniques to improve classification accuracy - advanced classification methods: Bayesian belief networks- Lazy learners.

Module:6	Cluster Analysis	5 hours

Types of data in cluster analysis - Partitioning methods - K Medoid Clustering - Density based methods - Grid based methods - Outlier analysis.

Module:7	Data Mining Trends and Research Frontiers	4 hours

Overview of Web mining-Temporal and Spatial mining-Other methodologies of data mining: Statistical data mining- Data mining applications.

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, third edition, 2013.	
Reference Books		
1.	Parteek Bhatia, Data Mining and Data Warehousing: Principles and Practical Techniques, Cambridge University Press, 2019.	
2.	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, Introduction to Data Mining, Pearson, 2nd Edition, 2019.	
Mode of Evaluation : Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test		
Recommended by Board of Studies	12-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BCSE208P	Data Mining Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the fundamental processes data warehousing and major issues in data mining.
2. To impart the knowledge on various data mining concepts and techniques that can be applied to text mining, web mining etc.
3. To develop the knowledge for application of data mining and social impacts of data mining.

Course Outcome

1. Interpret the contribution of data warehousing and data mining to the decision-support systems.
2. Construct the data needed for data mining using preprocessing techniques.
3. Discover interesting patterns from large amounts of data using Association Rule Mining.
4. Extract useful information from the labeled data using various classifiers and Compile unlabeled data into clusters applying various clustering algorithms.
5. Demonstrate capacity to perform a self-directed piece of practical work that requires the application of data mining techniques.

Indicative Experiments	
1.	Introduction to exploratory data analysis using R.
2.	Demonstrate the Descriptive Statistics for a sample data like mean, median, variance and correlation etc.,
3.	Demonstrate Missing value analysis using sample data.
4.	Demo of Apriori algorithm on various data sets with varying confidence and support.
5.	Demo of FP Growth algorithm on various data sets with varying confidence and support.
6	Demo on Classification Techniques such as Decision Tree (ID3 / CART), Bayesian etc., and using sample data.
7.	Demonstration of Clustering Techniques K-Medoid and Hierarchical.
8.	Demonstration on Document Similarity Techniques and measurements.
9.	Simulation of Page Rank Algorithm.
10.	Demonstration on Hubs and Authorities.
	Total Laboratory Hours **30 hours**

Text Book(s)

Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, third edition, 2013.

Reference Books

Parteek Bhatia, Data Mining and Data Warehousing: Principles and Practical Techniques, Cambridge University Press, 2019.

Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, Introduction to Data Mining, Pearson, 2nd Edition, 2019.

Mode of Assessment: Continuous Assessment / FAT / Oral examination and others

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE209L	Machine Learning	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To teach the theoretical foundations of various learning algorithms.
2. To train the students better understand the context of supervised and unsupervised learning through real-life examples.
3. To understand the need for Reinforcement learning in real – time problems.
4. Apply all learning algorithms over appropriate real-time dataset.
5. Evaluate the algorithms based on corresponding metrics identified.

Course Outcome

At the end of this course, student will be able to:

1. Understand, visualize, analyze and preprocess the data from a real-time source.
2. Apply appropriate algorithm to the data.
3. Analyze the results of algorithm and convert to appropriate information required for the real – time application.
4. Evaluate the performance of various algorithms that could be applied to the data and to suggest most relevant algorithm according to the environment.

Module:1	**Introduction to Machine Learning and Pre-requisites**	**4 hours**
Introduction to Machine Learning – Learning Paradigms – PAC learning – Version Spaces – Role of Machine Learning in Artificial Intelligence applications.		
Module:2	**Supervised Learning – I**	**7 hours**
Linear and Non-Linear examples – Multi–Class & Multi-Label classification – Linear Regression – Multiple Linear Regression – Naïve Bayes Classifier – Decision Trees – ID3 – CART – Error bounds.		
Module:3	**Supervised Learning – II**	**8 hours**
K-NN classifier – Logistic regression – Perceptron – Single layer & Multi-layer – Support Vector Machines – Linear & Non-linear – Metrics & Error Correction.		
Module:4	**Unsupervised Learning**	**9 hours**
Clustering basics (Partitioned, Hierarchical and Density based) - K-Means clustering – K-Mode clustering – Self organizing maps – Expectation maximization – Principal Component Analysis – Kernel PCA – tSNE (t-distributed stochastic neighbor embedding) - Metrics & Error Correction.		
Module:5	**Ensemble Learning**	**5 hours**
Bias – Variance Tradeoff – Bagging and Boosting (Random forests, Adaboost, XG boost inclusive) – Metrics & Error Correction.		
Module:6	**Machine Learning in Practice**	**3 hours**
Class Imbalance – SMOTE – One Class SVM – Optimization of hyper parameters.		
Module:7	**Reinforcement Learning (RL)**	**8 hours**
Basics of RL – RL Framework – Markov Decision Process – Exploration Vs Exploitation - Polices, Value Functions and Bellman Equations – Solution Methods – Q-learning.		
Module:8	**Contemporary Issues**	**1 hour**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.

2.	Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, A Bradford Book; 2018.			
Reference Books				
1.	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012.			
2.	Tom Mitchell, Machine Learning, McGraw Hill, 3rd Edition, 1997.			
3.	Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014			
Mode of Evaluation : Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies	09-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BCSE209P	Machine Learning Lab	0	0	2	1
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To teach the theoretical foundations of various learning algorithms.
2. To train the students better understand the context of supervised and unsupervised learning through real-life examples.
3. To understand the need for Reinforcement learning in real – time problems.
4. Apply all learning algorithms over appropriate real-time dataset.
5. Evaluate the algorithms based on corresponding metrics identified.

Course Outcome

1. At the end of this course, student will be able to:
2. Understand, visualize, analyze and preprocess the data from a real-time source.
3. Apply appropriate algorithm to the data.
4. Analyze the results of algorithm and convert to appropriate information required for the real – time application.
5. Evaluate the performance of various algorithms that could be applied to the data and to suggest most relevant algorithm according to the environment.

Indicative Experiments

1.	Linear & Multiple Linear Regression
2.	Naïve Bayes classifier
3.	Decision trees – ID3 & CART
4.	Logistic regression
5.	Support Vector Machines – Linear & Non-linear
6.	Single & Multilayer Perceptron
7.	K-NN, K-Means & K-mode clustering
8.	Random – forest
9.	Adaboost, XGboost
10.	Principal component analysis
11.	Self – Organizing maps
12.	Q-Learning

Total Laboratory Hours	**30 hours**

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

Recommended by Board of Studies	09-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE331L	Exploratory Data Analysis	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. The course introduces the methods for data preparation and data understanding.
2. It covers essential exploratory techniques for understanding multivariate data by summarizing it through statistical and graphical methods.
3. Supports to summarize use of predictive analytics, data science and data visualization.

Course Outcomes

At the end of the course, the student will be able to

1. Handle missing data in the real world data sets by choosing appropriate methods.
2. Summarize the data using basic statistics. Visualize the data using basic graphs and plots.
3. Identify the outliers if any in the data set.
4. Choose appropriate feature selection and dimensionality reduction.
5. Apply Techniques for handling multi-dimensional data.

Module:1	Introduction to Exploratory Data Analysis	4 hours

Introduction to Exploratory Data Analysis (EDA) –Steps in EDA, Data Types: Numerical Data – Discrete data, continuous data – Categorical data – Measurement Scales: Nominal, Ordinal, Interval, Ratio – Comparing EDA with classical and Bayesian Analysis – Software tools for EDA.

Module:2	Data Transformation	4 hours

Transformation Techniques: Performing data deduplication - replacing values – Discretization and binning. Introduction to Missing data, handling missing data: Traditional methods - Maximum Likelihood Estimation.

Module:3	Correlation Analysis and Time Series Analysis	4 hours

Types of analysis: Univariate analysis - bivariate analysis - multivariate analysis. Time Series Analysis (TSA): Fundamentals of TSA - characteristics of TSA – Time based indexing - visualizing time series – grouping time series data - resampling time series data.

Module:4	Data Summarization and Visualization	4 hours

Statistical summary measures, data elaboration, 1-D Statistical data analysis, 2-D Statistical data Analysis, contingency tables, n-D Statistical data analysis. Visualization: Scatter plots – Dot charts - Bar plots.

Module:5	Clustering Algorithms	4 hours

Introduction to Spectral clustering – Document clustering – Minimum Spanning Tree clustering. Overview of Model-based clustering – Expectation-Maximization algorithm – Hierarchical Agglomerative model-based clustering. Outlier detection using Clustering.

Module:6	Dimensionality Reduction	4 hours

Linear Methods: Principal Component Analysis (PCA) – Singular Value Decomposition – Factor Analysis -Intrinsic Dimensionality. Non Linear methods: Multidimensional Scaling – Manifold Learning – Self-Organizing Maps.

Module:7	Model Development and Evaluation	4 hours

Constructing linear regression model – evaluation – computing accuracy – understanding accuracy. Understanding reinforcement learning: Difference between supervised and reinforcement learning – Applications of reinforcement learning.

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**30hours**

Text Book(s)

1. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python" 1st Edition, 2020, Packt Publishing.
2. Martinez, W , Martinez A & J.L. Solka : Exploratory Data Analysis with MATLAB, CRC Press, A Chapman & Hall Book, 3rd Edition, 2017

Reference Books

1. Michael Jambu, "Exploratory and multivariate data analysis", 1991, 1st Edition, Academic Press Inc.
2. Charu C. Aggarwal, "Data Mining The Text book", 2015, Springer.
3. Craig K. Enders, "Applied Missing Data Analysis", 2010, 1st Edition, The Guilford Press.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE331P	Exploratory Data Analysis Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Emphasize the importance of programming in EDA.
2. Familiarize the student with R programming for various tasks.
3. Explore data structures and file processing facilities in R language.

Course Outcomes

At the end of the course, the student will be able to

1. Engrave simple R programs.
2. Debug and execute R programs using R studio.
3. Implement several algorithms in R language.

	Indicative Experiments	
1.	Data transformation and pre-processing. Write R programs to read data from keyboard and transform it to various ranges like [-3,+3], [-1,+1], [0,1] etc.	**4 hours**
2.	Write R programs to read data from keyboard or text files and compute summary measures like arithmetic mean, median, mode, variance and standard deviation. Also read a set of X,Y values and find covariance and correlation, use statistical techniques to identify outlier data	**6 hours**
3.	Estimation of missing data, global methods, class based methods, multiple imputation methods etc	**6 hours**
4	Exploratory Data Analysis for Structured Data	**4 hours**
4.	Write R programs to implement the k-means clustering algorithm by reading the data and user-specified value of k. Display the characteristics of the clusters found by the algorithm.	**6 hours**
5.	Write R programs for nearest neighbour algorithms for classification	**4 hours**
	Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE332L	Deep Learning	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Introduce major deep neural network frameworks and issues in basic neural networks.
2. To solve real world applications using Deep learning.

Course Outcomes

At the end of this course, student will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications.
4. Design of test procedures to assess the efficiency of the developed model.
5. To understand the need for Reinforcement learning in real – time problems.

Module:1	Introduction to neural networks and deep neural networks	7 hours

Neural Networks Basics - Functions in Neural networks – Activation function, Loss function - Function approximation - Classification and Clustering problems - Deep networks basics - Shallow neural networks – Activation Functions – Gradient Descent – Back Propagation – Deep Neural Networks – Forward and Back Propagation – Parameters – Hyperparameters.

Module:2	Improving deep neural networks	8 hours

Mini-batch Gradient Descent – Exponential Weighted Averages – Gradient Descent with Momentum – RMSProp and Adam Optimization – Hyperparameter tuning – Batch Normalization – Softmax Regression – Softmax classifier – Deep Learning Frameworks – Data Augmentation - Under-fitting Vs Over-fitting.

Module:3	Convolution neural networks	6 hours

Foundations of Convolutional Neural Networks – CNN operations – Architecture – Simple Convolution Network – Deep Convolutional Models – ResNet, AlexNet, InceptionNet and others.

Module:4	Recurrent networks	6 hours

Recurrent Neural Networks - Bidirectional RNNs, Encoder, Decoder, Sequence-to-Sequence Architectures, Deep Recurrent Networks, Auto encoders - Bidirectional Encoder Representations from Transformers (BERT).

Module:5	Recursive neural networks	6 hours

Long-Term Dependencies - Echo State Networks - Long Short-Term Memory and Other Gated RNNs - Optimization for Long-Term Dependencies - Explicit Memory.

Module:6	Advanced Neural networks	6 hours

Transfer Learning – Transfer Learning Models – Generative Adversarial Network and their variants – Region based CNN – Fast RCNN - You Only Look Once – Single shot detector.

Module:7	Deep reinforcement learning	5 hours

Deep Reinforcement Learning – Q-Learning – Deep Q-Learning – Policy Gradients - Advantage Actor Critic (A2C) and Asynchronous Advantage Actor Critic (A3C) – Model based Reinforcement Learning – Challenges.

Module:8	Contemporary issues	1 hour

	Total Lecture hours:	45 Hours

Text Book(s)

1.	Ian Goodfellow Yoshua Bengio Aaron Courville, Deep Learning, MIT Press, 2017.
2	Michael Nielsen, Neural Networks and Deep Learning, Determination Press, first Edition, 2013.
Reference Books	
1.	N D Lewis, Deep Learning Step by Step with Python, 2016.
2.	Josh Patterson, Adam Gibson, Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017.
3	Umberto Michelucci, Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Apress, 2018.
4	Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, Deep Learning with TensorFlow: Explore neural networks with Python, Packt Publisher, 2017.
Mode of Evaluation: CAT / Written Assignment / Quiz / FAT	

Recommended by Board of Studies	09-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE332P	Deep Learning Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Introduce major deep neural network frameworks and issues in basic neural networks.
2. To solve real world applications using Deep learning.

Course Outcomes

At the end of this course, student will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications.
4. Design of test procedures to assess the efficiency of the developed model.
5. Understand the need for Reinforcement learning in real – time problems.

Indicative Experiments

1.	Demonstration and implementation of Shallow architecture, using Python, Tensorflow and Keras. • Google Colaboratory - Cloning GitHub repository, Upload Data, Importing Kaggle's dataset, Basic File operations • Implementing Perceptron, • Digit Classification : Neural network to classify MNIST dataset	**10 hours**
2.	Hyper parameter tuning and regularization practice - • Multilayer Perceptron (BPN) • Mini-batch gradient descent,	**4 hours**
3.	Convolution Neural Network application using Tensorflow and Keras, • Classification of MNIST Dataset using CNN • Face recognition using CNN	**4 hours**
4.	Object detection using Transfer Learning of CNN architectures	**2 hours**
5.	Image denoising (Fashion dataset) using Auto Encoders • Handling Color Image in Neural Network aka Stacked Auto Encoders (Denoising)	**2 hours**
6.	Text processing, Language Modeling using RNN	**2 hours**
7.	Transfer Learning models for classification problems	**2 hours**
8.	Sentiment Analysis using LSTM	**2 hours**
9.	Image generation using GAN	**2 hours**
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

Recommended by Board of Studies	09-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE333L	Statistical Inference	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To study statistical methods for hypotheses testing and solving inference problems.
2. To interpret the results in a way that draws evidence-based and well-informed decisions from data.
3. To derive conclusions from data and analyze its implications**.**

Course Outcomes

At the end of the course, the student will be able to

1. Understand the notion of a parametric model, point estimation of the parameters and properties of a good estimator.
2. Learn the concept of interval estimation and confidence intervals.
3. Understand and perform large-sample tests of hypotheses.
4. Discuss nonparametric tests of hypotheses.
5. Translate and correlate the statistical analysis into Statistical inference

Module:1	Introduction to Estimator	4 hours

Population, sample, parameter and statistic- Estimator, Estimate-characteristics of a good estimator – Unbiasedness- Consistency-Invariance property of Consistent estimator- Sufficient condition for consistency- Sufficiency- Factorization Theorem- Minimal sufficiency- Efficiency- Applications of Lehmann-Scheffe's theorem, Rao - Blackwell Theorem and applications. Bayesian Estimation.

Module:2	Point Estimation	5 hours

Methods of point estimation- Maximum likelihood method (the asymptotic properties of ML estimators are not included), Large sample properties of ML estimator (without proof)- applications of MLE, Method of Minimum variance, method of moments, method of least squares, method of minimum chi-square.

Module:3	Interval Estimation	3 hours

Confidence limits and confidence coefficient; Duality between acceptance region of a test and a confidence interval; Construction of confidence intervals for population proportion (small and large samples) and between two population proportions(large samples); Confidence intervals for mean and variance of a normal population; Difference between the mean and ratio of two normal populations.

Module:4	Testing of hypotheses	4 hours

Types of errors, power of a test, most powerful tests; Neyman-Pearson Fundamental Lemmaand its applications; Notion of Uniformly most powerful tests; Likelihood Ratio tests: Description and property of LR tests - Application to standard distributions.

Module:5	Large sample tests	4 hours

Large sample properties; Tests of significance (under normality assumption)- Test for a single population mean, proportion; Test for equality of two means, proportions; Test for variance, Test for correlation and Test for Regression.

Module:6	Small sample tests	4 hours

Student's t-test, test for a population mean, equality of two population means, paired t-test, F-test for equality of two population variances; Chi-square test for goodness of fit, independence of attributes.

Module:7	Non-parametric tests	4 hours

Sign test, Wilcoxon Signed rank test, Median test, Wilcoxon-Mann-Whitney test, Run test and One sample Kolmogorov Smirnov test, Kruskal Wallis-H-test: Description, properties and applications.

Module:8	**Contemporary Issues**	**2 hours**
	Total hours	**30 hours**

Text Book(s)	
1.	Robert V Hogg, Elliot A Tannis and Dale L.Zimmerman, Probability and Statistical Inference, 9th Edition, Pearson publishers, 2015.
2.	Manoj Kumar Srivastava and Namita Srivastava, Statistical Inference Testing of Hypotheses, Prentice Hall of India, Kindle Edition, 2014.
Reference Books	
1.	Marc S. Paolella, Fundamental statistical inference: A computational approach, Wiley, 2018.
2.	B. K. Kale and K. Muralidharan, Parametric Inference, Narosa Publishing House, 2016.
3.	Miller, I and Miller, M, John E. Freund's Mathematical statistics with Applications, Pearson Education, 2002.
4.	George Casella and Roger L.Berger, Statistical Inference, 2nd edition, Casebound Engelska, 2002.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE333P	Statistical Inference Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To study statistical methods for hypotheses testing and solving inference problems.
2. To interpret the results in a way that draws evidence-based and well-informed decisions from data.
3. To derive conclusions from data and analyze its implications**.**

Course Outcomes

At the end of the course, the student will be able to

1. Understand the notion of a parametric model, point estimation of the parameters and properties of a good estimator.
2. Conquer the concept of interval estimation and confidence intervals.
3. Analyze and perform large-sample tests of hypotheses.
4. Discuss nonparametric tests of hypotheses.
5. Translate and correlate the statistical analysis into Statistical inference

	Indicative Experiments	
1	Methods of Estimation – MLE and Method of Moments	**2 hours**
2	Estimation of Confidence intervals	**4 hours**
3	*P*- value and Power of the test	**2 hours**
4	Large Sample Tests- Test for Population mean & Population proportions	**4 hours**
5	Small Sample Tests – t – test for population mean, Paired t-test	**4 hours**
6	F- test for population variances	**2 hour**
7	Chi-square test for goodness of fit and test for attributes	**4 hours**
8	Test for correlation and test for regression	**6 hours**
9	Non-parametric tests	**4 hours**
	Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE334L	Predictive Analytics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Learn the fundamental principles of analytics for business and learn how to Visualize and explore data to better understand relationships among variables.
2. To understand the techniques of modeling and examine how predictive analytics can be used in decision making.
3. Apply predictive models to generate predictions for new data.

Expected Course Outcome

Upon completion of the course the student will be able to

1. Understand the importance of predictive analytics and processing of data for analysis.
2. Describe different types of predictive models.
3. Apply regression and classification model on applications for decision making and evaluate the performance.
4. Analyze the impact of class imbalance on performance measure for model predictions and models that can mitigate the issue during training.
5. Define and apply time series forecasting models in a variety of business contexts.

Module:1	Introduction to Analytics	5 hours

Introduction to predictive analytics – Business analytics: types, applications- Models: predictive models – descriptive models – decision models - applications - analytical techniques.

Module:2	Data Pre-processing and Model Tuning	6 hours

Data transformations: Individual predictors, Multiple predictors, Dealing with missing values, Removing. Adding, Binning Predictors, Computing, Model Tuning, Data Splitting, Resampling.

Module:3	Predictive Modeling	6 hours

Propensity models, cluster models, collaborative filtering, applications and fundamental limitations. Statistical Modeling- Formal Definition, Model Comparison, Classification.

Module:4	Comparison of Regression Models	7 hours

Measuring Performance in Regression Models - Linear Regression and Its Cousins - Non-Linear Regression Models - Regression Trees and Rule-Based Models Case Study: Compressive Strength of Concrete Mixtures.

Module:5	Comparison of Classification Models	7 hours

Measuring Performance in Classification Models - Discriminant Analysis and Other Linear Classification Models - Non-Linear Classification Models - Classification Trees and Rule-Based Models - Model Evaluation Techniques.

Module:6	Remedies for Severe Class Imbalance	6 hours

The Effect of Class Imbalance - Model Tuning - Alternate Cutoffs - Adjusting Prior Probabilities - Unequal Case Weights - Sampling Methods - Cost-Sensitive Training. Measuring Predictor Importance - Factors that can affect Model Performance.

Module:7	Time Series Analysis	6 hours

Methods for time series analyses – Analysis: Motivation – Exploratory analysis – Prediction and forecasting – Classification – Regression analysis – Signal estimation – Segmentation. Models – Autoregressive model - Partial autocorrelation function.

Module:8	Contemporary Issues	2 hours

	Total Lecture Hours:	45 hours

Text Book(s)			
1.	Kuhn, Max, and Kjell Johnson. Applied Predictive Modeling, 3rd Edition, Springer, 2019.		
2.	Jeffrey Strickland, Predictive analytics using R, Simulation educators, Colorado Springs, 2015.		
Reference Books			
1.	Anasse Bari, Mohamed Chaouchi, Tommy Jung, Predictive Analytics for dummies, 2nd edition Wiley, 2016.		
2.	Daniel T.Larose and Chantal D.Larose, Data Mining and Predictive Analytics, 2nd edition Wiley, 2015.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE335L	Healthcare Data Analytics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Describe how data-based healthcare can help in improving outcomes for patient health.
2. To design data models that combine patient records from multiple sources to form a patient centric view of data.
3. To use data analytics to find health concerns and solutions to the problem faced by a patient.
4. To find meaningful patterns and trends in healthcare data to help the overall population.

Course Outcomes

At the end of the course, the student will be able to

1. Explain the concepts of Healthcare Data Analytics and healthcare foundations.
2. Apply machine learning techniques on healthcare data analytics.
3. Measure and analyse the quality of health-care systems.
4. Develop models for effective predictions in healthcare applications.
5. Use modern day emerging technologies in healthcare data analytics process.

Module:1	Introduction to Healthcare Data Analytics	3 hours

Introduction – Need for Healthcare Analytics - Foundations of Healthcare Analytics – Examples of Healthcare Analytics.

Module:2	Healthcare Foundations	5 hours

Healthcare delivery - Healthcare financing - Healthcare policy – Handling Patient data: the journey from patient to computer - Standardized clinical codesets - Breaking down healthcare analytics: population, medical task, data format, disease.

Module:3	Machine Learning Foundations for Healthcare	8 hours

Model frameworks for medical decision making: Tree-like reasoning, Probabilistic reasoning and Bayes theorem, Criterion tables and the weighted sum approach, Pattern association and neural networks - Machine learning pipeline: Loading the data, Cleaning and preprocessing the data, Exploring and visualizing the data, Selecting features, Training the model parameters, Evaluating model performance.

Module:4	Measuring Healthcare Quality	8 hours

Introduction to healthcare measures, Medicare value-based programs: The Hospital Value-Based Purchasing (HVBP) program, The Hospital Readmission Reduction (HRR) program, The Hospital-Acquired Conditions (HAC) program, The End-Stage Renal Disease (ESRD) quality incentive program, The Skilled Nursing Facility Value-Based Program (SNFVBP), The Home Health Value-Based Program (HHVBP), The Merit-Based Incentive Payment System (MIPS).

Module:5	Making Predictive Models in Healthcare	8 hours

Introduction to Predictive Analytics – Obtaining and Importing the NHAMCS Dataset – Making the Response Variable - Splitting the Data into Train and Test Sets - Preprocessing the Predictor Variables – Building the Models – Using the Models to Make Predictions – Improving our Models.

Module:6	Healthcare Analytics Applications	6 hours

Introduction - Descriptive Analytics Applications - Predictive Analytics Applications - Prescriptive Analytics Application.

Module:7	Healthcare and Emerging Technologies	5 hours

Healthcare analytics and the internet - Healthcare and the Internet of Things - Healthcare

analytics and social media - Healthcare and deep learning - Obstacles, ethical issues, and limitations.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	Kumar, Vikas Vik. Healthcare Analytics Made Simple: Techniques in healthcare computing using machine learning and Python. Packt Publishing Ltd, 2018.
2.	El Morr, Christo, and Hossam Ali-Hassan. Analytics in healthcare: a practical introduction. Springer, 2019.
Reference Books	
1.	Dinov, Ivo D. "Data Science and Predictive Analytics." Springer, Ann Arbor, MI, USA https://doi. org/10 1007 (2018): 978-3.
2.	Yang, Hui, and Eva K. Lee, eds. Healthcare analytics: from data to knowledge to healthcare improvement. John Wiley & Sons, 2016.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar / group discussion			
Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE336L	Financial Data Analytics	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To learn to model financial time series using liner ARMA type time series.
2. To study and analyze to test and model heteroscedastic effects using ARCH / GARCH type time series.
3. To learn how to test for unit root and construct ARMA models.

Course Outcomes

At the end of the course, the student will be able to

1. Approach and analyze any financial data.
2. Differentiate between various time series models.
3. Perform cross-validation of various financial models developed.
4. Forecast future observations on financial data.

Module:1	**Financial data and their properties**	**4 hours**

Asset Returns – Bond Yields and Prices – Implied Volatility – Examples and Visualization of financial data – Multivariate returns.

Module:2	**Linear models for financial time series**	**4 hours**

Simple autoregressive models – Simple moving average models – Simple ARMA models – Unit Root nonstationarity – Exponential smoothing.

Module:3	**Seasonal and Long memory models**	**4 hours**

Seasonal models – Regression models with time series errors – Long memory models.

Module:4	**Asset Volatility and Volatility models**	**4 hours**

Characteristics of Volatility – Structure of a model – Testing for ARCH Effect – ARCH Model – GARCH Model – GARCH-M Model – Exponential Garch Model – Threshold GARCH model – Stochastic volatility model – alternative approaches.

Module:5	**Applications of Volatility Models**	**4 hours**

Garch Volatility Term structure – Option pricing and hedging – Time Varying Correlations and Betas – Minimum Variance Portfolios – Prediction.

Module:6	**High Frequency Financial Data**	**4 hours**

Nonsynchronous trading – Bid ask spread of trading prices – Empirical characteristics of trading data – Models for price changes.

Module:7	**Value at Risk**	**4 hours**

Risk measure and Coherence – Risk metrics –Extreme value approach to Value at Risk – Peak over thresholds.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Ruey S. Tsay An Introduction to Analysis of Financial Data with R, Wiley, 2013.

Reference Books

1. Analysis of Financial Time Series, by Ruey S. Tsay, 3rd edition, Wiley Series in Probability and Statistics, 2010.
2. William G. Foote, Financial Engineering Analytics: A Practice Manual Using R, 2018.
3. Statistical Analysis of Time-Series Data in SPlus, by Ren´e Carmona, Springer, March 4, 2004.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE336P	Financial Data Analytics Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Learn how to model financial time series using liner ARMA type time series.
2. Study how to test and model heteroscedastic effects using ARCH / GARCH type time series.
3. Acquire how to test for unit root and construct ARMA models.

Course Outcome

At the end of the course, the student will be able to

1. Approach and analyze any financial data.
2. Differentiate between various time series models.
3. Perform cross-validation of various financial models developed.
4. Forecast future observations on financial data.

Indicative Experiments

1.	Given a simple daily return of a concern as data, implement and execute a R program to compute the sample mean, standard deviation, skewness, excess kurtosis, minimum and maximum of each simple return series.	**8 hours**
2.	Consider the daily range (daily high–daily low) of Apple stock from January 2, 2007 to December 23, 2011. One can obtain the data by the package quantmod from Yahoo. Compute the first 100 lags of ACF of the series. Is there evidence of long-range dependence? Why? If the range series has long memory, build an ARMA model for the data.	**8 hours**
3.	Consider the 30-year conventional mortgage rates from April 1971 to November 2011. Build a pure time series model for the monthly mortgage rate. Perform model checking and find the fitted model.	**8 hours**
4.	Use the quantmod package to obtain the daily prices of Apple stock from January 2, 2007, to November 30, 2011. Use an ARMA–GARCH model to obtain the daily volatility of the stock. Compare the three volatility series.	**6 hours**
	Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment / FAT / Oral examination and others

Recommended by Board of Studies	12-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

PROJECTS AND INTERNSHIP

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

Course Code	Course Title	L	T	P	C
BCSE399J	Summer Industrial Internship	0	0	0	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objective

1. The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.

Course Outcomes

1. Demonstrate professional and ethical responsibility.
2. Understand the impact of engineering solutions in a global, economic, environmental and societal context.
3. Develop the ability to engage in research and to involve in life-long learning.
4. Comprehend contemporary issues.

Module Content

Four weeks of work at industry site.
Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
BCSE497J	Project - I	0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcomes

1. Demonstrate professional and ethical responsibility.
2. Evaluate evidence to determine and implement best practice.
3. Mentor and support peers to achieve excellence in practice of the discipline.
4. Work in multi-disciplinary teams and provide solutions to problems that arise in multi- disciplinary work.

Module Content

Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

Can be individual work or a group project, with a maximum of 3 students.

In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.

Carried out inside or outside the university, in any relevant industry or research institution.

Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
BCSE498J	Project – II / Internship	0	0	0	5
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcomes

1. Formulate specific problem statements for well-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution. Document the results in the form of technical report / presentation.

Module Content

1. Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	09-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BRIDGE COURSE

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

Course Code	Course Title	L	T	P	C
BENG101N	Effective English Communication	0	0	4	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To hone LSRW skills for effective communication
2. To enhance communication skills for future career aspirations
3. To gain critical communication skills in writing and public speaking

Course Outcomes

1. Write effective sentences using appropriate grammar and vocabulary
2. Express clearly in everyday conversations with lucid pronunciation
3. Analyse the given listening inputs for effective comprehension
4. Apply different reading strategies to various texts and use them appropriately

Indicative Experiments

1.	**Fundamentals of Grammar:** Parts of Speech, Articles, Tenses, Sentence Structure, Types of Sentences, Subject-Verb Agreement. **Activity:** Exercises and worksheets
2.	**Speaking for Self-Expression:** Formal Self-Introduction, Expressing Oneself. **Activity:** Self-Introduction, Just a Minute (JAM)
3.	**Basic Listening:** Listening to Simple Conversations, Short Speeches/Stories. **Activity:** Gap fill exercises
4.	**Reading Skills:** Reading Strategies, Skimming and Scanning. **Activity:** Glaze reading, Reading comprehension, Reading newspaper articles
5.	**Drafting Paragraphs:** Keywords Development, Writing Paragraphs using Connectives **Activity:** Picture and poster interpretation
6	**Vocabulary Enrichment:** Synonyms and Antonyms, Prefixes and Suffixes, Word Formation, One Word Substitution, Frequently used Idioms and Phrases, Homophones and Homonyms. **Activity:** Crossword puzzles and worksheets
7	**Listening for Pronunciation:** Introduction to Phonemes, Listening to Native Speakers, Listening to Various Accents. **Activity:** Listening and imitating, Spell Bee
8	**Interactive Speaking:** Everyday Conversations, Team Interactions, Simulations. **Activity:** Situational role plays
9	**Email and Letter Writing:** Types and Format of Emails and Letters. **Activity:** Official e-mails and letters, personal letters
10	**Reading for Comprehension:** Short Stories by Indian Writers. **Activity:** Summarising, loud reading

Total Laboratory hours: 30 hours

Mode of assessment: Continuous assessment/ FAT/ Written assignments/ Quiz/ Oral examination / Group activity

Recommended by Board of Studies	**28-06-2021**		
Approved by Academic Council	**No. 63**	**Date**	**23-09-2021**

NON-GRADED CORE REQUIREMENT

(2023-2024)

B.Tech. Computer Science and Engg (Data Science)

Non-Graded Core Courses

BCHY102N	Environmental Sciences	L	T	P	C
		0	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

The course is aimed at students to

1. Understand and appreciate the unity of life in all its forms and their implications of life style on the environment.
2. Identify the different causes for environmental degradation.
3. Analyze individual's contribution to environmental pollution.
4. Evaluate the impact of pollution at the global/local level and find solutions for remediation.

Course Outcomes

At the end of the course, the students will be able to:

1. Recognize the environmental issues in a problem-oriented, interdisciplinary perspective.
2. Classify the key environmental issues, the science behind those problems and potential solutions.
3. Demonstrate the significance of biodiversity and its preservation.
4. Identify various environmental hazards.
5. Design various methods for the conservation of resources.
6. Formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects.

Module: 1	**Environment and Ecosystem**	**5 hours**

Environment: definition; Earth–life support system. Ecosystem definition, components and types. Key environmental problems, their basic causes and sustainable solutions. Food chain, food web and their significance, Energy flow in ecosystem; Ecological succession-stages involved, primary and secondary succession - hydrarch, mesarch, xerarch.

Module: 2	**Biodiversity**	**4 hours**

Biodiversity-definition, levels and importance. Species: roles: types: extinct, endemic, endangered and rare species. Hot-spots –Significance, Mega-biodiversity. Threats to biodiversity due to natural and anthropogenic activities, Conservation methods. GM crops-advantages and disadvantages.

Module: 3	**Sustaining Environmental Quality**	**4 hours**

Environmental hazards: definition, types, causes and solutions: Biological (Malaria, COVID-19), Chemical (BPA, heavy metals), and Nuclear (Chernobyl); Air, water and soil quality management and conservation; Solid waste management methods.

Module: 4	**Clean and Green Energy**	**5 hours**

Renewable energy resources: Solar energy-thermal and photovoltaic; Hydroelectric energy. Wind energy, Ocean thermal energy; Geothermal energy; Energy from biomass; Hydrogen energy; Solar-hydrogen revolution. Electric and CNG vehicles.

Module: 5	**Environmental Protection Policies**	**4 hours**

Environmental Protection (EPA) objectives; Air Act, water Act, Forest conservation Act and Wild life protection Act. Environmental Impact Analysis: guidelines, core values. Impact assessment methodologies.

Module: 6	**Sustainable development**	**4 hours**

Effect of population-urban environmental problems; Population age structure; Sustainable human societies: tools in economics, sustainable development goals SDGs and promoting awareness. Women and child welfare, Women empowerment.

Module: 7	**Global Climate Change**	**4 hours**
Global climate change and green-house effect. Kyoto Protocol-carbon credits, The Paris Agreement, carbon sequestration: definition, types and methodologies. Ozone layer depletion: causes and impacts. Mitigation of ozone layer depletion- Montreal Protocol. Role of Information Technology in environment.		
Total Lecture hours:		**30 hours**
Assessment: Seminars, Quiz, Case Studies, Final Assessment Test.		
Text Books		
1. G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengagelearning. 2. Benny Joseph, (2012), Environmental Science and Engineering, 5th Edition, Tata McGraw Hill Education Private Limited, New Delhi, India.		
Reference Book(s)		
1. David M. Hassenzahl, Mary Catherine Hager, Linda. R. Berg (2011), Visualizing Environmental Science, 4th Edition, John Wiley & Sons, USA. 2. Raj Kumar Singh, (2012), Environmental Studies, Tata McGraw Hill Education Private Limited, New Delhi, India. 3. George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.		

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

BCSE101N	Introduction to Engineering	L	T	P	C
		0	0	0	1
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objective:

- To make the student comfortable and get familiarized with the facilities available on campus
- To make the student aware of the exciting opportunities and usefulness of engineering to society
- To make the student understand the philosophy of engineering

Course Outcome:

- To know the infrastructure facilities available on campus
- To rationally utilize the facilities during their term for their professional growth
- To appreciate the engineering principles, involve in life-long learning and take up engineering practice as a service to society

General Guidelines

1. Student should observe and involve in the activities during the induction programme. Both general activities and those which are discipline-specific should be included here.
2. Student should get familiarized with the infrastructure facilities available on campus during the general induction, school induction programme and also from the institutional website.
3. Student should attend the lecture by industries, including those on career opportunities, organized by the School and probably involve in 'Do-it-yourself' projects or projects involving reverse-engineering.
4. Activities under 'Do-it-Yourself' will be detailed by the School.
5. Student should prepare a report on the activities and observations, as per the specified format, and submit the same in institutional LMS, VTOP for further evaluation

   General instruction on formatting: Document to be prepared with the titles given in the template; Arial type with font size of 12 to be used; photographs can be included in the document as per the requirement; 1.5 line spacing to be used.

Mode of Evaluation: Evaluation of the submitted report and interaction with the students

Recommended by Board of Studies	02.07.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

BHUM101N	Ethics and Values	L	T	P	C
		0	0	0	2
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity.
2. To understand the negative health impacts of certain unhealthy behavior.
3. To appreciate the need and importance of physical, emotional health and social health.

Expected Course Outcomes:

1. Students will be able to:
2. Follow sound morals and ethical values scrupulously to prove as good citizens.
3. Understand various social problems and learn to act ethically.
4. Understand the concept of addiction and how it will affect the physical and mental health.
5. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.
6. Identify the main typologies, characteristics, activities, actors and forms of cybercrime.

Module:1	**Being Good and Responsible**
Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society.	
Module:2	**Social Issues 1**
Harassment – Types - Prevention of harassment, Violence and Terrorism.	
Module:3	**Social Issues 2**
Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices; White collar crimes - Tax evasions – Unfair trade practices.	
Module:4	**Addiction and Health**
Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides; Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases.	
Module:5	**Drug Abuse**
Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.	
Module:6	**Personal and Professional Ethics**
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism.	
Module:7	**Abuse of Technologies**
Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites.	
Total Lecture Hours:	**60 hours**

Text Books :

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2019, 2nd Revised Edition, Excel Books, New Delhi.
2. Hartmann, N., "Moral Values" , 2017, United Kingdom: Taylor & Francis.

Reference Books :

1. Rachels, James & Stuart Rachels, "The Elements of Moral Philosophy", 9th edition, 2019, New York: McGraw-Hill Education.

2.	Blackburn, S. "Ethics: A Very Short Introduction", 2001, Oxford University Press.
3.	Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts", 2016, Writers Choice, New Delhi, India.
4	Ministry of Social Justice and Empowerment, "Magnitude of Substance Use in India", 2019, Government of India.
5.	Ministry of Home Affairs, "Accidental Deaths and Suicides in India", 2019, Government of India.
6.	Ministry of Home Affairs, "A Handbook for Adolescents/ Students on Cyber Safety", 2018, Government of India.

Mode of Evaluation: Poster making, Quiz and Term End - Quiz			
Recommended by Board of Studies	27-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BSSC101N	Essence of Traditional Knowledge	L	T	P	C
		0	0	0	2
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives:

1. To impart the knowledge on Indian tradition and Culture.
2. To enable the students to acquire the traditional knowledge in different sectors.
3. To analyze and understand the Science, Management and Indian Knowledge System.

Course Outcomes:

1. Familiarize the concept of Traditional Indian Culture and Knowledge.
2. Explore the Indian religion, philosophy and practices.
3. Analyze and understand the Indian Languages, Culture, Literature and Arts.
4. Gives a clear understanding on the Indian perspective of modern scientific world and basic principles of Yoga and holistic health care system of India.
5. Enable knowledge on Legal framework and traditional knowledge.

Module:1	**Introduction to Traditional Knowledge**	
Traditional knowledge: Definition, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge, characteristics, Traditional knowledge vis-a-vis Indigenous knowledge, Traditional knowledge Vs Western Knowledge.		
Module:2	**Culture and Civilization**	
Introduction to Culture and Civilization, Culture and Heritage, Characteristics features of Indian Culture, Importance of Culture, Cultural practices in Ancient India, Medieval India and Modern India.		
Module:3	**Languages and Literature**	
Indian Languages and Literature: the role of Sanskrit, significance of scriptures to current society, Indian philosophies, other Sanskrit literature and literatures of South India.		
Module:4	**Religion and Philosophy**	
Religion and Philosophy: Religion and Philosophy in ancient India, Religion and Philosophy in Medieval India, Religious Reform Movements in Modern India (selected movements only).		
Module:5	**Fine Arts in India**	
Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama. Science and Technology in India, Development of science in ancient, medieval and modern India. Traditional Medicine – Herbal Healing - Yoga and Pranayama practices.		
Module:6	**Traditional Knowledge in different sectors**	
Traditional knowledge and engineering, Traditional medicine system, Traditional knowledge in agriculture, Dependence of Traditional Societies on food and healthcare needs; Importance of conservation and sustainable development of environment, Management of biodiversity and Protection of Traditional knowledge.		
Module:7	**Legal framework and Traditional Knowledge**	
Introduction on Legal framework and Traditional Knowledge: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, The protection of traditional knowledge bill, 2016.		
Total Lecture Hours:		**60 hours**

Text Books :

1.	Shikha Jain, Parul G Munjal And Somya Joshi,(2020) Traditional Knowledge Systems And Cultural Heritage, Aryan Books International, India.
2.	Anindya Bhukta(2020), Legal Protection for Traditional Knowledge: Towards A New

	Law for Indigenous Intellectual Property, Emerald Publishing Limited, United Kingdom.
Reference Books :	
1.	Traditional Knowledge System in India, by Amit Jha, 2009.
2.	Basant Kumar Mohanta & Vipin Kumar Singh (2012), "Traditional Knowledge System & Technology in India", Pratibha Prakashan, India.
3.	S. Baliyan, Indian Art and Culture, Oxford University Press, India.
4	http://indiafacts.org/author/michel-danino/
5.	GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, Vidyanidhi Prakasham, Delhi,2016.
Mode of Evaluation: Quiz and Term End – Quiz	

Recommended by Board of Studies	16-11-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

Course Code	Course Title	L	T	P	C
BSSC102N	Indian Constitution	0	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

This Course is an introduction of Indian Constitution and basic concepts highlighted in this course for understanding the Constitution of India.

Course Outcome

At the end of the course, the student will acquire:

1. A basic understanding of Constitution of India.
2. The ability to understand the contemporary challenges and apply the knowledge gained from the course to current social contemporary legal issues.
3. The understanding of constitutional remedies.

Module:1	Introduction to Indian Constitution	5 hours

Introduction to the constitution of India and the Preamble - Sources of Indian Constitution - Features of Indian Constitution - Citizenship - Fundamental Rights and Duties - Directive Principles of state policy

Module:2	Union Government and its Administration Structure of the Indian Union	8 hours

Federalism, Centre- State relationship - President: Role, Power and Position - Prime Minister and Council of ministers - Cabinet and Central Secretariat - Lok Sabha - Rajya Sabha- The Supreme Court and High Court: Powers and Functions

Module:3	State Government and its Administration	4 hours

Governor- Role and Position - Chief Minister and Council of Ministers - State Legislative Assembly - State secretariat: Organization, Structure and Functions

Module:4	Local Administration	7 hours

District's Administration Head- Role and Importance - Municipalities: Introduction, Mayor and role of Elected Representative - Panchayati Raj: Composition and Functions Evolution and 73rd and 74th Amendments - Zila Parishad and district administration: Composition and Functions Elected officials and their roles, CEO Zila Panchayat: Position and role- Panchayat Samiti: Composition and Functions - Gram Panchayat: Composition and Functions Importance of grass root democracy

Module:5	Election Commission	6 hours

Role of Chief Election Commissioner - State Election Commission - Functions of Commissions for the welfare of SC/ST/OBC and women.

	Total Lecture hours:	30 hours

Reference Books				
1.	Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, 2018 (23rd edn.)			
2.	M.V.Pylee, India's Constitution, New Delhi; S. Chand Pub., 2017 (16th edn.)			
3.	J.C Johari, Indian Government and Politics, Shoban Lal & Co., 2012			
4.	Noorani, A.G , Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.			
5.	R. Bhargava, (2008) 'Introduction: Outline of a Political Theory of the Indian Constitution', in R. Bhargava (ed.) Politics and Ethics of the Indian Constitution, New Delhi: Oxford University Press.			
6.	Bidyut Chakrabarty & Rajendra Kumar Pandey, Indian Government and Politics, SAGE, New Delhi, 2008			
7.	G. Austin, The Indian Constitution: CornerStone of a Nation, Oxford, Oxford University Press, 1966			
Mode of Evaluation**:** CAT, Written assignment, Quiz and FAT				
Recommended by Board of Studies		27-10-2021		
Approved by Academic Council		No. 68	Date	19-08-2022