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

(2024-25)

B. Tech. Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

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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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School of Computer Science and Engineering

B. Tech. Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

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. Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

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.

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

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

PO_06: Having problem solving ability- solving social issues and engineering problems

PO_07: Having adaptive thinking and adaptability

PO_08: Having a clear understanding of professional and ethical responsibility

PO_09: Having cross cultural competency exhibited by working in teams

PO_10: Having a good working knowledge of communicating in English

PO_11: Having a good cognitive load management [discriminate and filter the available data] skills

PO_12: Having interest in lifelong learning

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School of Computer Science and Engineering

B. Tech. Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Analyze, design, develop and test mathematical foundations in the development of computational solutions of both computer software and hardware.
2. Demonstrate the knowledge about the application of AI technologies and methodologies for robots to adapt to challenging environments.
3. Develop skills to approach and solve social issues with AI enabled robots to ensure ethics.

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School of Computer Science and Engineering

B. Tech. Computer Science and Engineering with Specialization in Artificial Intelligence and Robotics

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
Foundation Core Courses	**53**
Basic Sciences and Mathematics	24
Engineering Sciences	14
Humanities, Social Sciences and Management (HSM)	15
Discipline-linked Engineering Science Courses	**12**
Discipline Core Courses	**47**
Specialization Elective Courses	**21**
Open Elective Courses	**09**
Project and Internship	**09**
Total Graded Credit Requirement	**151**
Non Graded Credit Requirement	11

Bachelor of Technology in Computer Science and Engineering

with Specialization in Artificial Intelligence and Robotics
School of Computer Science and Engineering

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Non-Graded Credit Requirement	11

Basic Sciences and Mathematics **24**

		L	T	P	C
BPHY101L	Engineering Physics	3	0	0	3
BPHY101P	Engineering Physics Lab	0	0	2	1
BCHY101L	Engineering Chemistry	3	0	0	3
BCHY101P	Engineering Chemistry Lab	0	0	2	1
BMAT101L	Calculus	3	0	0	3
BMAT101P	Calculus Lab	0	0	2	1
BMAT102L	Differential Equations and Transforms	3	1	0	4
BMAT201L	Complex Variables and Linear Algebra	3	1	0	4
BMAT202L	Probability and Statistics	3	0	0	3
BMAT202P	Probability and Statistics Lab	0	0	2	1

Engineering Sciences **14**

BEEE102L	Basic Electrical and Electronics Engineering	3	0	0	3
BEEE102P	Basic Electrical and Electronics Engineering Lab	0	0	2	1
BCSE101E	Computer Programming: Python	1	0	4	3
BCSE102L	Structured and Object-Oriented Programming	2	0	0	2
BCSE102P	Structured and Object-Oriented Programming Lab	0	0	4	2
BCSE103E	Computer Programming:Java	1	0	4	3

Humanities, Social Sciences and Management **15**

BENG101N	Effective English Communication (NGC)	0	0	4	2
BENG101L	Technical English Communication	2	0	0	2
BENG101P	Technical English Communication Lab	0	0	2	1
BENG102P	Technical Report Writing	0	0	2	1
BSTS101P	Quantitative Skills Practice I	0	0	3	1.5
BSTS102P	Quantitative Skills Practice II	0	0	3	1.5
BSTS201P	Qualitative Skills Practice I	0	0	3	1.5
BSTS202P	Qualitative Skills Practice II	0	0	3	1.5
BFLE200L	Foreign Language	2	0	0	2
BHSM200L	HSM Elective	3	0	0	3

Discipline-linked Engineering Science Courses **12**

BECE102L	Digital Systems Design	3	0	0	3
BECE102P	Digital Systems Design Lab	0	0	2	1
BECE204L	Microprocessors and Microcontrollers	3	0	0	3
BECE204P	Microprocessors and Microcontrollers Lab	0	0	2	1
BMAT205L	Discrete Mathematics and Graph Theory	3	1	0	4

Discipline Core Courses **47**

BCSE202L	Data Structures and Algorithms	3	0	0	3
BCSE202P	Data Structures and Algorithms Lab	0	0	2	1
BCSE203E	Web Programming	1	0	4	3
BCSE204L	Design and Analysis of Algorithms	3	0	0	3
BCSE204P	Design and Analysis of Algorithms Lab	0	0	2	1
BCSE205L	Computer Architecture and Organization	3	0	0	3
BCSE301L	Software Engineering	3	0	0	3
BCSE301P	Software Engineering Lab	0	0	2	1
BCSE302L	Database Systems	3	0	0	3
BCSE302P	Database Systems Lab	0	0	2	1
BCSE303L	Operating Systems	3	0	0	3
BCSE303P	Operating Systems Lab	0	0	2	1
BCSE304L	Theory of Computation	3	0	0	3
BCSE305L	Embedded Systems	3	0	0	3
BCSE306L	Artificial Intelligence	3	0	0	3
BCSE307L	Compiler Design	3	0	0	3
BCSE307P	Compiler Design Lab	0	0	2	1
BCSE308L	Computer Networks	3	0	0	3
BCSE308P	Computer Networks Lab	0	0	2	1
BCSE309L	Cryptography and Network Security	3	0	0	3
BCSE309P	Cryptography and Network Security Lab	0	0	2	1

Specialisation Elective Courses					**21**
BCSE420L	Sensors, Actuators and Signal Conditioning	2	0	0	2
BCSE420P	Sensors, Actuators and Signal Conditioning Lab	0	0	2	1
BCSE421L	Robotics, Kinematics, Dynamics and Motion Control	3	0	0	3
BCSE422L	Robot Modeling and Simulation	2	0	0	2
BCSE422P	Robot Modeling and Simulation Lab	0	0	2	1
BCSE423L	Robot Programming	2	0	0	2
BCSE423P	Robot Programming Lab	0	0	2	1
BCSE424L	Machine Learning for Robotics	2	0	0	2
BCSE424P	Machine Learning for Robotics Lab	0	0	2	1
BCSE425L	Robotic Perception	3	0	0	3
BCSE425P	Robotic Perception Lab	0	0	2	1
BCSE426L	Robotic Process Automation	2	0	0	2
BCSE426P	Robotic Process Automation Lab	0	0	2	1
BCSE427L	Cognitive Robotics	2	0	0	2
BCSE427P	Cognitive Robotics Lab	0	0	2	1
BCSE428L	Autonomous Drones	2	0	0	2
BCSE428P	Autonomous Drones Lab	0	0	2	1
BCSE432E	Reinforcement Learning	3	0	2	4

Open Elective Courses	**9**

Engineering Disciplines | Projects | Sciences | Humanities | Social Sciences | Liberal Arts | Economics | Finance | Entrepreneurship | Management | Skills | Reading

Project / Internship		**9**
BCSE399J	Summer Industrial Internship	1
BCSE497J	Project-I	3
BCSE498J	Project-II / Internship	5
BCSE499J	One Semester Internship	14

Non-Graded Credit Requirement		**11**
BCSE101N	Introduction to Engineering	1
BSSC101N	Essence of Traditional Knowledge	2
BSSC102N	Indian Constitution	2
BEXC100N	Extracurricular Activities	2
BCHY102N	Environmental Sciences	2
BHUM101N	Ethics and Values	2

Basic Sciences and Mathematics

BPHY101L	Engineering Physics	L	T	P	C
		3	0	0	3
Pre-requisite	**12th of equivalent**	**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 - Standing waves and their eigenfrequencies - waves with dispersion - Superposition of waves and Fourier method (qualitative) - Wave packet - phase velocity and group velocity.

Module:2	**Electromagnetic waves**	**7 hours**

Physics of divergence - gradient and curl - surface and volume integral - Maxwell Equations (Qualitative) - Continuity equation for current densities - Displacement current - Electromagnetic wave equation in free space - Plane electromagnetic waves in free space - Hertz's experiment.

Module:3	**Elements of quantum mechanics**	**7 hours**

Need for Quantum Mechanics: Idea of Quantization (Planck and Einstein) - Compton effect (Qualitative) – de Broglie hypothesis - justification of Bohr postulate - Davisson-Germer experiment - Wave function and probability interpretation - Heisenberg uncertainty principle - Gedanken experiment (Heisenberg's microscope) - Schrödinger wave equation (time dependent and time independent).

Module:4	**Applications of quantum mechanics**	**6 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 CO_2 lasers and their engineering applications.

Module:6	**Propagation of EM waves in optical fibers**	**5 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**	**5 hours**

Introduction to semiconductors - direct and indirect bandgap – p-n junction, Sources: LED and laser diode, Photodetectors: PN and PIN

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

Guest lectures from Industry and, Research and Development Organisations

	Total Lecture hours:	**45 hours**

Text Book(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, 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		
3.	Physics, 2019, 10th Edition, Cengage Learning, USA.		
4.	K. Krane, Modern Physics, 2020, 4th Edition, Wiley Edition, India.		
5.	M.N.O. Sadiku, Principles of Electromagnetics, 2015, 6th Edition, Oxford University Press, India.		
	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

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

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: **Total Tutorial hours :**	**45 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

Engineering Sciences

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

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 - Union

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. Mariano Anaya, Clean Code in Python: Develop maintainable and efficient code, 2nd Edition, Packt Publishing Limited, 2021.

Reference Book(s)

2. 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

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

Humanities, Social Sciences and Management

BENG101N	Effective English Communication	L	T	P	C
		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:** Cloze 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 **60 hours**

Mode of Evaluation: 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

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	L	T	P	C
		0	0	2	1
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 - Abstract/Summary – 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		
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

Discipline Linked Engineering Science Course

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 Course

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 Courses

Course Code	Course Title	L	T	P	C
BCSE420L	Sensors, Actuators and Signal Conditioning	2	0	0	2
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

1. To summarize and analyze the different types of sensors, signal conditioning circuits, and actuators.
2. To introduce students the criteria for selecting a sensor for a particular measurement.
3. To elucidate students the types of actuators: electrical, pneumatic, and hydraulic and enlighten their operation.
4. To familiarize students with the basic techniques of designing the required signal conditioning for a particular sensor.

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the behavior of different types of sensors.
2. Analyze the characteristics and performance measures of sensors and select suitable sensor for the given industrial applications.
3. Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.
4. Elucidate the construction and working of various industrial parameters / devices used to measure temperature, pressure, flow, level and displacement.
5. Design the sensor interfacing and signal conditioning for various applications.
6. Implement the data acquisition systems with different sensors for real-time applications.
7. Realize the trends in sensor technology, industrial network and automation.
8. Conduct experiments and measurements in laboratory and realize hands-on experience on real components, sensors and actuators.

Module:1	Basics of Energy Transformation	2 hours

Introduction to sensors and transducers, Principle of sensing and transduction, Classification of sensors.

Module:2	Performance Characteristics of Sensors	4 hours

Static characteristics: accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics, Mathematical model of transducer: zero, first and second, Response to impulse, step, ramp and sinusoidal inputs, Selection criteria of sensor.

Module:3	Actuator Performance and Selection	5 hours

Electrical actuating systems: solid-state switches, solenoids and electric motors: DC motor, stepper motor, and Inertial measurement unit, Mechanical actuating systems: types of motion, kinematic chains, cams and gears, Pneumatic and hydraulic actuating systems: diaphragms, bellows and control valves.

Module:4	Measurement of Industrial Parameters	6 hours

Measurement of temperature: thermistor and LM35, Measurement of pressure: strain gauge and piezoelectric type, Measurement of distance: ultrasonic, linear variable differential transformer and capacitance type, proximity sensor, Infrared sensor, Pulse oximeter and Tachometer.

Module:5	Signal Conditioning	5 hours

Amplification, Filtering, Multiplexing, Conversion techniques, Sensor interface design: Wheatstone bridge and operational amplifier circuits for various applications.

Module:6	**Data Acquisition System**	**3 hours**
Data Acquisition: single channel and multi-channel data acquisition, Data logging, Interfacing of sensors using DAQ cards, Applications: automobile and biological systems.		
Module:7	**Sensor Technology**	**3 hours**
Process of developing sensors, Trends in sensor technology and IC sensors, Sensor array's and multi-sensor systems, Smart sensors, Industrial network and automation.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	D. Patranabis, "Sensors and Actuators", 2nd Edition, PHI Learning, New Delhi, India, 2013.
2.	Ramon Pallas-Areny, John G. Webster, "Sensors and Signal Conditioning", 2nd Edition, Wiley India Pvt. Ltd., India, 2012.

Reference Books

1.	D. Patranabis, "Sensors and Transducers", 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, India, 2011.
2.	Jon S. Wilson, "Sensor Technology Hand Book", Newnes Publishing Company, Boston, USA, 2005.
3.	A.K. Sawhney, Puneet Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Co. Pvt. Ltd., New Delhi, India, 2014.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE420P	Sensors, Actuators and Signal Conditioning Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To summarize and analyze the different types of sensors, signal conditioning circuits, and actuators.
2. To introduce students the criteria for selecting a sensor for a particular measurement.
3. To elucidate students the types of actuators: electrical, pneumatic, and hydraulic and enlighten their operation.
4. To familiarize students with the basic techniques of designing the required signal conditioning for a particular sensor.

Course Outcome

Comprehend, classify and analyze the behavior of different types of sensors.

1. Analyze the characteristics and performance measures of sensors and select suitable sensor for the given industrial applications.
2. Gain the knowledge about the types of actuators: electrical, pneumatic, and hydraulic, performance criteria and selection.
3. Elucidate the construction and working of various industrial parameters / devices used to measure temperature, pressure, flow, level and displacement.
4. Design the sensor interfacing and signal conditioning for various applications.
5. Implement the data acquisition systems with different sensors for real-time applications.
6. Realize the trends in sensor technology, industrial network and automation.
7. Conduct experiments and measurements in laboratory and realize hands-on experience on real components, sensors and actuators.

Indicative Experiments	
1.	Interfacing of sensors for monitoring the physical quantities (distance, pressure, temperature, light intensity) and raising an alarm/ actuating a signal if the quantity exceeds specified limit.
2.	Measurements using proximity sensor and LiDAR sensor. Control of speed, direction and number of revolutions of a stepper motor.
3.	Obstacle avoidance robotic systems using servomotors, ultrasonic sensor and IR sensor.
4.	Design and test a signal conditioning circuit for the sensor interface: Instrumentation amplifier, filter and comparator.
5.	Interfacing data acquisition system hardware with computer to measure and control the robotic system.
	Total Laboratory Hours | 30 hours

Text Book(s)

1. D. Patranabis, “Sensors and Actuators”, 2nd Edition, PHI Learning, New Delhi, India, 2013.
2. Ramon Pallas-Areny, John G. Webster, “Sensors and Signal Conditioning”, 2nd Edition, Wiley India Pvt. Ltd., India, 2012.

Reference Books

1. D. Patranabis, “Sensors and Transducers”, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, India, 2011.
2. Jon S. Wilson, “Sensor Technology Hand Book”, Newnes Publishing Company, Boston, USA, 2005.
3. A.K. Sawhney, Puneet Sawhney, “A Course in Electrical and Electronic Measurements

	and Instrumentation", Dhanpat Rai and Co. Pvt. Ltd., New Delhi, India, 2014.		
Mode of assessment: Continuous assessment / FAT / Oral examination and others			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE421L	Robotics: Kinematics, Dynamics and Motion Control	3	0	0	3
Pre-requisite	NIL	Syllabus Version 1.0			

Course Objectives:

1. To summarize and analyze the fundamentals of robotics.
2. To introduce students the kinematics and dynamics of robots.
3. To elucidate students the types of motion control.
4. To familiarize students with the basic techniques of designing the robots.

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the fundamentals of robotics.
2. Analyze the inverse manipulator kinematics and dynamics.
3. Gain the knowledge about the manipulator design and mechanism.
4. Elucidate the role of actuators, drive systems and sensors in robotics.

Module:1	**Introduction, Spatial Descriptions and Transformations**	**7 hours**
Introduction: Fundamentals and robot - components, joints, degrees of freedom, coordinates. The mechanics & control of mechanical manipulators. Spatial Descriptions and Transformations: Descriptions – Positions, Orientations, and Frames, Mappings, Operators – Translations, Rotations, and Transformations, Transformation arithmetic and transform equations, transformation of free vectors, Representation & Orientation.		
Module:2	**Manipulator Kinematics**	**4 hours**
Manipulator Kinematics: Links & Connections. Actuator Space, Joint Space and Cartesian Space. Tools & Computational considerations.		
Module:3	**Inverse Manipulator Kinematics**	**5 hours**
Solvability, Algebraic and Geometric. Standard Frames, Repeatability and Accuracy. Jacobians: Velocities and Static Forces: Time varying position and orientation.		
Module:4	**Velocities and Static Forces**	**5 hours**
Linear and rotational velocity of rigid bodies. Jacobians & Singularities. Cartesian transformation of velocities and static forces.		
Module:5	**Manipulator Dynamics**	**7 hours**
Mass Distribution. Newton's and Euler's Equations. Iterative and Closed Form. Lagrangian formulation of manipulator dynamics. Manipulator Dynamics in Cartesian Space. Non-rigid body effects.		
Module:6	**Manipulator-Mechanism Design**	**7 hours**
Kinematic Configuration. Workspace measures and attributes. Redundant and closed chain structures. Actuation Schemes, Stiffness & Deflections. Position Sensing & Force Sensing.		
Module:7	**Motion Control Systems**	**7 hours**
Basic components & terminology. System Dynamics. Laplace transform and inverse Laplace transform. First and second order transfer functions. Proportional and proportional plus controllers. State space control methodology. Digital control and non-linear control systems.		
Module:8	**Contemporary issues**	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. John J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education Limited 2022,
2. Saeed B. Niku, "Introduction to Robotics Analysis, Control, Applications", John Wiley & Sons Ltd 2020.

Reference Books			
1.	Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel and Ashish Dutta. “Industrial Robotics-Technology, Programming and Applications”, McGraw Hill Education; 2nd edition, 2017.		
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE422L	Robot Modeling and Simulation	2	0	0	2
Pre-requisite	BCSE421L	Syllabus Version			
		1.0			

Course Objectives:

1. To create parameter models of simple dynamic systems
2. To make quantitative estimates of model parameters from experimental measurements
3. To obtain the time-domain response of linear systems to initial conditions and/or common forcing functions by computational methods
4. To obtain the frequency-domain response of linear systems to sinusoidal inputs
5. To compensate the transient response of dynamic systems using feedback techniques
6. To model multi-domain engineering systems at lower level of granularity suitable for design and control system implementation

Course Outcomes:

After the completion of the course, student will be able to:

1. Comprehend, classify and analyze the fundamentals: kinematics, statics and trajectory planning
2. Analyze the characteristics of the actuators, sensors and control unit
3. Gain the knowledge about the concepts of dynamics and motion control of robot manipulators
4. Elucidate the construction and working of mobile robot
5. Realize the trends in robot movements and motion planning
6. Build and master a program to simulate the system and produce the expected results

Module:1	Mathematical Modeling of Robots	3 hours

Symbolic Representation of Robot Manipulators, The Configuration Space, The State Space, The Workspace, Robots as Mechanical Devices, Classification of Robotic Manipulators, Robotic Systems, Accuracy and Repeatability, Wrists and End Effectors, Common Kinematic Arrangements, Various Manipulators, Manipulator Arms, Underactuated and Mobile Robots

Module:2	Kinematics, Differential Kinematics and Statics	5 hours

Pose of a Rigid Body, Rotation Matrix, Composition of Rotation Matrices, Euler Angles, Angle and Axis, Homogeneous Transformations, Direct Kinematics, Kinematics of Typical Manipulator Structures, Joint Space and Operational Space, Kinematic Calibration, Geometric Jacobian, Jacobian of Typical Manipulator Structures, Kinematic Singularities, Analysis of Redundancy, Inverse Differential Kinematics, Analytical Jacobian, Inverse Kinematics Algorithms, Statics

Module:3	Trajectory Planning, Actuators & Sensors	5 hours

Path and Trajectory, Operational Space Trajectories, Joint Actuating System, Drives, Proprioceptive Sensors, Exteroceptive Sensors

Module:4	Control Architecture & Dynamics	4 hours

Functional Architecture, Programming Environment, Hardware Architecture, Dynamics: Lagrange Formulation, Notable Properties of Dynamic Model, Dynamic Model of Simple Manipulator Structures, Dynamic Parameter Identification, Direct Dynamics and Inverse Dynamics, Dynamic Scaling of Trajectories, Operational Space Dynamic Model, Dynamic Manipulability Ellipsoid

Module:5	Motion Control and Force Control	4 hours

Motion Control: The Control Problem, Joint Space Control, Decentralized Control, Computed Torque Feedforward Control, Centralized Control, Operational Space Control

Force Control: Compliance Control; Impedance Control, Force Control, Constrained motion, Natural and Artificial Constraints, Hybrid Force/Motion Control

Module:6	**Introduction to Visual Servoing**	**3 hours**
Vision for Control, Image Processing, Pose Estimation, Stereo Vision, Camera Calibration, Position based visual Servoing, Image based Visual Servoing		
Module:7	**Mobile Robots and Motion Planning**	**4 hours**
Nonholonomic Constraints, Kinematic Model, Chained form, Dynamic Model, Planning, Motion Control, Odometric Localization, Configuration Space, Planning via Retraction, Planning via Cell Decomposition, Probabilistic Planning, Planning via Artificial Potentials		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer Publishing Company, 2010.
2.	M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, 2nd Edition, JOHN WILEY & SONS, INC, 2020.
Reference Books	
1.	Daniel L. Ryan, Robotic Simulation, First Edition, CRC Press, 1993.
2.	John Brown, Robot Simulation and Programming: From Simulation to Real World Implementation, E-book Edition, 2018

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE422P	Robot Modeling and Simulation Lab	0	0	2	1
Pre-requisite	BCSE421L	Syllabus version			
		1.0			

Course Objectives

1. To create parameter models of simple dynamic systems
2. To make quantitative estimates of model parameters from experimental measurements
3. To obtain the time-domain response of linear systems to initial conditions and/or common forcing functions by computational methods
4. To obtain the frequency-domain response of linear systems to sinusoidal inputs
5. To compensate the transient response of dynamic systems using feedback techniques
6. To model multi-domain engineering systems at lower level of granularity suitable for design and control system implementation

Course Outcome

1. Comprehend, classify and analyze the fundamentals: kinematics, statics and trajectory planning
2. Analyze the characteristics of the actuators, sensors and control unit
3. Gain the knowledge about the concepts of dynamics and motion control of robot manipulators
4. Elucidate the construction and working of mobile robot
5. Realize the trends in robot movements and motion planning
6. Build and master a program to simulate the system and produce the expected results

Indicative Experiments

Toolboxes: Matlab, Simulink, CoppeliaSim robot simulator

1.	Introduction to modern robotics, Configuration space and Rigid body motions
2.	Velocity kinematics & Statics, Inverse kinematics, Kinematics of closed chains
3.	Dynamics of open chain, Trajectory generation
4.	Motion planning, Robot control
5.	Grasping and manipulation. Wheeled mobile robots
	Total Laboratory Hours: 30 hours

Text Book(s)

1.	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Robotics: Modelling, Planning and Control, Springer Publishing Company, 2010.
2.	M.W. Spong, S. Hutchinson and M. Vidyasagar, Robot Modeling and Control, 2nd Edition, JOHN WILEY & SONS, INC, 2020.

Reference Books

1.	Daniel L. Ryan, Robotic Simulation, First Edition, CRC Press, 1993.
2.	John Brown, Robot Simulation and Programming: From Simulation to Real World Implementation, E-book Edition, 2018

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

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Ttle	L	T	P	C
BCSE423L	Robot Programming	2	0	0	2
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

1. To introduce the fundamentals of robotic programming
2. To understand the ROS fundamentals.
3. To introduce students the criteria for selecting a sensor and actuator for a particular ROS robotic application.
4. To familiarize with various hardware based robotic application

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand the robotics design and implementation.
2. Gain the knowledge on fundamentals of robotic programming
3. Comprehend, classify and analyze the behavior of different types of sensors and actuators.
4. Understand the ROS fundamentals
5. Design robotic applications using ROS

Module:1	**Introduction**	**4 hours**
Robot Introduction- Seven Criteria of Defining a Robot, Robot controllers-major components, Giving the Robot Instructions, Robot vocabularies, RSVP: Robot Scenario Visual Planning-Mapping the Scenario, Pseudocode and Flowcharting RSVP, State charts for Robots and Objects, checking the actual capabilities of your robot		
Module:2	**Introduction to ROS**	**5 hours**
ROS Basics – ROS Equation, History of ROS, Sensors and robots supporting ROS, ROS architecture and concepts, roslaunch, catkin, Workspaces, and ROS Packages, Names, Namespaces, and Remapping, rosrun, Coordinate Transforms, Poses, Positions, and Orientations.		
Module:3	**ROS Programming**	**5 hours**
Topics- Publishing to a Topic, Subscribing to a Topic, Defining Your Own Message Types, Services - Defining a Service, Implementing a Service, Using a Service. Actions - Defining an Action, Implementing a Basic Action Server, Using an Action.		
Module:4	**Robots Sensing and Moving**	**4 hours**
Robots and Simulators, Sensing and Actuation: Wander-bot, Moving Around Using ROS: Teleop-bot- Keyboard Driver, Motion Generator, Velocity Ramps.		
Module:5	**Perception and Behavior**	**4 hours**
Perception and Behavior: Follow-bot- Acquiring Images, Detecting the Line, Following the Line.		
Module:6	**ROS Robotics Projects/ Applications**	**6 hours**
Assembling robot, Programming robot firmware, Face Detection and Tracking using ROS-hardware and software prerequisites, creating and working with face tracker ROS packages, Building a siri-like chatbot in ROS.		
Module:7	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Hughes, C. and Hughes, T., Robot programming: a guide to controlling autonomous robots. Que Publishing, 2016
2. Quigley, M., Gerkey, B. and Smart, W.D., Programming Robots with ROS: a practical introduction to the Robot Operating System. O'Reilly Media, Inc.", 2015

Reference Books	
1	Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018.
2	Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018.
3.	Anil Mahtani, Luis Sanchez, Enrique Fernandez, Aaron Martinez, Lentin Joseph. ROS Programming: Building Powerful Robots. Packt Publishing, 2018.
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).	

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE423P	Robot Programming Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To introduce the fundamentals of robotic programming
2. To understand the ROS fundamentals.
3. To introduce students the criteria for selecting a sensor and actuator for a particular ROS robotic application.
4. To familiarize with various hardware based robotic application

Course Outcome

1. Understand the robotics design and implementation.
2. Gain the knowledge on fundamentals of robotic programming
3. Comprehend, classify and analyze the behavior of different types of sensors and actuators.
4. Understand the ROS fundamentals
5. Design robotic applications using ROS

Indicative Experiments

1.	Setting up the environment: Introduction to ROS, core components, installation, command line tools.
2.	Create nodes and program to demonstrate how nodes publish and subscribe to messages.
3.	Create nodes and program to demonstrate how nodes call and offer services.
4.	Create nodes that are able to call/offer an action service. Use standard actions to control robots.(Set a trajectory and move the robot along the trajectory)
5.	Setup a robot simulation environment. Launch the simulation with roslaunch to inspect created nodes and topics. (Use Gazebo from ROS by configuring launch files)
6.	Move the robot either by commanding the velocities or by using random velocities (using a package). (Continuation of 5)
7.	Setup an environment with a simulated camera and a fiducial marker detector to determine and evaluate the pose of objects (Detect the chessboard corners).
8.	Demonstrate ros_control within gazebo environment to define trajectories and also interface with real hardware (Joint limits interface).
9.	Use robotics arm (off the shelf) and program it to pick and place blocks. Stack one block on top of the other.
10.	Use prewritten programs (off the shelf), try various configurations to solve towers of honoi problem. (Continuation of 8)
11.	Program the robot to cope with sudden change in the process and environment.
12.	Program the robot to detect and track colored objects.
	Total Laboratory Hours | 30 hours

Text Book(s)

1.	Hughes, C. and Hughes, T., Robot programming: a guide to controlling autonomous robots. Que Publishing, 2016
2.	Quigley, M., Gerkey, B. and Smart, W.D., Programming Robots with ROS: a practical introduction to the Robot Operating System. O'Reilly Media, Inc.", 2015

Reference Books

1.	Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018.
2.	Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition,

	Packt Publishing, 2018.
3.	Anil Mahtani, Luis Sanchez, Enrique Fernandez, Aaron Martinez, Lentin Joseph. ROS Programming: Building Powerful Robots. Packt Publishing, 2018.

Mode of assessment: Continuous assessment / FAT / Oral examination and others			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE424L	Machine Learning for Robotics	2	0	0	2
Pre-requisite	NIL	Syllabus version			
Course Objectives:		1.0			

1. To teach the theoretical foundations of various learning algorithms.
2. To understand the context of supervised and unsupervised learning through real-life examples.
3. Apply all learning algorithms over appropriate real-time dataset.
4. Evaluate the algorithms based on corresponding metrics identified.
5. Analyze the requirements of Machine Learning applications in context-aware robotic environment.

Course Outcomes:

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 robotic environment.

Module:1	**Introduction to Machine Learning**	**3 hours**
Introduction – Exploration – Learning Paradigms – Role of Machine Learning in Robotic applications		
Module:2	**Supervised Learning – I**	**6 hours**
Linear and Non-Linear – Multi–Class & Multi-Label classification – Linear Regression – Multilinear Regression – Naïve Bayes Classifier – Decision Trees – ID3 – CART – Fine tuning of algorithms for robotic environment.		
Module:3	**Supervised Learning – II**	**6 hours**
K-NN classifier – Logistic regression – Perceptrons – Single layer & Multi-layer – Support Vector Machines – Linear & Non-linear – Error Bounds Fine tuning of algorithms for robotic environment.		
Module:4	**Unsupervised Learning**	**5 hours**
Clustering basics (Partitioned, Hierarchical and Density based) - K-Means clustering – K-Mode clustering – Principal Component Analysis – Kernel PCA - Error Bounds – Ensemble Learning (Random Forest, XGBoost) – Fine tuning of algorithms for robotic environment.		
Module:5	**Reinforcement Learning**	**3 hours**
Basics of RL – RL Framework – Markov Decision Process – Exploration Vs Exploitation		
Module:6	**Real time Datasets – Pre-processing**	**3 hours**
Class Imbalance – SMOTE – One Class SVM – Optimization of hyperparameters.		
Module: 7	**Robotics & Machine Learning Alliance**	**3 hours**
Design constraints and considerations – setting up the environment – Applications and case studies in Robotics		
Module:8	**Contemporary Issues**	**1 Hour**

	Total Lecture:	**30 Hours**

Text Books:	
1	Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
2	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2012.
3	Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2nd edition, Richard S. Sutton and Andrew G. Barto, A Bradford Book; 2018, ISBN 978-0262039246
References Books:	
1	Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997.
2	Charu C. Aggarwal, "Data Classification Algorithms and Applications", CRC Press, 2014.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Ttle	L	T	P	C
BCSE424P	Machine Learning for Robotics Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Apply all learning algorithms over appropriate real-time dataset.
2. Evaluate the algorithms based on corresponding metrics identified.
3. Analyze the requirements of Machine Learning applications in context-aware robotic environment.

Course Outcome

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 robotic environment.

Indicative Experiments	
1.	Linear & Multi-Linear Regression
2.	Logistic Regression
3.	Naïve Bayes classifier
4.	Decision trees – ID3 & CART
5.	Support Vector Machines – Linear & Non-linear
6.	K-NN, K-Means & K-Mode Clustering
7.	Random-Forest classifier & Regressor
8.	Principal Component Analysis
	Total Laboratory Hours: 30 hours

Software requirement:

Python, Numpy, Tensorflow, Keras, Pandas, OpenCV

Appropriate datasets from the following repository (suggestive) can be taken. Datasets to be pre-processed, implemented and error analysis and visualization to be done.

1. https://archive.ics.uci.edu/ml/datasets.html
2. http://sci2s.ugr.es/keel/datasets.php#sub1

Mode of assessment: Continuous assessment & FAT

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE425L	Robotic Perception	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

1. To learn basic robotic sensing and vision
2. To learn computer vision for robot motion control
3. To recognize objects and the basics of visual learning and neural networks for the purpose of classification
4. To learn the applications of vision system in modern manufacturing environment

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand the basic robotic sensing and vision
2. Design controllers for tracking control of a robot
3. Apply computer vision control of robotic systems
4. Learn the applications of vision system in modern manufacturing environment

Module:1	**Basics / Fundamentals**	**2 hours**
Perception and Decision-Making in Robotics Overview, Specifications of Robots.		
Module:2	**Robot Sensing & Vision:**	**7 Hours**
Use of Sensors and Sensor Based System in Robotics, Machine Vision System, Description, Sensing, Digitizing, Image Processing and Analysis, segmentation-Thresholding- edge detection- binary morphology – grey morphology and Application of Machine Vision System, Robotic Assembly Sensors and Intelligent Sensors, visual servo-control.		
Module:3	**Vision Algorithms**	**7 Hours**
Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement : Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation – Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction.		
Module:4	**Estimation in Robotics**	**5 Hours**
Optimal Estimation in Robotics: Applications, Overview of general principle, Derivation of Linear Kalman Filter, Optimal Integration of Sensor Measurements in Humans.		
Module:5	**Object Recognition**	**8 hours**
Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of depth values. Histogram of oriented gradients (HOG), R-CNNs (Region based CNNs), YOLO's architecture based on CNNs		
Module:6	**Image Feature Extraction & Multiple Images**	**8 hours**
Region Features, Line Features, Point Features. Using Multiple Images: Geometry of Multiple Views, Stereo Vision, Bundle Adjustment, Point Clouds.		
Module:7	**Robotic Learning**	**6 hours**
Vision-Based Control, Position-Based Visual Servoing, Image-Based Visual Servoing, Using Other Image Features		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2.	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced Robotics, Volume 118, Second Edition, 2016
3.	Kevin M. Lynch and Frank C. Park, Modern Robotics Mechanics, Planning, And Control, May 3, 2017
Reference Books	
1.	David Forsyth and Jean Ponce, Computer Vision: A modern Approach, Prentice Hall India 2004
2.	Klafter, Chmielewski and Negin, *Robotic Engineering - An Integrated approach,* PHI, 1st edition, 2009.
3.	Robert J. Schilling, "Fundamentals of Robotics Analysis and Control", PHI Learning, 2009.
4.	Deb S R and Deb S, "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd, 2010.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE425P	Robotic Perception Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To learn basic robotic sensing and vision
2. To learn computer vision for robot motion control
3. To recognize objects and the basics of visual learning and neural networks for the purpose of classification
4. To learn the applications of vision system in modern manufacturing environment

Course Outcome

After the completion of the course, student will be able to:

1. Understand the basic robotic sensing and vision
2. Design controllers for tracking control of a robot
3. Apply computer vision control of robotic systems
4. Learn the applications of vision system in modern manufacturing environment

Indicative Experiments	
1.	Lane Detection algorithms
2.	Edge Detection algorithms,
3.	Color Image Segmentation algorithms
4.	Object detection algorithms
5.	Tracking static and real-time objects.
	Total Laboratory Hours **30 hours**

Text Book(s)

1.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2.	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms, Springer Tracts in Advanced Robotics, Volume 118, Second Edition, 2016
3.	Kevin M. Lynch and Frank C. Park, Modern Robotics Mechanics, Planning, And Control, May 3, 2017

Reference Books

1.	David Forsyth and Jean Ponce, Computer Vision: A modern Approach, Prentice Hall India 2004
2.	Klafter, Chmielewski and Negin, Robotic Engineering - An Integrated approach, PHI, 1st edition, 2009.
3.	Robert J. Schilling, “Fundamentals of Robotics Analysis and Control”, PHI Learning, 2009.

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

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE426L	Robotic Process Automation	2	0	0	2
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

1. To provide insights on robotic process automation (RPA) technology and its value proposition
2. To introduce different platforms for RPA
3. To illustrate basic programming concepts and the underlying logic/structure related to RPA
4. To describe the different types of variables, Control Flow and data manipulation techniques in a RPA platform
5. To describe automation to Email and various types of Exceptions and strategies to handle

Course Outcomes:

After the completion of the course, student will be able to:

1. Gain insights into Robotic Process Automation Technology
2. Demonstrate the underlying logic/structure related to RPA using UiPath platform
3. Classify several types of data inside a workflow and, gain skills in building workflows in UiPath
4. Comprehend different types of variables, Control Flow and data manipulation techniques
5. Identify and understand Image, Text and Data Tables Automation
6. Design automation to Email and various types of Exceptions and strategies to handle
7. Realize the trends in RPA technology and industrial process automation using RPA

Module:1	Introduction to Robotic Process Automation	2 hours
Emergence of Robotic Process Automation (RPA), Defining Robotic Process Automation & its benefits, Types of Bots, Application areas of RPA, RPA development methodology and key considerations, List of Robotic Process Automation Tools.		
Module:2	**Bot development**	**5 hours**
Activities, Flowcharts and Sequences, Sequencing the workflow, Activities, Log Message, Variables, Control flow, various types of loops, and decision making, Best Practices for Bot Development, Step-by-step example using Sequence and Flowchart, Step-by-step example using Sequence and Control flow		
Module:3	**Data Manipulation**	**5 hours**
Data table usage, Clipboard management, File operation, Data transfer between CSV/Excel and data table		
Module:4	**Taking Control of the Controls**	**6 hours**
Finding the control, Techniques for waiting for a control, Act on controls – mouse and keyboard activities, Handling events, Recording and scraping		
Module:5	**Handling User Events and Assistant Bots**	**6 hours**
Assistant bots, Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event,		
Module:6	**Exception Handling and Logging**	**2 hours**
Exception Handling: Common exceptions and ways to handle them, Logging and taking screenshots: Client logging, Server logging		
Module:7	**Managing and Maintaining the Code**	**2 hours**
Project organization, When to use Flowcharts, State Machines, or Sequences		
Module:8	**Contemporary issues**	**2 hours**

	Total Lecture hours:	**30 hours**
Text Book(s)		
1.	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018.	
2.	Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.	
Reference Books		
1.	Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant" (1st Edition), Independently published, 2018. ISBN 978-1983036835	
2.	Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020	
3.	Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, "Introduction to Robotic Process Automation: A Primer (Kindle Edition)", Institute of Robotic Process Automation,	
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).		
Recommended by Board of Studies	13-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BCSE426P	Robotic Process Automation Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide insights on robotic process automation (RPA) technology and its value proposition
2. To introduce different platforms for RPA
3. To illustrate basic programming concepts and the underlying logic/structure related to RPA
4. To describe the different types of variables, Control Flow and data manipulation techniques in a RPA platform
5. To describe automation to Email and various types of Exceptions and strategies to handle

Course Outcome

1. Gain insights into Robotic Process Automation Technology
2. Demonstrate the underlying logic/structure related to RPA using UiPath platform
3. Classify several types of data inside a workflow and, gain skills in building workflows in UiPath
4. Comprehend different types of variables, Control Flow and data manipulation techniques
5. Identify and understand Image, Text and Data Tables Automation
6. Design automation to Email and various types of Exceptions and strategies to handle
7. Realize the trends in RPA technology and industrial process automation using RPA

Indicative Experiments	
1.	Setup and Configure UiPath Studio and understand the user interface of UiPath Studio; • Create a Sequence to obtain user inputs display them using a message box; • Create a Flowchart to navigate to a desired page based on a condition; • Create a State Machine workflow to compare user input with a random number
2.	Build a process in UiPath using UI Automation Activities. • Create an automation process using key System Activities, Variables and Arguments • Also implement Automation using System Trigger
3.	Automate login to Email account
4.	Recording mouse and keyboard actions to perform an operation, scraping data from website and writing to CSV
5.	Different ways of Error Handling in UiPath • Browse through the log files related to UiPath Project
6.	Using various components of Orchestrator • Create an automated Gmail Login Application • Create an automated Remote Data Entry Application
7.	Data manipulation in the workbook PDF Data Extraction
	Total Laboratory Hours | **30 hours**

Text Book(s)

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018.
2. Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.

Reference Books

1. Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots,

	Automate Repetitive Tasks & Become an RPA Consultant" (1st Edition), Independently published, 2018. ISBN 978-1983036835			
2.	Gerardus Blokdyk, "Robotic Process Automation Rpa A Complete Guide ", 2020			
3.	Frank Casale, Rebecca Dilla, Heidi Jaynes and Lauren Livingston, "Introduction to Robotic Process Automation: A Primer (Kindle Edition)", Institute of Robotic Process Automation,			
Mode of assessment: Continuous assessment / FAT / Oral examination and others				
Recommended by Board of Studies	13-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course Code	Corse Title	L	T	P	C
BCSE427L	Cognitive Robotics	2	0	0	2
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives:

1. To understand the main types of cognitive (vision, motor control, language, social skills) robots and their driving requirements (engineering operations, navigation, cooperation)
2. To understand advanced methods for creating efficient and dynamic cognitive robots.
3. To understand the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics.
4. To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards.

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand how our psychology and neuroscience understanding of behavior and intelligence informs the design of robotics models and applications
2. Compare, select and apply different machine learning methods for intelligent behavior in robots.
3. Analyze the methods and software/hardware technologies for robotics research and applications.
4. Discuss the state of the art in cognitive and intelligent robotics models, and how this leads to the design of future robot applications.

Module:1	Introduction	2 hours

Thinking, Cognition, and Intelligence, Defining Intelligence – Embodiment and Its Implications, Synthetic Methodology for Intelligence.

Module:2	Cybernetic View of Robot Cognition and Perception	4 hours

Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, and Robot Cognition.

Module:3	Intelligent System Design, Cognition Development and control	5 hours

Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, Matching brain and Body Dynamics, Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN, Introduction to CNN.

Module:4	Map Building	5 hours

Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Map Building.

Module:5	Randomized Path Planning	5 hours

Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

Module:6	Simultaneous Localization and Mapping (SLAM)	5 hours

Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms.

Module:7	Robot Programming methods	3 hours

Python Robot Programming Methods-: Go-to-Goal Behavior, Avoid-Obstacles Behavior, Hybrid Automata (Behavior State Machine), Follow-Wall Behavior. A Complete Program for autonomous mobile robot.		
Module:8	**Contemporary issues**	**1 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Patnaik, Srikanta, “Robot Cognition and Navigation – An Experiment with Mobile Robots”, Springer Verlag Berlin and Heidelberg, 2007
2.	Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, “Principles of Robot Motion-Theory, Algorithms, and Implementation”, MIT Press, Cambridge, 2005.
3	David Vernon, “Artificial Cognitive Systems: A Primer” ,The MIT Press, 1st Edition,2014
Reference Book(s)	
1.	HoomanSomani, “Cognitive Robotics”, CRC Press, 2015
2.	Jared Kroff, “Cognitive Robotics: Intelligent Robotic Systems”, Wilford Press, 2016
3.	https://www.toptal.com/robotics/programming-a-robot-an-introductory-tutorial

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE427P	**Cognitive Robotics Lab**	**0**	**0**	**2**	**1**
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives:

1. To understand advanced methods for creating efficient and dynamic cognitive robots
2. To apply one or more core reasoning methods to create a simple agent that is driven by goals or rewards

Course Outcomes:

After the completion of the course, student will be able to:

1. Understand how our psychology and neuroscience understanding of behavior and intelligence informs the design of robotics models and applications
2. Compare, select and apply different machine learning methods for intelligent behavior in robots.
3. Apply the methods and software/hardware technologies for robotics research and applications.
4. Implement the state of the art in cognitive and intelligent robotics models, and how this leads to the design of future robot applications.

List of Challenging Experiments (Indicative)

1	Introduction to the Python language and Python libraries, including NumPy, SciPy and NXT Python • Introduction to numerical arrays and parallel arithmetic • Introduction to numerical data plotting • • Introduction to numerical regression techniques • Installing Raspbian OS on the Raspberry Pi 3	4 hours
2	Introduction to microcontrollers (32-bit ARM-based devices) in embedded applications used in automobiles and home appliances (such as washing machines, microwave ovens, telephones, and computer system peripherals) • Controlling GPIO pins (e.g., connected to LEDs) on the Raspberry Pi 3 using Python • Controlling motors • Collecting sensor data (such as light-color sensor, touch sensor, infrared proximity sensor and ultrasonic sensor) • Writing and uploading robotic control programs	4 hours
3	Interfacing data acquisition system hardware with computer to measure and control the robotic system.	4 hours
4	Robotic motion and autonomous responses • Path following, solving a Rubix cube, book scanning, and other fun problems	4 hours
5	Machine learning algorithms for neural network pattern recognition	4 hours
6	Extend the deep learning exercises (e.g. Multi-Layer Perceptron (MLP) and/or Convolutional Neural Network (CNN) exercises for image datasets) to optimize the training for robotics (vision) applications.	6 hours
7	SLAM in ROS	4 hours
	Total Laboratory Hours	**30 hours**

Text Book(s)

1.	Learning Computing with Robots, Deepak Kumar, Institute for Personal Robots in Educaition, June 2008

Reference Books

1.	Programming Cognitive Robots, Hector J. Levesque, 2019
2.	Learning Robotics Using Python, Lentin Joseph, 2015
3.	https://www.ieee-ras.org/cognitive-robotics/resources (Research Challenges)

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE428L	Autonomous Drones	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To know the principles of flight and how they apply to robotic drones
2. To know different kinds of airframes and how to assemble a drone.
3. To know the basics of drone design and how to choose the right components.

Course Outcomes

1. Understand the evolution and classification of Drones / Unmanned aerial Vehicle (UAVs)
2. Gain knowledge on UAVs technology side of things (i.e. sensors, platforms, navigation, power source, communication, range, altitude and speed)
3. Illustrate the commercial applications used by various types of drones such as aerial photography, law enforcement surveillance, and border enforcement.
4. Discuss Indian government airspace policy, regulations, and a comparison of other international regulations, and risk factors
5. Realize the emerging technologies being integrated into the drone market including semi-autonomous and autonomous systems for various applications.

Module:1	**Introduction to Autonomous Drones**	**4 hours**
History of Drones – Types of drones – Airframe – Batteries – Motors – ESC: Electronic Speed Controller – Propellers.		
Module:2	**Design Fundamentals**	**3 hours**
Flight Controllers – RC Transmitters – FPV Systems – Telemetry – Timing Gates.		
Module:3	**Drone Basics**	**5 hours**
Flight Basics – Preflight Checks – Flight Modes – The Maiden Flight – Roll, Pitch, Throttle & Yaw – Key Skills – Simulators – Manual Mode – GPS Autopilot – Intelligent Flight Modes		
Module:4	**Modelling and Control With MATLAB/Simulink Implementation**	**5 hours**
Quadcopter Project: Quadcopter Physical Characteristics, Vehicle Dynamic, Components, Simulink Modelling.		
Module:5	**Stability and control**	**5 hours**
Static stability, Dynamic stability, static stability and control, Longitudinal control, stick forces, directional stability and control, roll stability and control.		
Module:6	**Applications**	**3 hours**
Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Search and Rescue, Infrastructure Inspection, Conservation		
Module:7	**Expanding Drones Abilities**	**3 hours**
Add a camera and FPV, Collect more data with other sensors, Altering Speed and Increasing flight times. Building a Quadcopter		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 Hours**

Text Book(s)

1. Adam Juniper, “The Complete Guide to Drones”, 2nd Edition, ilex.
2. John Baichtal “Building your own Drones A beginners Guide to Drones, UAVs and ROVs”, Que Publishing 2016
3. Terry Kilby and Belinda Kilby, Make: Getting Started with Drones, First Edition, Maker Media Inc, San Francisco CA, 2016

4.	Robert C.Nelson, “Flight Stability and Automatic control”, McGraw-Hill.		
5.	https://in.mathworks.com/help/aeroblks/quadcopter-project.html		
Reference Books			
1.	A. R. Jha, “Theory, Design, and Applications of Unmanned Aerial Vehicles”, First Edition, CRC Press, 2020		
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BCSE428P	Autonomous Drones Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To gain insight into the basic elements of commercial-off-the-shelf (COTS) drone systems used in civilian missions
2. To introduce unmanned aerial systems (UAS) including drones and autonomous unmanned aerial vehicles (UAV) with sensors

Course Outcome

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

1. Gain knowledge on UAVs technology side of things (i.e. sensors, platforms, navigation, power source, communication, range, altitude and speed)
2. Illustrate the commercial applications used by various types of drones such as aerial photography, law enforcement surveillance, and border enforcement.

Indicative Experiments

1.	Basic building blocks and 3D Design of a Drone
2.	Making the drone to be stable and fly autonomously with little human intervention
3.	Design a control system architecture that will hover a quadcopter
4.	**Position Control:** To implement a local navigation algorithm through the use of a PID controller.
5.	**Navigation by position:** To implement an autopilot by using the GPS sensor, the IMU, and a position-based PID controller. For this exercise, a simulated 3D world has been designed that contains the quadrotor and five beacons arranged in a cross. The objective is to program the drone to follow a predetermined route visiting the five waypoints in a given sequence. It illustrates the algorithms typically included in commercial autopilots such as ArduPilot or PX4.
6.	**Following an object on the ground:** To implement the logic that allows a quadrotor to follow a moving object on the ground, using a primary color filter in the images and a vision-based PID controller. The drone keeps its altitude and moves only in a 2D plane.
7.	**Searching for people to rescue within a perimeter:** The objective of this exercise is to implement the logic of a global navigation algorithm to sweep a specific area systematically and efficiently, in conjunction with visual face-recognition techniques, to report the location of people for subsequent rescue. The drone behavior is typically implemented as a finite state machine, with several states such as go-to-the-perimeter, explore-inside-the-perimeter, or go-back-home.
	Total Laboratory Hours **30 hours**

Text Book(s)

1.	Terry Kilby and Belinda Kilby Make: Getting Started with Drones, First Edition, Maker Media Inc, San Francisco CA, 2016

Reference Books

1.	Mohammad H. Sadraey “Design of Unmanned Aerial Systems” First Edition, John Wiley & Sons, Inc., USA 2020
2.	A. R. Jha, “Theory, Design, and Applications of Unmanned Aerial Vehicles”, First Edition, CRC Press, 2020

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

Recommended by Board of Studies	13-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCSE432E	Reinforcement Learning	3	0	2	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the main concepts of reinforcement learning and its scope
2. To identify and apply classic Reinforcement Learning methods and Approximate solution methods for problem solving
3. To understand and apply deep reinforcement learning for complex real-world problems

Course Outcomes

1. Articulate the fundamental concepts of reinforcement learning (RL) underlying finite Markov Decision Processes, optimal policies, and value functions.
2. Demonstrate proficiency in implementing/formulating RL algorithms to solve real-world problems with finite state spaces for prediction, control, and planning.
3. Critically analyze and compare approximate solution methods, policy gradient methods, actor-critic methods etc., evaluating the efficiency and trade-offs of these methods for complex reinforcement learning challenges.
4. Evaluate the effectiveness of deep reinforcement learning algorithms in solving problems in diverse domains

Module:1	Introduction	4 hours

Reinforcement learning, Examples, Elements of reinforcement learning, An extended example: Tic-Tac-Toe, Limitations and Scope

Module:2	Tabular solution methods	7 hours

Finite Markov Decision Processes, Optimal Policies and Optimal Value Functions, Dynamic Programming and its efficiency, Monte Carlo methods, Monte Carlo Prediction & Control.

Module:3	Other tabular solution methods, Planning & Learning	8 hours

Temporal-difference learning, Temporal-difference prediction, SARSA, Q-learning, n-step bootstrapping; Models and Planning, Dyna: Integrated Planning, Acting, and Learning, Trajectory Sampling, Real-time Dynamic Programming, Planning at Decision Time, Monte Carlo Tree Search

Module:4	Approximate solution methods	6 hours

On-policy Prediction with Approximation, On-policy Control with Approximation, Policy Gradient Methods, Actor-Critic methods.

Module:5	Applications & Case Studies	4 hours

TD-Gammon, Samuel's Checkers Player, Watson's Daily-Double Wagering, Optimizing Memory Control, Human-level Video Game Play, Mastering the Game of Go, Personalized Web Services, Reinforcement learning in robotics

Module:6	Deep Reinforcement Learning	8 hours

Introduction to Deep Learning, Deep Q-Learning, Value-based Deep RL: Deep Q-network, Policy-based Deep RL: REINFORCE, Asynchronous Methods for Deep RL: Advantage Actor-Critic (A2C), Model-based Deep RL		
Module:7	**Other Deep RL Algorithms**	**6 hours**
Real world applications of Algorithms: Deep Deterministic Policy Gradient - Off Policy Methods: Proximal Policy Optimization – Soft Actor Critic. Multi-Agent reinforcement Learning, Inverse Reinforcement Learning, Reinforcement Learning with Human Feedback.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Richard S. Sutton and Andrew G. Barto. Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2018, 2nd edition, A Bradford Book. ISBN 978-0262039246
2.	Dong, Hao, Ding, Zihan, Zhang, Shanghang (Eds.), Deep Reinforcement Learning Fundamentals, Research and Applications. 2020. Springer. ISBN 978-981-15-4094-3
Reference Books	
1.	Aske Plaat Learning to Play: Reinforcement Learning and Games, 2020, Springer ISBN 978-3-030-59237-0
2.	Taweh Beysolow, Applied Reinforcement Learning with Python With OpenAI Gym, Tensorflow, and Keras, 2019 Apress, ISBN 978-1-4842-5126-3
3.	Chong Li and Meikang Qiu, Reinforcement Learning for Cyber-Physical Systems with Cybersecurity Case Studies, 2020 Chapman and Hall/CRC, ISBN 9780367656638
4	Hadelin de Ponteves, AI Crash Course: A fun and hands-on introduction to machine learning, reinforcement learning, deep learning, and artificial intelligence with Python, 2019 Packt, ISBN: 978-1838645359
5.	Wen Yu, Adolfo Perrusquia, Human-Robot Interaction Control Using Reinforcement Learning, 2021, Wiley-IEEE Press ISBN: 978-1-119-78274-2
Mode of Evaluation: CAT, written assignment, Quiz, FAT, Seminar	

Indicative Experiments implemented in RL Environments/ from scratch	
1	Solving Tic Tac Toe with Reinforcement learning
2	GRID WORLD - DYNAMIC PROGRAMMING
3	GRID WORLD - MONTE CARLO
4	GRID WORLD - TEMPORAL DIFFERENCE
5	Implementing Value iteration agents
6	Policy Iteration for the Grid World
7	TD SARSA - Taxi-v2
8	Q-Learning - Taxi-v2
9	DQN – implementation – financial markets
10	Double DQN
11	REINFORCE with baseline
12	Actor Critic Algorithms A2C A3C
13	PPO Algorithm

14	DDPG Algorithm – train ticket booking
15	Multi-armed bandits
16	Comparing TD(0) and constant alpha MC learning on the Random Walk Example
17	Comparison of the number of planning steps in Dyna maze planning
18	Reinforcement learning with Mario Bros
19	Crypto trading – Soft actor Critic algorithm
20	Games with multiple RL Algorithms
	Total Laboratory Hours | **30 hours**
Reference Books	
1	Andrea Lonza, Reinforcement Learning Algorithms with Python, 2019, Packt.
2	Taweh Beysolow, Applied Reinforcement Learning with Python With OpenAI Gym, Tensorflow, and Keras, 2019 Apress, ISBN 978-1-4842-5126-3
3	Miguel Morales, grokking Deep Reinforcement Learning, 2020, Manning
4	Hadelin de Ponteves, AI Crash Course: A fun and hands-on introduction to machine learning, reinforcement learning, deep learning, and artificial intelligence with Python, 2019 Packt, ISBN: 978-1838645359
5	Mohit Sewak, Deep Reinforcement Learning: Frontiers of Artificial Intelligence, 2019 Springer, ISBN 978-981-13-8287-1
6	Sudharsan Ravichandiran Deep Reinforcement Learning with Python: Master classic RL, deep RL, distributional RL, inverse RL, and more with OpenAI Gym and TensorFlow, 2020 2nd Edition, Packt, ISBN-13 : 978-1839210686
7	Laura Graesser and Wah Loon Keng, Foundations of Deep Reinforcement Learning: Theory and Practice in Python, 2019 1st edition Addison-Wesley Professional;, ISBN: 978-0135172384

Mode of assessment: Continuous assessment, FAT			
Recommended by Board of Studies	03-11-2023		
Approved by Academic Council	No.72	Date	13-12-2023

Project/Internship

BCSE399J	Summer Industrial Internship	L	T	P	C
		0	0	0	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

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 Outcome:

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

BCSE497J	Project - I	L	T	P	C
		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 Outcome:

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

BCSE498J	Project – II / Internship	L	T	P	C
		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 Outcome:

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.
6. 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

Non Graded Credit Requirement

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

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

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

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

Foreign Language Basket Courses

BARB101L	Arabic	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Demonstrate proficiency in communicating in Arabic language.
2. Develop the ability to narrate and describe in past, present, and future time by acquiring Arabic grammar knowledge.
3. Develop the knowledge of Arabic literature, culture, and Arabic technical terminologies.

Course Outcome

The student will be able to:

1. Remember Arabic Alphabets and Vowel signs.
2. Remember simple phrases like days, months, colors with simple conversation in professional and corporate mellow.
3. Understand the parts of speech and conjugations (Past, Present, Futures & Imperative).
4. Remember the Cardinal and Ordinal numbers and different types of members of the family as well as society.

Module:1	حروف لهجاء	**2 hours**
Arabic alphabet. The Pronunciation (Phonetic symbol of Arabic Alphabet). Shapes of Arabic letters.		
Module:2	حروف لعلة	**3 hours**
The Vowel. The Vowel Signs & the Cases. The Sun letters & Moon letters.		
Module:3	قسام لكلمة	**4 hours**
The Noun. The Verb. The Particle. The Definite & the Indefinite.		
Module:4	لجنس. لمؤنث ولصفة	**5 hours**
The Gender. Singular, Dual & Plural. Adjective and Noun qualified.		
Module:5	لضمائر	**5 hours**
The Personal Pronoun. The Demonstrative Pronoun. The Relative Pronoun. The Subject & the Predicate. The Demonstrative Phrase.		
Module:6	تصريف الفعال (لماضي ولمضارع والأمر)	**5 hours**
Conjugations. Daily usage vocabularies.		
Module:7	الأعداد ولمصطلحات لتقنية	**4 hours**
Numerals. Days of the week. Months of the year. Seasons. Colors. Relationship. Technical terminologies (Computer, Civil & Mechanical Engineering)		
Module:8	محاضرات	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)

1. Dr. V. Abdur Rahim, Arabic Course for English Speaking students (Vol-1, 2 & 3), 2019, First Edition, Goodword Books, New Delhi. ISBN: 978-0-9879146-2-0.

Reference Books

1. Dr. W. A. Nadwi, A Practical Approach to the Arabic Language, Islamic studies Research.
2. Academy, New Delhi. Revised edition-2016. ISBN: 9798189202148
   Dr. Aurang zeb Azmi, A New approach to the Arabic Grammar, Al-balagh Publication-New Delhi. 2018. ISBN: 978-93-83313-57-0.

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

Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BCHI101L	Chinese I	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop basic Chinese and do simple conversation.
2. Write Chinese writing system and basic Chinese characters.
3. Understand basic language texts relating to common daily settings and develop translation ability (Chinese to English & vice-versa).

Course Outcome

The students will be able to:

1. Greeting people in Chinese and use of personal pronouns and interrogative pronouns.
2. Express family names and understand yes – no question and correct use of phonetics.
3. Create expressions related to nationality, place of origin and special questions.
4. Learnoccupations in Chinese, Adverbials of time and place and noun and pronouns and create expressions related to age, numbers, special questions in Chinese.

Module:1	**Phonetics语音 YuYin**	**3 hours**

- Phonetics: Syllable initials:/ b/ / p/m /f ;;
- Syllable simple finals:/ a //o// e//i/u// ü;
- Phonetics: Syllable initials:/ d//t/ /n/l;
- Syllable compound finals: an// ie //uo/
- Phonetics: Syllable initials:/ g/k/ h/;
- Syllable compound finals::/ ai // ao//ei//en/
- Phonetics: Syllable initials:/j//q//x/;
- Syllable compound finals: /ang //eng//ong//iang// iong/
- Phonetics: Syllable initials:/z/c//s/;
- Phonetics: Syllable initials:/zh//ch//sh//r;
- Tones: /1// 2 // 3/ /4/

Module:2	**Writing System书写系统 shuxiexitong**	**4 hours**

- Chinese Characters
- Radicals
- Stroke order

Module:3	**Greetings问候 wenhou**	**3 hours**

- Learn the basic ways to greet people, and tell one's own name and other's name
- The personal pronouns"你，我，他/她，您，您们"
- Question with the interrogative pronoun"谁"

Module:4	**Family Names名姓 mingxing**	**4 hours**

- Learn to ask and tell Family names, given names
- Special questions with "什么"
- The Affirmative-Negative questions

Module:5	**Nationality国籍 guoji**	**4 hours**

- Learn to ask and tell one's Nationality and origin)
- Using "不" to express negation
- Special questions with "哪儿"or "什么地方"

Module:6	**Occupation职业 zhiye**	**5 hours**

• Learn to ask and tell one's occupation • Adverbials of time and place • Noun/pronoun+"的"+noun		
Module:7	**Numbers数字 shuzi**	**5 hours**
• Age (Learn to ask and tell one's age) • The numerals • The special questions with "几" • Time (Learn to tell time in native speakers' style) • Currency (Get idea about the usage of notes and coins in China) • The questions with "多少" and "怎么"		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)	
1.	Jiang Liping (2014) 《HSK Standard Course 1》Beijing, Beijing Language and Culture University Press, ISBN7-5619-3709-9.
Reference Books	
1.	Kang Yuhua & Lai Siping, (2005) 《Conversational Chinese 301》 Book-1& 2, Beijing, Beijing Language and Culture University Press, ISBN 978-7-5619-1403-8/ H 05014.
Mode of Evaluation: CAT, Digital assignment, Quiz, FAT	

Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BFRE101L	French I	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop language competencies for effective communication in French.
2. Provide insights into the French culture and make them understand the nuances through communication activities.
3. Enable the students to communicate effectively in general and in a professional context.

Course Outcome

The students will be able to:

1. Acquaint with the basics of the French Language.
2. Comprehend the various parts of speech and grammar concepts to frame basic sentences in French.
3. Translate and acquire knowledge on a broad range of printed materials for general, specific, and practical information.
4. Acquire and explain the culture of French people through the language studied in the class.

Module:1	**Saluer et se presenter:**	**6 hours**

Les Alphabets, Les Salutations, Les nombres (0-100000), L'heure, Les jours de la semaine, Les mois de l'année, Les Pronoms personnels sujets, La conjugaison des verbes réguliers (Les verbes ER) / irréguliers (avoir / être)

Savoir-faire et savoir-agir :

Saluer, Se présenter, Présenter quelqu'un, Donner des informations, Discuter de la classe / l'université.

Module:2	**L'activitéinteractive:**	**6 hours**

La Nationalité du Pays, Les articles définis / indéfinis, Les prépositions de lieu et l'article contracté, L'heure en français, La Couleur, La conjugaison des verbes - habiter / venir/Aller etc.

Savoir-faire et savoir-agir :

Localiser des lieux dans une ville, Exprimer l'heure en français et Échanger des informations sur un hébergement.

Module:3	**Les activités quotidiennes:**	**4 hours**

Les adjectifs possessifs, L'accord des adjectifs, Les pronoms toniques, La conjugaison du verbe 'faire' avec du, de la, de l', des. L'interrogation avec combien / comment / où etc. L'adjectif démonstratif, L'adjectif interrogatif,**La traduction simple** (français-anglais/anglais-français)

Savoir-faire et savoir-agir :

Parler de la famille, Décrire une personne, parler de nos goûts, parler de nos activités.

Module:4	**S'exprimer:**	**4 hours**

Les parties du corps. Avoir mal à + les parties du corps

La conjugaison des verbes pronominaux, La conjugaison des verbes réguliers (ir) et les autres verbes tels que -lire, écrire, pouvoir, vouloir, devoir, et sortir.

Savoir-faire et savoir-agir :

Parler de nos quotidiennes, proposer une sortie, inviter, accepter et refuser une invitation.

Module:5	**La culturefrançaise:**	**3 hours**

La gastronomie française. Les endroits. Le présent progressif, L'article partitif, Mettez les phrases au pluriel et faites des phrases avec les mots donnés, Trouvez les questions.

Savoir-faire et savoir-agir :

Décrire une journée extraordinaire, Répondre aux questions générales en français, Faire

des phrases.		
Module:6	**L'activitédialogique:**	**2 hours**
La traduction avancée (français-anglais/anglais-français) **Savoir-faire et savoir-agir :** Faire des achats, Demander la direction, Réserver une chambre dans un hôtel, La compréhension écrite et orale.		
Module:7	**L'activité de loisir**	**3 hours**
La rédaction / Dialogue:Décrire / parler de: ses goûts et préférences/ une personne / une place/ à la cafeteria / la profession / l'université/ les loisirs.		
Module:8	**Faciliter des échanges académiques**	**2 hours**
	Total Lecture hours:	**30hours**

Textbook(s)	
1.	Nathalie Hirschsprung, Tony Tricot, COSMOPOLITE- 1- Méthode de français, 2017, Hachette Français Langue t rang re, Paris.
Reference Books	
1.	Celine Braud, EDITO 1, Méthode de français, 2016, Didier,Paris.
2.	Marie-Noelle Cocton, GÉNÉRATION 1, Méthode de français, 2016, Didier,Paris.

Mode of Evaluation:CAT , Digital assignment , Quiz , FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BGER101L	German I	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Demonstrate proficiency in reading, writing, and speaking in basic German.
2. Communicate in German in everyday situations.
3. Understand German culture and adapt in German speaking countries or to work with German speaking people.

Course Outcome

The students will be able to:

1. Understand basic expressions, words, signs and simple conversations.
2. Understand and translate short texts, simple descriptions, directions and illustrated narratives about daily activities.
3. Write grammatically correct sentences, short paragraphs, informal letters/e-mails, post cards etc… on matters of personal relevance and describe places and people in a simple language.
4. Use German in easy day-to-day conversations and demonstrate understanding of German culture.

Module:1	**Die ersteBegegnung**	**4 hours**

Grüßen und Verabschieden; sich und andere vorstellen; Namen, Telefonnummer und E-Mail-Adresse buchstabieren; Zahlen bis 100 und mehr nennen; über Länder, Sprachen und Nationalitäten sprechen.

Wortschatz: Begrüßungen, verabschieden, das Deutsche Alphabet, Zahlen, Länder und Sprachen
Grammatik: ,,W" Fragen, Aussagesätze, Personalpronomen im Singular und Verbkonjugation (sein/kommen/wohnen/lernen/studieren/sprechen/buchstabieren), Bestimmter Artikel
Schreiben: sich und andere vorstellen

Module:2	**Hobbys und Berufe**	**4 hours**

Über Hobbys und Freizeitaktivitäten sprechen; Wochentage und Monate nennen; die Uhrzeit nennen; über Arbeit, Berufe und Arbeitszeiten sprechen;

Wortschatz: Hobbys und Berufe, Uhrzeiten
Grammatik: Regel-und-Unregelmäßigen verbkonjugationen, haben konjugatio, Bestimmter und Unbestimmter Artikeln, Ja/Nein Fragen, die entsprechende Präpositionen (um/am/im/von...bis), Negation (nicht vs kein), Verbpositionen und Wortfolge
Schreiben: Was machst du in deiner Freizeit?

Module:3	**Familie**	**4 hours**

über Familie sprechen;

Wortschatz: Familie
Grammatik: Possessivpronomen, Nominativ und Akkusativ (Artikel und Personalpronomen)
Schreiben: ,,Meine Familie"

Module:4	**Essen und Trinken**	**4 hours**

Über Essen sprechen; Gespräche beim Essen führen; Gespräche beim Einkauf führen; über Vorlieben beim Essen sprechen;

Wortschatz: Lebensmittel, Getränke, Mahlzeiten
Grammatik: Verben - möchten/mögen, Akkusativ, Verben mit Akkusativ, Präpositionenmit dem Akkusativ (für/ohne)

Module:5	**ZusammenmitFreunden**	**4 hours**
Etwas gemeinsam planen; eine Speisekarte verstehen; im Restaurant bestellen und bezahlen; sich im Kaufhaus orientieren Wortschatz: Glückwünsche, Redemittel, Stockwerke und Waren im Kaufhaus Grammatik: Imperativ mit du und ihr, Artikel im Dativ, Personalpronomen im Dativ, Dativpräpositionen (mit, nach, ab, von), Modalverben (können, sollen, wollen) Schreiben: Inoffizielle Emails schreiben		
Module:6	**MeineWohnung**	**4 hours**
Wohnungsanzeigen verstehen, Wohnsituationen beschreiben; ein Zimmer beschreiben; Positionen beschreiben, Gefallen und Missfallen ausdrücken; Wortschatz: Wohnung, Zimmer und Räume, Möbel und Geräte, Farben Grammatik: Adjektiv mit sein, zu/sehr+Adj, Wechselpräpositionen Schreiben: ,,Wohnung“		
Module:7	**Eine Stadtrundfahrt**	**4 hours**
Nach dem Weg fragen; Verkehrsmittel und Verkehrsschilder benennen; Wortschatz: Plätze und Gebäude, Verkehrsmittel, Richtungen, Sehenswürdigkeiten Grammatik: Imperativ mit Sie, Modalverben (müssen/dürfen), Zeitadverbien: zuerst, dann, später…, Schreiben: ,,Meine Stadt“		
Module:8	**Training vom Sprechen**	**2 hours**
	Total Lecture hours:	**30hours**

Textbook(s)

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Netzwerk A1, 2017, Stuttgart.

Reference Books

1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Netzwerk A1 Deutsch als Fremdsprache Intensivtrainer, 2019, Stuttgart
2.	Hartmut Aufderstrasse,JuttaMüller, Thomas Storz, Lagune, 2012.
3.	Dallapiazza, Rosa-Maria; Jan, Eduard von; Schönherr, Til, Hueber Verlag, 2008: Tangram aktuell.
4.	Hermann Funk, Christina Kuhn, Corneslen Verlag, Studio d A1,2010, Berlin.

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

Recommended by Board of Studies	01-11-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BITL101L	Italian	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Communicate in Italian in their day-to-day life.
2. Describe in simple terms (both in written and oral form) aspects of their background, immediate environment and needs.
3. Learn crucial aspects of Italian culture and civilization, as well as the role of the Italian economy in the global market.

Course Outcome

The students will be able to:

1. Use Italian language in everyday conversation.
2. Analyze the evolution of Modern European languages, understanding the important connections between English and Neo-Latin languages by using Italian language in written form, thus becoming more conscious of English vocabulary which is derived from Latin and Italian.
3. Understand important cultural aspects and socio-economic issues in contemporary Europe, developing their aptitude for critical thinking and adopting an internationally oriented approach in learning.
4. Understand the concept of Made in Italy, concerning the world-renowned Italian design, fashion, food, manufacturing, craftsmanship, and engineering industries.

Module:1	**Primicontatti- Basic interaction**	**4 hours**

Communicative functions:

Salutare (greetings); chiedere il nome (asking someone's name); presentarsi (introducing yourself); chiedere e indicare la provenienza (asking and talking about one's provenance); congedarsi (leaving from a conversation); chiedere il numero di telefono e l'indirizzo e rispondere (sharing personal details such as telephone numbers and addresses); chiedere di ripetereun'informazione (asking someone to repeat a sentence or a piece of information).

Grammar and vocabulary skills:

I pronomi soggetto (subjectpronouns io, tu, Lei); il presente di essere, avere, chiamarsi al singolare (simplepresent tense of the verbs essere, avere, chiamarsi); l'alfabeto (the alphabet); gli articoli determinativi (definite articles il & la); gli aggettivi di nazionalità al singolare (adjectives of nationality - singular); gli interrogativi: come, di dove, quale (interrogatives come, dove, qual); gli aggettivi numerali cardinali da 1 a 20 (numeral cardinal adjectives from one to twenty).

Module:2	**Persone e professioni – People and professions**	**4 hours**

Communicative functions:

Chiedere e dire l'età(asking and telling someone's age); indicareoccupazione e luogo di lavoro (share information about one's profession and work place); chiedere e fornireinformazionipersonali (sharing personal details, such as email, phone number etc.); informarsidelleconoscenzelinguistichealtrui e fornire le proprie (sharing information about one's spoken languages); scusarsi e ringraziare (excusing oneself, thanking someone); chiedere e dire l'età (asking and telling about someone's age).

Grammar and vocabulary skills:

I verbi regolari in -are (regular verbs - first conjugation); i verbi essere, avere, fare e stare (auxiliaryverbs avere and essere, irreguarverbs fare and stare); i sostantivi al singolare (singularnouns); la negazione (negative clauses); articoli determinativi e indeterminativi

(definite and indefinite articles); dimostrativi questo e questa (demonstratives); le preposizioni a e in (prepositions a, in); gli interrogativi che, chi, dove, quanti (interrogatives: what, who, where, howmany); gli aggettivi numerali cardinali fino a 100 (numeral cardinal adjectives up to 100).		
Module:3	**Cibi e bevande - Gastronomic culture in Italy**	**4 hours**
Communicative functions: ordinare al bar e al ristorante (placing an order at a restaurant/café/bar); chiedere e ordinarequalcosa in modo cortese (asking something politely); chiederequalcosachemancasultavolo (making special requests to a waiter); chiedere il conto (requesting the bill); fare una prenotazionetelefonica (making a reservation over phone); compitare (spelling a name/address). Grammar and vocabulary skills: i verbi regolari in -ere (regular verbs - second conjugation); i verbi volere e preferire (irreguarverbs volere and preferire); il plurale dei sostantivi (pluralnouns); articoli determinativi plurali (plural definite articles); bene e buono | (adverb bene and adjective buono); gli interrogativi che cosa, quali, quante (interrogative forms: what, which one, howmany).		
Module:4	**Tempo libero, attivitàabituali - Free time and routine activities**	**4 hours**
Communicative functions: parlare del tempo libero (discussing about free time and leisure); parlaredellafrequenza con cui si fa qualcosa (talking about the frequency of a certain activity). Grammar and vocabulary skills: i verbi regolari in -ire (regular verbs - thirdconjugation); i verbi andare, giocare, leggere e uscire (verbs andare, giocare, leggere and uscire); gli avverbi di frequenza (adverbs of frequency).		
Module:5	**La casa e la stanza d'albergo - Describing a room and everyday objects**	**4 hours**
Communicative functions: Descrivereun'abitazione (describing a home); descrivereiservizi di un albergo (describing a hotel room and the services available); recensire un albergo (writing a simple hotel review); chiedereassistenza (asking for someone's assistance). Grammar and vocabulary skills: iverbiregolari in -ire con -isc (regular verbs - third conjugation in -isc)c' / ci sono (usage of there is / there are); iverbipotere / venire (to be able to, to come); le preposizioni di tempo da… a (prepositions da… a); le preposizioniarticolate (articulated prepositions); imesidell'anno (months of the year); aggettivinumeraliordinali (ordinal numeral adjectives); l'interrogativoquanto (usage of quanto); i numeri cardinalimaggiori di 100 (cardinal numerals above 100); la data (date and time).		
Module:6	**Spazio e tempo – Space and Time**	**4 hours**
Communicative functions: descriverela propria città(describing one's city); chiedereun'informazione e reagire (asking for directions in an interactive way); descrivere un percorso (describing a route); rammaricarsi/scusarsi (expressing regret/apologizing); indirizzarequalcunoadaltrepersone (giving directions); parlaredegliorari di apertura e chiusura (talking about opening hours); parlare del tempo atmosferico (talking about weather). Grammar and vocabulary skills: ci e il verbo andare (usage of the particle ci in combination with the verb to go); la concordanza degli aggettivi con i sostantivi (adjective-noun agreement); gli aggettivi in -co/-ca (adjectivesending in -co and -ca); il partitivo - l'articolo indeterminativo al plurale (partitives and quantitatives); molto (usage of molto); i verbi dovere e sapere (the verbs dovere and sapere); c' un…? / dov' il…? (usage of isthere a…? / whereis the…?); gli interrogativi quando e dove (interrogatives: when&where); l'orario - a che ora…? (usage of a cheora…? - at what time…?).		

Module:7	**Parliamo di me – Habits and Preferences**	**4 hours**
Communicative functions: parlare di gusti e preferenze (talking about preferences and one's tastes); esprimereaccordo e disaccordo (expressing agreement and disagreement); chiedere e dire l'ora (asking and telling the time). Grammar and vocabulary skills: preposizioni in, a, con (prepositions in, a, con); i giorni della settimana (days of the week); mi piace/mi piacciono (usage of mi piace); l'interrogativo perché (the interrogative perché).		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)	
1.	L. Ziglio, G. Rizzo, *Nuovo Espresso 1: Libro dello studente e esercizi*, 2018(under license of ALMA, Italy), ISBN: 978-9386862853,Goyal Publishing House, New Delhi.
Reference Books	
1.	C.M. Naddeo, E. Orlandino, *Dieci lezioni di italiano – Corso di lingua italiana per stranieri A1*, 2020, ALMA edizioni, Florence (Italy).
Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT.	

Recommended by Board of Studies	01-11-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BJAP101L	Japanese I	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus Version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop interest in Japanese language by teaching them culture and general etiquettes.
2. Develop four basic skills that is reading, writing, listening, and speaking Japanese language.
3. Develop skills to understand and use everyday expressions as well as basic phrases.

Course Outcome

Students will be able to:

1. Greet in Japanese and remember Japanese alphabets.
2. Introduce themselves as well as can briefly exchange the personal details related to family, home, favorite foods etc., in Japanese.
3. Create simple questions and its answers in Japanese as well as can briefly describe their daily routine in Japanese.
4. Understand the Japanese culture and etiquettes.

Module:1	**Introduction, Hiragana, Katakana and Kanji**	**4 hours**

Introduction of Japanese language and alphabets; Hiragana and katakana
Reading and writing Hiragana and Katakana, 20 Nouns in Hiragana and 10 Nouns in Katakana, Numerals
Basic rule of Japanese phonetics.

Module:2	**Konnichiwa. Hajimemashite.**	**4 hours**

Daily greetings and basic phrases to introduce yourself
Express about your name, occupation, age, where you live, where you are from and what language you can speak
Body Language such as bowing, pointing to your face, etc.

Module:3	**WatashinoKazoku**	**4 hours**

Talk briefly about your family, how many members there are and who they are,
Talk about your family showing a photo. Learn some phrases to give compliments.

Module:4	**Sukinatabemono. Hitotsukudasai.**	**4 hours**

Talk briefly about your favorite foods and dishes. Talk about your breakfast and where to go for lunch.
Order food in a fast food restaurant.

Module:5	**Watashinoie. Ojamashimasu.**	**4 hours**

Say what kind of home you live in. Say what you have in your room and around your home
Invite your friend to your place / visit your friend's house.

Module:6	**Nanjiniokimasuka. Itsugaiidesuka.**	**4 hours**

Say the time and days you do something, Talk about your plans in the week
Talk about your plans and schedule.

Module:7	**KonoHitohaDareDesuka.**	**4 hours**

Demonstrative pronoun - Kore, Sore, Are and Dore, (This, That, Over there, which) Kono, sono, Ano and Dono (this, that, over there, which) Kochira, Sochira, Achira and Dochira. this way....) Koko, Soko, Asoko and Doko (Here, There…. location).Classification of Question words (Dare, Nani, Itsu, Doyatte, dooshite, Ikutsu, Ikura).

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

Textbook(s)			
1.	The Japan Foundation (2017), Marugoto Japanese Language and Culture Starter (A1)Course book For Communicative Language Activities, New Delhi: Goyal Publishers (9788183078054).		
Reference Books			
1.	The Japan Foundation (2017), Marugoto Japanese Language and Culture Starter A1 Course book For Communicative Language Competences, New Delhi: Goyal Publishers (9788183078047).		
2.	Banno, Eri et al (2020), Genki: An Integrated Course in Elementary Japanese I [Third Edition], Japan: The Japan Times.		
Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BGRE101L	Modern Greek	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Master the Greek terminology widely used in their subjects of specialization.
2. Communicate in Modern Greek in their day-to-day life.

Course Outcome

The students will be able to:

1. Make use of the Modern Greek language in everyday conversation.
2. Understand contents from scientific texts that use Greek letters and words, becoming familiar with fundamental linguistic aspects of the International Scientific Vocabulary, and becoming able to formulate hypotheses about unknown compound words derived from Greek.
3. Understand critical socio-economic issues in contemporary Europe, developing their aptitude for critical thinking.
4. Become more aware of linguistic theory and phonetics and correctly pronounce Greek letters and words, be more conscious and confident in using their English vocabulary derived from Greek and compare Modern Greek with a wide number of other languages through a deeper understanding of the International Phonetic Alphabet.

Module:1	**ΤοΕλληνικό αλφάβητο, ηφωνητικήκαιηπροφορά, τομονοτονικόσύστημακαιτασημείαστίξης - IntroductiontotheGreekAlphabet, Phonetics, Accentuation&Punctuation**	**10 hours**

Correct usage and pronunciation of Greek letters; Greek symbols used in mathematics, science and engineering; Greek suffixes and prefixes used in International Scientific Vocabulary; International Phonetic Alphabet and phonetics of Modern Greek; Greek monotonic system (usage of grave accent and diaeresis); word stress rules; capitalization and punctuation rules.

Module:2	**Η Δομή των Φράσεων και η Πρόταση: Γραμματική - Structureandgrammar**	**3 hours**

Gender (masculine, feminine, neuter), number (singular/plural) and case (nominative, genitive, accusative and dative); adjectives: explaining agreement (concord); definite and indefinite articles; personal, interrogative, possessive, demonstrative, indefinite pronouns.

Module:3	**Χαιρετισμοί: πληθυντικόςευγενείας -Formal and informal greetings**	**3 hours**

Communicative functions: using formal and informal greetings; introducing oneself using affirmative form.

Morphology and Syntax**:** Auxiliary verb είμαι; personal pronouns (nominative form); cardinal numerals from 1 to 20.

Module:4	**Συστήνω τον εαυτό μου- Introductions**	**3 hours**

Communicative functions: asking and providing information about basic personal details (name, age, nationality, studies, profession).

Morphology and Syntax**:** 1st conjugation verbs (ending in -ω, simple present tense); masculine nouns in -ας/-ης/-ος (nominative singular); feminine nouns in -α/-η (nominative singular); neuter nouns in -ο/-ι (nominative singular).

Module:5	**Καταγωγήκαι οικογένεια - Nationality and Family**	**3 hours**
Communicative functions: asking and providing information about nationality and languages known; describing the members of a nuclear or extended family. Morphology and Syntax**:**2nd conjugation verbs (ending in -αω, simple present tense); accusative case (singular, parisyllabic nouns); accusative case (singular personal pronouns); adjectives of nationality.		
Module:6	**Ηκαθημερινήρουτίνα - Daily Routine and Transportation**	**3 hours**
Communicative functions: asking and providing information about habits and daily routine; telling and asking the time; asking for and giving directions. Morphology and Syntax**:**verbs πάω, τρώω, λέω, ακούω; simple present tense and adverbs of frequency; simple prepositions.		
Module:7	**Ο καιρός, οι εποχές του χρόνου και η ζωή στην πόλη - Weather, SeasonsandUrbanActivities**	**3 hours**
Communicative functions: talking about the weather; asking the date; asking for prices; making calculations and perform a simple commercial transaction. Morphology and Syntax**:**accusative case (time); cardinal numerals up to one million; ordinal numbers; indefinite articles; accusative case (plural parisyllabic nouns).		
Module:8	**Διάλεξημε προσκεκλημέν-ο/η ομιλ-ητή/ήτρια: κοινωνίακαιπραγματικότητα της σύγχρονης Ελλάδας – contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)

1.	GeorgantziEvangelia, RaftopoulouEleana, *Greek for you - Ελληνικάγιασας: Textbook A1 Beginners*,March 2018, New Bilingual Edition (ISBN: 978-9607307682), Neohel, Athens, Greece.
2.	GeorgantziEvangelia, RaftopoulouEleana, *Greek for you - Ελληνικάγιασας: Workbook A1 Beginners*, March 2018, New Bilingual Edition (ISBN: 978-9607307736), Neohel, Athens, Greece.

Reference Books

1.	Terpsi Gavala, Konstantinos Oikonomou, *Λυδία. 'Ενα καλοκαίρι στην Ελλάδα!*,2019, firstedition, Omilo, Athens, Greece.
2.	GeorgantziEvangelia, *Greek for you - Ελληνικάγιασας: Textbook A0 Early Beginners + CD mp3*, 2018, Bilingual Bundle Edition (ISBN: 978-9607307668), Neohel, Athens, Greece.

Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT.

Recommended by Board of Studies	01-11-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

BESP101L	Spanish I	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Demonstrate proficiency in reading, writing, and speaking in basic Spanish.
2. Learn vocabulary related to profession, education centers, day-to-day activities, food, culture, sports and hobby, family set up, workplace, market, and classroom activities.
3. Demonstrate the ability to describe things in simple forms and their details and translate from Spanish to English and vice versa.

Course Outcome

The students will be able to

1. Remember greetings, give personal details and identify genders by using correct articles.
2. Apply the correct use of SER, ESTAR, and TENER verbs to describe people, place, and things.
3. Discuss time and weather conditions by knowing months, days, and seasons in Spanish.
4. Create opinion about people and places by using regular verbs and reflexive verbs and creating small paragraphs about the daily routine, hometown, best friend, and family.

Module:1	**Abecedario; Saludos y Despedidas**	**4 hours**

El Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Números Cardinales (1-100)

Recursos Gramaticales: Vocales y Consonantes, Sílabas. Artículos definidos e indefinidos (Número y Género).

Recursos Comunicativos: Saludar y despedirse: Aprender a Presentarnos, a preguntar cosas en clase.

Module:2	**Datos personales; recursos para preguntar sobre las palabras**	**4 hours**

Edad y posesión. Números Cardinales (101-100 000), Profesión, Los días de la semana.

Recursos Gramaticales: Pronombres personales. Adjetivos. Los verbos SER y TENER. Los verbos regulares (-AR, -ER, -IR) en el presente.

Recursos Comunicativos: Escribe sobre mismo/a y los compañeros de la clase.

Module:3	**Describir lugares; Expresar existencia y ubicación**	**4 hours**

Hacer un conocimiento del mundo Hispano. Vocabulario de Mi habitación, Países y Ciudades. Colores, Números Ordinales:

Del Primero a Décimo (1 - 10). Descripción de lugares y cosas.

Recursos Gramaticales: Adjetivos posesivos. El uso del verbo SER y ESTAR. Diferencia entre SER y ESTAR. ¿qué, cuál / cuáles, cuántos / cuántas, dónde, cómo, quién, cuándo?

Recursos Comunicativos: Mi habitación, Mi Ciudad.

Module:4	**Mi familia; Direcciones; Expresar la hora y los gustos**	**4 hours**

Mi familia. Direcciones. Expresar la hora.

Los meses del año. Expresar y preguntar sobre gustos e intereses.

Recursos Gramaticales: Frases preposicionales. Uso del HAY.

La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR, JUGAR,

Recursos Comunicativos: Mi familia. Dar opiniones sobre tiempo.

Module:5	**El clima; habilidades y aptitudes; Cualidades y defectos de las personas**	**4 hours**

Expresar fechas, el tiempo y las direcciones. Presentar y Describir a una persona y lugar.

Recursos Gramaticales: Los verbos irregulares (E-IE, O-UE, E-I) en el presente.

Recursos Comunicativos: Mi mejor amigo/a. Expresar fechas. Traducción Inglés al español y español al inglés.		
Module:6	**Describir el diario; Las actividades cotidianas;**	**4 hours**
Describir el diario. Las actividades cotidianas. Identificar objetos, expresar necesidad. Recursos Gramaticales:Los Verbos y pronombres reflexivos y posesivos. Recursos Comunicativos:El horario. Traducción Inglés a español y español a inglés.		
Module:7	**La Gastronomía: Ir al Restaurante**	**4 hours**
La Gastronomía: ¡A Comer! Dar opiniones sobre alimentos y bebidas. Describir mi ciudad y Ubicar los sitios en la ciudad. Recursos Gramaticales: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo. Recursos Comunicativos:En la cafetería, Conversación en un restaurante. Mi ciudad natal. Mi Universidad.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)	
1.	Jaime Corpas, Eva Garcia, Agustin Garmendia, AULA INTERNACIONAL 1, Curso de Español, 1 January 2016, GoyalPublishers and DistributorsPvt. Ltd, New Delhi, India
Reference Books	
1.	Shalu Chopra, VIVA LATINO 1, January 2019, Goyal Publishers and Distributors Pvt.Ltd, New Delhi, India
2.	Ramón Díez Galán, NuevoDELE A1: Versión 2020. Preparación para el examen. Modelos de examen
3.	DELE A1 (Spanish Edition), July 14, 2020, Independently Published. Spain.
	Charo Cuadrad, Pilar Melero, Enrique Sacristan, PROTAGONISTAS A1. LIBRO DEL ALUMNO,1 January 2018, GoyalPublishers and DistributorsPvt. Ltd, New Delhi, India

Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT

Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2021

HSM Basket Courses

Course code	Course Title	L	T	P	C
BMGT101L	Principles of Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide knowledge on management key concepts, evaluation of management thoughts and theories.
2. To understand the various functions of management and framework.
3. To gain a holistic understanding of multidisciplinary nature of management for effective functioning.

Course Outcomes

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

1. Understand the basic concepts of management.
2. Analyse the environmental factors that affect the organization and its growth.
3. Identify and apply appropriate techniques to manage an organisation.
4. Critically analyse the problem in each functions of the management.
5. Ascertain the role of technologies in management.

Module:1	Management Basics	6 hours

Management - nature and purpose, evolution of management concept, approaches to management process, functions and roles of management, influence of external and internal environment on decision making, factors affecting social responsibility and sustainability, and ethical business management.

Module:2	Planning	6 hours

Types of plans, steps in planning, strategic planning process, SWOT matrix, portfolio matrix, Porter's industry analysis and generic competitive strategies, decision making - importance of decision making, development of alternatives and evaluation of alternatives, and decision making under certainty, uncertainty and risk.

Module:3	Organizing	7 hours

Formal and informal organization, organizational levels and span of management, organization reengineering, structure and process of organizing, departmentation, matrix organization, strategic business units, virtual organization, line and staff authority, decentralization and delegation of authority, and organization culture.

Module:4	Staffing	6 hours

Overview to staffing functions, factors affecting staffing, position requirements, job design, job description, selection process and techniques, orientating new employees, performance appraisal and career strategy - appraisal criteria, team evaluation, rewards, and formulating career strategy, managerial training and development, conflict management, managing change, and learning organization.

Module:5	Leading	6 hours

Understanding motivation, motivation theories, leadership traits, styles, and types, committees, groups, and team decision making, communication purpose, communication process, and barriers to effective communication.

Module:6	Controlling	6 hours

Basic control process, critical control points, standards and bench marking, real-time information and control, feedforward or preventive control, control of overall performance, profit and loss control, control through ROI, management audits - balanced scorecard, bureaucratic and clan control, and control techniques and information technology.

Module:7	Managing Operations and Technology	6 hours

Operations management and corporate strategy, value chain management, role of technology in modern management practices, virtual organization and its structure, online business management, applications of digital technology, e-commerce, m-commerce, social media, and artificial intelligence in business management, and challenges to modern management practices.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Harold Koontz and Heinz Weihrich, Essentials of Management: An International and Leadership Perspective, 2020, 11th edition, McGraw-Hill, India.
Reference Books	
1.	Stephen P. Robbins, Mary Coulter and Agna Fernandez, Fundamentals of Management, 2019, 14th Edition, Pearson Education, India.
2.	Robert N. Lussier, Management Fundamentals: Concepts, Applications, & Skill Development, 9th Edition, 2020, Sage Publications, USA
3.	Pravin Durai, Principles of Management – Texts and Cases, 2019, 2nd Edition, Pearson Education, India.
Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT	

Recommended by Board of Studies	27-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BMGT102L	Human Resource Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the contributions of human resources to organizational effectiveness.
2. To apply various concepts of HR to manage the organization effectively.
3. To create various HRM concepts to enhance personal and organizational effectiveness.

Course Outcomes

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

1. Appraise and evaluate the basic principles of HRM.
2. Develop appropriate HR planning process for effective recruitment and selection.
3. Design various skills, procedures, and techniques to retain human resources.
4. Evaluate the basic and mandatory labor laws governing human resources.
5. Create a safety environment for managing human resources.

Module:1	HRM – Overview	6 Hours

Nature and scope of HRM, evolution and development of HRM, HR philosophy, policies, procedures and practices, dynamics of HRM environment, business ethics and CSR, equal employment opportunity, work force diversity, HR audit and evaluation, e-HRM, and strategic HRM.

Module:2	Human Resource Planning Process	6 Hours

Human resource planning and process - forecasting requirements, succession planning, job analysis, job analysis methods, job descriptions, job design, and global talent management.

Module:3	Recruitment and Selection	6 Hours

Recruitment process, methods, databases, job posting and bidding, recruitment sources, technology for recruiting, selection tests, interview planning, screening, selection decision, metrics for evaluating the effectiveness of recruitment, and factors affecting the selection process.

Module:4	Training and Development (T&D)	6 Hours

Training and development process, training needs, training methods, training and development delivery systems, implementing T&D programs, metrics for evaluating T&D effectiveness, and factors influencing T&D process.

Module:5	Performance Management and Appraisal	7 Hours

Performance appraisal process, establishing criteria for performance appraisal, performance appraisal methods and interview, appraisal problems, performance management, career planning and development, employee engagement, executive development, knowledge management, and importance of knowledge sharing culture for organizational effectiveness.

Module:6	Compensation and Benefits	6 Hours

Compensation overview, components of direct financial compensation, contextual influences on direct financial compensation, job evaluation, competitive pay structure, indirect compensation benefits - legal benefits, health care plans, retirement plans, workplace flexibility, and employment law.

Module:7	Employee Relations, Safety, and Health	6 Hours

Need for a safe and healthy environment, employee union and union structure, welfare activities, nature of industrial relations and labor laws, internal employee relations, resolving disputes, concept of collective bargaining, workplace bullying and violence,

social networking and employee wellness, physical fitness programs, employee assistance programs, and HR ethical practices.				
Module:8	**Contemporary Topics**			**2 Hours**
	Total Lecture Hours			**45 hours**
Text Book(s)				
1.	Gary Dessler & Biju Varrkey, *Human Resource Management*, 2020, 16th Edition, Pearson Education, India			
2.	Neeru Kapoor, *Concept Building Approach to Human Resource Management*, 2021, 2nd Edition, Cengage Learning, India			
Reference Books				
1.	Sharon Armstrong & Barbara Mitchell, *The Essential HR Handbook*, 2019, 10th Edition, Red Wheel/Weiser, USA			
2.	K Aswathappa and Sadhna Dash, *Human Resource Management - Text and Cases*, 2021, 9th Edition, McGraw-Hill, India			
Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT				
Recommended by Board of Studies	27-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BMGT103L	Organizational Behavior	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To familiarize the basic concepts of organizational behavior.
2. To understand, evaluate, and manage individual and group behavior effectively in an organization.
3. To formulate appropriate strategies based on individual and group behaviour.

Course Outcomes

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

1. Appraise the basic organizational and individual behaviour.
2. Describe the various dimensions of motivations.
3. Measure and monitor different aspects of stress and emotions.
4. Explain the various elements of groups and teams.
5. Analyze the different dimensions of organizational structure, culture, and change.
6. Formulate leadership traits for effective work culture.

Module:1	Organisational Behaviour - Essentials	5 hours

Understanding organizational behaviour, learning style, OB model, demographic and cultural diversity in organizations, ethical behaviour, tools of OB research, and challenges and opportunites for OB.

Module:2	Attitudes, Personality, and Values	7 hours

Individual attitudes, attitudes and behaivour, job attitudes, job satisfaction, job dissatisfaction, job satisfaction and job performance, personality frameworks, personality traits in OB, personality and situations, understanding values, values and workplace, and international values.

Module:3	Motivation	7 hours

Theories of motivation - need-based and process-based theories, designing a motivating environment, motivating employees through job design, employee involvement, benefits, and rewards to employees, and goal setting.

Module:4	Managing Stress and Emotions	4 hours

Meaning of stress, sources of stress, consequences of stress at work, avoiding and managing stress, understanding emotions, sources of emotions, and emotional intelligence.

Module:5	Group Behaviour, Work Teams, and Communications	8 hours

Group development, group size and dynamics, difference between groups and teams, types of teams, team design characteristics, management of teams, and barriers to effective teams, communication - functions, directions, and modes of communication, barriers to effective communication, power and politics, and conflict and negotiation.

Module:6	Organizational Structure, Culture, and Change	6 hours

Different types of organizational structures - common and alternate designs, organizational designs and employee behaviour, organizational culture - role of culture in organizaitons, creating and sustaining organizational culture, organizational change - forces, resistance,

and approcaches to organizational change.		
Module:7	**Leadership**	**6 hours**
Theories of leadership - tradional and contemporary styles, positive and responsible leadership, attributes of a leader, developing leaders across the organization, leadership grid, and challenges to understanding leadership.		
Module:8	**Contemporary Topics:**	**2 hours**
Guest lectures from Industry and, Research and Development Organisations		
	Total Lecture Hours	**45 hours**

Text Book(s)	
1.	Stephen P. Robbins and Timothy A. Judge, *Organizational Behaviour*, 2019, 14th Edition, Pearson Education, India
2.	Knud Sinding, Robert Kreitner, and Angeloi Kinecki, *Organisational Behaviour,* 2018, 6th Edition, McGraw-Hill Education, UK
Reference Books	
1.	*Organizational Behavior,* Open Textbook, University of Minnesota Libraries Publishing, 2017, ISBN 13: 9781946135155
2.	J.Stewart Black et.al., *Organizational Behavior*, OpenStax Textbook, Rice University, USA, Web Version Last updated: Feb 23, 2021
3.	Christopher P. Neck, Jeffrey D. Houghton and Emma L. Murray, *Organizational Behavior: A Skill-Building Approach*, 2019, 2nd Edition. Sage Publications, USA
Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT	

Recommended by Board of Studies	27-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
BMGT104L	Marketing Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To comprehend the basics of marketing and its related concepts.
2. To develop marketing plan for the given situation.
3. To carry out market research survey.

Course Outcomes

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

1. Create marketing strategy for the given business scenario.
2. Analyze the factors that affect the marketing program of an organization.
3. Identify market gaps and develop product ideas with appropriate STP strategies.
4. Formulate marketing mix strategies for a given business situation.
5. Develop promotional mix for a given business case.
6. Ascertain the latest trends in marketing.

Module:1	Marketing Basics	6 hours

Understanding marketing, scope of marketing, company orientation towards the marketplace, core concepts of marketing, types of market, marketing mix, value chain, core competencies, marketing strategy, and marketing plan.

Module:2	Environment Scanning and Market Research	6 hours

SWOT analysis, environment analysis - micro and macro factors, Porter's five forces framework, marketing research process, and demand measurement.

Module:3	Connecting with Customers and Building Strong Brands	9 hours

Building customer value, satisfaction, and loyalty, maximizing customer life time value (CLV), consumer buying decision process, segmentation, targeting, and positioning (STP) strategy - levels and bases of segmentation, market targeting, positioning, repositioning, understanding brand equity, building and managing brand equity.

Module:4	Setting Product and Pricing Strategies	8 hours

Product classifications, product levels, product line and mix, product life cycle (PLC), product-market growth strategies - Ansoff matrix and BCG matrix, new product development (NPD), understanding pricing, pricing strategies and methods, and responding to price change.

Module:5	Channel Management	5 hours

Channel functions and flows, channel levels, channel design, channel integration and systems, distribution strategies, channel intermediaries - wholesalers and retailers, understanding private labels, and channel conflict and resolution strategies.

Module:6	Integrated Marketing Communications (IMC)	6 hours

Advertising - ad types, advertising medium, and evaluation of ads, Sales Promotion - salesforce promotion, trade promotion, and consumer promotion, Direct Marketing - kiosk, catalogues, e-mail, SMS, vending machines, and telemarketing, Public Relations - publicity, newsletter, CSR, sponsorships, and advertorials, Digital Advertising - Types of digital media, display ads, search engine ads, social media marketing, and artificial intelligence based marketing techniques, and Personal Selling.

Module:7	Marketing for long-term Success	3 hours

Holistic marketing organization, socially responsible business models, cause-related

marketing, social marketing, marketing implementation and control, and future of marketing.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Philip Kotler and Keller Kevin, *Marketing Management*, 2021, Global Edition (16th), Pearson Education, UK	
2.	Ramaswamy, V. S., and S. Namakumari, *Marketing Management: Indian Context, Global Perspective*, 2018, 6th Edition, SAGE Publications India Pvt Limited, India	
Reference Books		
1.	Hermawan Kartajaya, Iwan Setiawan and Philip Kotler, *Marketing 5.0: Technology for Humanity*, 2021, 1st Edition, Wiley, USA	
2.	Lilien, Gary L., Arvind Rangaswamy, and Arnaud De Bruyn, *Principles of Marketing Engineering and Analytics*, 2017, 3rd Edition, DecisionPro Inc.	
Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT		
Recommended by Board of Studies	27-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BMGT105L	Consumer Behavior	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To learn the dynamics of consumer behavior and market.
2. To critically evaluate various factors influencing the buying behavior of individuals.
3. To execute consumer research survey based on the given problem.

Course Outcomes

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

1. Appraise the basics of consumer behavior and consumer decision making process.
2. Analyze psychological and personal factors that influence consumer behavior.
3. Evaluate social, cultural, and digital influence on consumer behavior.
4. Associate various theories of consumer behavior in consumer decision making process.
5. Comprehend the significance of marketing and consumer ethics.
6. Apply consumer research process for a given problem.

Module:1	Consumer Behavior - Basics	5 hours

Evolution of consumer behavior, dynamism in consumer behavior, consumer behavior and technology, market segmentation, targeting, and positioning, customer value, satisfaction, and retention, effects of marketing mix on consumer behavior, consumer decision making and integration of various disciplines, and consumer decision making process.

Module:2	Psychological Influence - Perception and Learning	6 hours

Meaning of perception, components of perception, perception process, theories of perception, perception level, challenges in formulating consumer perception, perception and semiotics, perception and positioning, perceived quality and perceived risk, meaning of learning, elements of learning, categories of learned behavior, dimensions of learning, theories of learning, and learning and memory.

Module:3	Psychological Influence - Motivation, Beliefs, and Attitude	6 hours

Types of motives, drivers of motivation, categories and theories of motivation, consumers' emotions, motivation and decision making, types of beliefs and consumer behavior, elements and characteristics of attitude, attitude formation, tri-component model of attitude, multi-attribute models, cognitive dissonance, and conflict resolution.

Module:4	Personal, Social, and Cultural Influence	9 hours

Understanding personality, elements of personality, personality theory, self-concept, personality traits, anthromorphism, elements and categories of lifestyle, values and lifestyle, approaches to marketing strategies based on personality and lifestyle, types of reference groups, role of reference groups, impact of reference groups on marketing strategies, family and consumer behavior, family structure, family life cycle, cultural influence on consumer behavior, cultural theories, Indian culture and socialization, and effect of cross-cultures on consumer behavior.

Module:5	Digital and Social Media Influence	6 hours

Media integration and consumer behavior, theoretical frameworks - TRA and UG, consumer behavior on digital platforms, blogs and consumer behavior, virtual and brand communities influence on consumer behavior, usage of mobile and its influence on consumer behavior, virtual shopping and its influence on consumer behavior, luxury and consumer behavior, and changing tri-component model of attitude.

Module:6	Information Processing and Decision Making	6 hours

Understanding information processing, information processing theories, information processing and persuasive communication, information processing and memory, methods of

information processing, information retrieval, levels of decision making, decision making methods, and consumer decision making models.		
Module:7	**Marketing Ethics and Consumer Behavior Research**	**5 hours**
Socially responsible marketing, consumers' privacy, misleading labels, camouflaged advertising, consumer ethics, and consumer research and process.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
Text Book(s)		
1.	Schiffman Leon G., Wisenblit Joe, Kumar S. Ramesh, *Consumer Behavior*, 2018, 12th Edition, Pearson Education, India	
2.	Jain, Varsha, and Jagdish Sheth. *Consumer Behavior: A digital Native,* 2019, 1st Edition, Pearson Education, India	
Reference Books		
1.	David L Mothersbaugh, Del I. Hawkins, Amit Mookerjee, *Consumer Behavior: Building Marketing Strategy*, 2019, 13th Edition, McGraw-Hill, India	
2.	Hoyer, Wayne D., Deborah J. MacInnis, and Rik Pieters, *Consumer Behavior*, 2016, 7th Edition, Cengage Learning, USA	
3.	Marieke de Mooij, *Consumer Behaviour and Culture: Consequences for Global Marketing and Advertising*, 2019, 3rd Edition, SAGE, USA	
Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT		
Recommended by Board of Studies	27-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Code	L	T	P	C
BMGT106L	Digital Marketing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To evaluate digital marketing and digital media.
2. To get exposed to various digital marketing channels.
3. To develop online ads and assess the performance of ads.

Course Outcomes

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

1. Create digital marketing strategies for a given business scenario.
2. Develop search engine marketing strategy with the use of SEO and AdWords.
3. Formulate strategies for various digital marketing channels.
4. Develop ad campaigns on any one of the social media platforms and analyze its outcomes.
5. Know the tabs on google analytics dashboard and measure campaign performance.
6. Ascertain contemporary technologies of DM and its effects on DM.

Module:1	Digital Marketing (DM) Fundamentals	6 hours

Marketing basics, introduction to DM, origin and development of DM, traditional Vs digital marketing, digital marketing channels, digital customer journey and mapping, digital marketing funnel, creating buyer persona, types of digital media (paid, shared, owned, and earned), IMC in DM, developing DM strategy and objectives, and challenges to DM.

Module:2	Search Engine Optimization (SEO)	6 hours

Building websites and web pages, web hosting, subdomains and subfolders, website navigation, social media icons, advanced website features, setting up google analytics, search engine work mechanism, pillars of SEO, on-page and off-page optimization, SEO - visual and voice search, SEO tactics - white-hat and black-hat SEO, SEO - UX and UI, content marketing for SEO success, and external link building.

Module:3	Display Advertising & Search Engine Advertising	7 hours

Display advertising media, digital/ad metrics, types of display ads, targeting categories, geographic and language tagging, programmatic display advertising, ad server, ad exchange, challenges to display advertising. Search engine payments, google AdWords, Ad placements, Ad ranks, enhancing ad campaign, performance reports, and e-commerce ads Vs google ads.

Module:4	Social Media Marketing – Facebook, LinkedIn, & Instagram	8 hours

Developing social media ad strategy - listening, goal setting, strategy, implementation, measurement, social entertainment, and gamification. Facebook marketing - organic marketing, paid marketing, marketing with 3D posts, FB ads manager, FB pixel, FB business manager, and useful design tools. Importance of LinkedIn presence, LinkedIn strategy, LinkedIn website demographics, content strategy, LinkedIn native videos, LinkedIn analytics, and ad campaign. Instagram: objectives, content strategy, style guidelines, hashtags, sponsored ads, and apps.

Module:5	Twitter, Mobile, and Video Marketing	6 hours

Twitter building blocks, content strategy, Twitter usage, Twitter ads, Twitter analytics, Twitter tools and tips for marketers. Mobile advertising model, mobile marketing (MM) media (paid and owned), MM features, mobile apps, website and mobile responsive ads, MM strategy, and MM analytics. Needs of video marketing (VM), VM channels, VM strategy, and types of marketing videos, video production process, video optimization, and video analytics.

Module:6	Digital Analytics and Online Reputation Management (ORM)	6 hours

Data collection, key metrics, affiliate marketing, multi-channel attribution, types of tracking codes, and competitive intelligence. ORM Vs SEO, social commerce: reviews and ratings, user generated content, blogs, marketing partners, native advertising, landing page, and influencer marketing.		
Module:7	**Technological Advancements in DM**	**4 hours**
Voice search, beacon strategy, micro-moment marketing, cross device marketing, anthropomorphic AI, virtual reality (VR), augmented reality (AR), mixed reality (MR), extended reality (XR), chat bots, block chain technology, and role of virtual agents in customer relationship management.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**
Text Book(s)		
1.	Seema Gupta, *Digital Marketing*, 2020, 2nd Edition, McGraw-Hill Education, India	
2.	Alan Charlesworth, *Digital Marketing: A practical Approach*, 2018, 3rd Edition, Routledge, UK	
Reference Books		
1.	Jeremy Kagan and Siddharth Shekhar Singh, *Digital Marketing: Strategy and Tactics*, 2020, 1st Edition, Wiley, USA	
2.	David Meerman Scott, *The new rules of marketing and PR: How to use Content Marketing, Podcasting, Social Media, AI, Live Video, And NewsJacking to reach buyers directly*, 2020, 7th Edition, Wiley, USA	
3.	Dave Chaffey and Paul Russell Smith, *Digital Marketing Excellence: Planning, Optimizing and Integrating Online Marketing*, 2017, 5th Edition, Routledge, UK	
Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT.		
Recommended by Board of Studies	27-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BMGT107L	Business Analytics	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To summarize, analyze, and report the data for effective business decision-making.
2. To comprehend the advanced analytical tools available for various business problems.
3. To evaluate various analytical tools and choose the appropriate tool(s) for the given problem and data.

Course Outcomes

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

1. Compare various BA tools and evaluate various data types and scales.
2. Examine the characteristics of data to summarize it effectively.
3. Apply various supervised and unsupervised learning algorithms to business problems.
4. Use different techniques of BA to any one of the management domains.
5. Create and interpret the data analysis report to make business decisions.

Module:1	Overview to Business Analytics (BA)	5 hours
Need for business analytics, BA Vs data science, BA Vs big data, terminologies - business intelligence, machine learning algorithms - supervised and unsupervised learning, and data mining, pillars of BA, roadmap for analytics, data types and scales, data cleansing and data preparation.		
Module:2	**Descriptive Analytics**	**9 hours**
Descriptive analytics - measures of central tendency and dispersion, data visualization and exploration - histogram, bar chart, scatter plot, pie chart, box plot, and tree plot, probability, probability distributions, hypotheses testing, significance value (*p*-value) and relationship among variables.		
Module:3	**Regression Techniques**	**6 hours**
Simple linear regression and multiple linear regression (MLR), - theory, assumptions, goodness of fit, and model comparison. Applications of simple linear regression, MLR, using business problem and data.		
Module:4	**Classification Techniques**	**8 hours**
Binary logistic regression, decision tree, KNN, Naïve Bayes, LDA - theory and evaluations of classifiers (ROC and confusion matrix). Applications of binary logistic regression decision tree, KNN, Naïve Bayes, and LDA using business problem and data.		
Module:5	**Clustering and Dimensionality Reduction**	**6 hours**
Basics and uses of cluster analysis (K-means and Hierarchical clustering), and dimensionality reduction (FA and PCA). Interpretations to the outputs of K-means clustering, Hierarchical clustering, FA, and PCA.		
Module:6	**Applications of BA**	**6 hours**
Domain Applications of BA: HR analytics / marketing and retail analytics / web and social media analytics / financial analytics.		
Module:7	**Report Writing**	**3 hours**
Report writing - summary, problem identification, objectives, data visualization and exploration, methodology, interpretations, findings, and conclusions.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

1.	Dinesh Kumar U, *Business Analytics: The Science of Data-Driven Decision Making*, 2017, 1st Edition, Wiley, India.			
2.	Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, and David R. Anderson, *Essentials of Business Analytics*, 2017, 2nd Edition, Cengage Learning Inc., USA.			
Reference Books				
1.	Evans, J. R., *Business Analytics: Methods, Models and Decisions*, 2021, 3rd Edition, Pearson Education, USA.			
2.	Albright, S. C., and Winston, W. L.., Business Analytics: *Data Analysis and Decision Making*, 2020, 7th Edition, Cengage Learning India Pvt. Ltd, India.			
3.	Shmueli, G., Bruce, P. C., Yahav, I., Patel, N. R., and Lichtendahl, K. C., *Data Mining for Business Analytics: Concepts, Techniques, and Applications in R*, 2017, 1st Edition, Wiley, USA.			
Mode of Evaluation: CAT, Written Assignment, Quiz, Project, Seminar, Group Discussion, Case Study, and FAT				
Recommended by Board of Studies	27-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BHUM102E	Indian Classical Music	2	0	2	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. Bring in awareness of Music and understand the basics
2. Bring in awareness of Indian Classical Music
3. Developing skills to sing with tāḷaṁ and śruti

Course Outcome

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

1. Acquire basic knowledge on sound, music and history of Indian Music
2. Interpret the structure of hindusthāni, karṇāṭaka saṁgītaṁ and the musical forms in both styles
3. Practice different aspects in music
4. Attain skills in different genres of music
5. Explain the advanced scientific aspects of music
6. Sing songs with perfection

Module:1	The World of Music	4 hours
Sound-Music – Rhythm - Introduction to Different Genres of Music.		
Module:2	**History of Indian Classical Music**	**4 hours**
Indian Classical music History and evolution from Sanskrit tradition to modern era (hindusthāni and karṇāṭaka saṁgītaṁ), Folk Music.		
Module:3	**Carnatic Classical Music**	**4 hours**
nādaṁ-svaraṁ-śruti-rāgaṁ,tāḷaṁ-sinkarṇāṭakasaṁgītaṁ.Compositions (gītaṁsvarajati varṇaṁkīrttanaṁpadaṁtillāna) – Legends of karṇāṭaka saṁgītaṁ.		
Module:4	**Hindustani Music**	**4 hours**
Origin-Evolution-musical forms (khayāl,dhrupad,tappa andtarāna) - Tendhāt-s. Majorgharāna-sinhindusthāni Music - Legends in hindusthāni Music.		
Module:5	**Film Music**	**4 hours**
Contemporary music, Western music, Background Music- Music Composing.		
Module:6	**Music and Mind**	**4 hours**
Emotions – Conditioning -Therapeutic Effects of Music, Science and Music, science in music. Artificial intelligence used in music.		
Module:7	**Music as a Profession**	**4 hours**
Concert Platforms, Different Types of Shows, New avenues in Music industry.		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lectures by Academician/ Industrial Experts		
	Total Lecture Hours:	**30 hours**

Text Book (s)

1.	Prof. P. Sambamoorthi (2021), South Indian Music, Volume I – Indian Music Publishing House
2.	Vijay Prakash Singha (2018), An Introduction to Hindustani Classical Music: A Guidebook for Beginners, Roli Books.

Reference Books

1.	Sangeetha Widwan A.S. Panchapakesa Iyer (2014), Ganamrutha Bodhini, Ganamrutha Prachuram.
2.	Dr. P T Chelladurai (2010), The Splendor of South Indian Music, Vaigarai Publishers, Dindigul.

3.	Lakshminarayana Subramaniam (2018), Classical Music of India: A Practical Guide, Tranquebar Publisher.			
4.	B.Subbarao (1979), Raganidhi, Music Academy, Madras.			
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
List of Challenging Experiments (Indicative)				
1.	Swara exercises (sarali variśai, janta variśai, madhyasthāyi variśai, dhātu variśai) listening to music.			6 hours
2.	Tāḷaexercises(alaṁkāraṁ-sRūpakatāḷaṁ.ēkatāḷaṁ, triputatāḷaṁ)			4 hours
3.	Compositions: (gītaṁ-s.)			2 hours
4.	Compositions: kīrttanaṁ in Telugu			2 hours
5.	Compositions: kīrttanaṁinTamil			2 hours
6.	Compositions: kīrttanaṁ in Kannaḍa			2 hours
7.	Compositions: kīrttanaṁ in Malayāḷaṁ			2 hours
8.	Compositions: kabeer ke dohe and abhang			2hours
9.	Music composing techniques			4 hours
10.	Basics of audio recording			4 hours
		Total Laboratory Hours		**30 hours**
Mode of Evaluation: Lab Experiments and Lab Final Assessment Test				
Recommended by Board of Studies	23-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
BHUM103L	Micro Economics	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To enable students to understand economic concepts from a managerial perspective.
2. To integrate theoretical knowledge with quantitative and qualitative evidence for effective decision making.
3. To evaluate the consequences of market structure, pricing and competition at the domestic and global levels.

Course Outcome

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

1. Describe traditional and modern definitions of economics.
2. Analyse supply and demand forces that determine equilibrium in a market economy.
3. Evaluate the factors affecting firm behaviour, such as production and costs.
4. Develop the skills to apply theories, models, and graphs to analyze the national and internationalcases.
5. Discuss the behaviour of market, industry and the performance of firms under different market structures.
6. Examine the market failures and the role of government in dealing with those failures.

Module:1	Microeconomic Principles	5 hours

Introduction to Economics – Definition (Wealth, Welfare, Scarcity and Growth); Economics as Arts versus Science; Positive versus Normative Approaches.

Module:2	Consumer Behavior Theories	8 hours

Ordinal versus Cardinal approach- Law of Diminishing Marginal Utility - Indifference curveanalysis - Consumer equilibrium - Demand Analysis – movement and shift in Demand; exception to law of demand; Demandforecasting; Law of supply – Market equilibrium – Resource Allocation.

Module:3	Elasticity of Demand and Supply	5 hours

Elasticity of Demand: Price, Income and Cross – Price elasticity's; measurement of elasticity –Elasticity of supply.

Module:4	Production Function	5 hours

Production Function; Features of Production - The Production Function with One Variable Input and The Production Function with Two Variable Inputs – Law of Returns to Scale – Iso - quant and Iso - cost line - Producer Equilibrium.

Module:5	Cost and Revenue Functions	5 hours

Cost Functions – Nature of cost – Short Run cost function and Long Run cost curves - Revenue Functions – Types. Break-even analysis.

Module:6	Market Structure – Partial Equilibrium	8 hours

Products Markets – Perfect and Imperfect Competition- Monopoly, Monopolistic competition, Duopoly and Oligopoly, Efficiency and Regulation Factor market – Factor pricing.

Module:7	General Equilibrium and Economic Welfare	7 hours

General Equilibrium of Production and Exchange; Externalities - Asymmetric information, Adverse selection - Moral hazard; Pareto Optimality; Social Welfare Function.

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

Text Book(s)

1.	N. Gregory Mankiw (2015), “Principles of Microeconomics”, South-western Cengage Learning, USA, 7th Edition.			
Reference Books				
1.	Jeffrey M Perloff (2019), “Microeconomics”, Pearson Education, 17th Edition.			
2.	Dominick Salvatore ((2020), “Managerial Economics Principles and World Wide Applications”, Oxford University Press, 9th Edition.			
3.	Varian H.R. (2015), “Intermediate Microeconomics: A Modern Approach”, East West Press Pvt., Ltd, New Delhi, 9th Edition.			
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies		23-05-2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BHUM104L	Macro Economics	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To enable students to identify the determinants of macroeconomic aggregates and the major challenges associated with the measurement of these aggregates.
2. Enable students to critically evaluate the consequences of macroeconomic aggregates under differing economic conditions.
3. To discuss the linkages between financial markets and the real economy.

Course Outcome

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

1. Describe the macroeconomics aggregates.
2. Compute different measures of macroeconomic activity such as the national income.
3. Explain the general principles of consumption function and Investment function.
4. Develop the skills to use theories of multiplier and accelerator models to analyze everydayproblems in real world situations and evaluate economic policies.
5. Analyse macroeconomics concepts such as growth and inflation.
6. Evaluate how the government and central bank can influence the economy andthe markets through fiscal and monetary policies.

Module:1	Macroeconomic Principles	5 hours

Introduction to Macroeconomics – Macroeconomic issues – Importance of Macroeconomics – Macroeconomic Aggregates.

Module:2	National Income	5 hours

Circular flow of income, National income: Meaning, - Concepts – Nominal and real income -Methods of measurement – Importance – Problems in measurement.

Module:3	Theory of Income and Employment Determination	5 hours

Classical dichotomy – Keynesian income determination model – Money illusion, wage price rigidity – stability of equilibrium– stabilization of fiscal policy, Labour market and unemployment
– Aggregate demand, aggregate supply and price level.

Module:4	Consumption and Investment Function	7 hours

Consumption: Meaning - Components – Determinants - Consumption function: Meaning – Kinds
- Investment: Meaning - Components – Determinants - Investment function: Meaning – Kinds –Application.

Module:5	Multiplier and Accelerator	7 hours

Multiplier: Meaning – Working of multiplier – Accelerator: meaning – Working of accelerator –
Super multiplier.

Module:6	Inflation and Deflation	7 hours

Inflation: Meaning - Types - Causes – Philips curve - The long-run Phillips curve. Inflation
Expectations. The rational expectations - Deflation: Meaning – Causes – Consequences.

Module:7	Money, Banking and Financial Market and Institution	7 hours

Demand and Supply of money – The IS curve. Money Market and the LM curve. Liquidity trap. The IS-LM model – Central Bank - Monetary policy: meaning – Objectives – Variables – The instruments of Monetary control. Financial Markets - Savings, Investment and Financial System – Financial Markets and Financial Intermediaries. Financial Institution. Global Economic Indicators.

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

Text Book (s)	
1.	Mankiw, G. (2019), Macroeconomics, Worth Publishers, 10th Edition.
Reference Books	
1.	Frederic S. Mishkin (2017), "The Economics of Money Banking and Financial Markets", Pearson, 12th Edition.
2.	Blanchard, O. (2016), "Macroeconomics", Pearson Education Inc. 17th Edition.
3.	Paul A Samuelson Williamson (2017), "Macroeconomics", Gaurav-APM2NBMGSCY9L,19th Edition.

Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
Recommended by Board of Studies	23-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BHUM105L	Public Policy and Administration	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To introduce the students to the various aspects of Public Administration and Public Policy
2. To impart knowledge on administrative machinery in India and its contribution to public policy.
3. To study the various State and Central level programmes related to social and economic issues in India.

Course Outcome

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

1. Familiarize with the conceptual aspects and theoretical frameworks of public administration.
2. Describe the principles of public organisation and management.
3. Analyse the public finance management and budgeting system in India.
4. Acquire knowledge on the personal administration system in India, including the recruitment and service condition of central and state civil service cadres.
5. Demonstrate public policy making, implementation and evaluation.
6. Evaluate and interpret various legal and welfare policies framed by the different governments.

Module:1	**Background of Public Administration**	**6 hours**
Meaning, nature and scope of public administration, Private and public administration, Evolution of public administration, New public administration.		
Module:2	**Theories of Public Administration**	**6 hours**
Scientific theory, Classical theory, Bureaucratic theory, Human relation theory.		
Module:3	**Basic Concepts and Principles**	**6 hours**
Hierarchy, Unity of command, Span of control, Delegation, Line, staff and auxiliary agencies.		
Module:4	**Financial Administration**	**6 hours**
Organs of financial administration, Concepts and types of Budgeting, Preparation of budget, Enactment of budget, Execution of budget, Auditing of budget, Control over public finance.		
Module:5	**Personnel Administration in India**	**6 hours**
Role of Civil Service in Administration, All India and central services, Recruitment, Training, Promotion, Pay and service conditions.		
Module:6	**Introduction to Public Policy**	**6 hours**
Meaning, nature and significance of Public Policy, Evolution of Public Policy and Policy Sciences, Public Policy and Public Administration		
Module:7	**Public Policy Process in India**	**6 hours**
Formulation, implementation and evaluation.		
Module:8	**Contemporary Issues**	**3 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

1. Bidyut Chakrabarty, Prakash Chand Kandpal (2020), Public Administration in a Globalizing World: Theories and Practices, Sage Publications, New Delhi.

2.	Rumki Basu (2012), Public Administration: Concepts and Theories, Sterling Publication, New Delhi.
Reference Books	
1.	Raymond W Cox III, Susan Buck, Betty Morgan (2015), Public Administration in Theory and Practice, Routledge, New York.
2.	Christoph Knill, JaleTosun (2020), Public Policy: A New Introduction, Bloomsbury Publishing, London.
3.	Bidyut Chakrabarty, Prakash Chand (2019), Public Policy: Concept, Theory and Practice, Sage Publications, New Delhi.
4.	B.L. Fadia and Kuldeep Fadia (2015), Public Administration: Administrative Theories and Concepts, Sahitya Bhawan Publication, Agra.
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test	

Recommended by Board of Studies	23-05-2022		
Approved by Academic Council	No.66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BHUM106L	Principles of Sociology	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To develop awareness on sociological perspectives and sociological concepts.
2. To introduce students to the basic social processes of society, social institutions and patterns of social behavior.
3. To explore and understand sociology not merely as a social science discipline but as a distinctive branch of knowledge.

Course Outcomes:

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

1. Define sociology as a discipline and differentiate from other disciplines.
2. Discuss the field of sociology, major concepts and vocabulary.
3. Explain the relevance of socialization, groups, and institution's influence and constrain on individual agency.
4. Interpret the structural distinctions of caste and class within social dynamics.
5. Analyze various social phenomena through the lens of sociological perspectives.
6. Develop and prescribe models and solutions to address societal issues.

Module:1	**Sociology**	**6 hours**
Definition – Nature -Scope - Field - Importance - Relationship with other Social Sciences.		
Module:2	**Sociological Concepts**	**7 hours**
Society - Community-Association -Institution - Social Process - Social Structure- Role and Status.		
Module:3	**Culture**	**5 hours**
Meaning**–** Characteristics – Functions - Elements - Cultural Lag - Culture and Civilization.		
Module:4	**Socialization**	**6 hours**
Meaning - Socialization as a Process - Factors - Importance – Agents – Types –Adult Socialization.		
Module:5	**Social Groups**	**6 hours**
Meaning – Characteristics - Importance- Types: Primary group and Secondary group-In-group and Out-group-Reference group.		
Module:6	**Social Institutions**	**6 hours**
Marriage – Family – Education – Economics – Polity and Religion.		
Module:7	**Social Stratification**	**7 hours**
Meaning – Characteristics – Functions – Types. Caste system: Meaning – Factors - Characteristics – Origin – Functions and Changes. Social Class: Meaning – Nature – Differences between Caste and Class.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

1. Richard T. Schaefer (2021), Sociology – A Brief Introduction, McGraw Hill; 13th Edition.
2. Antony Giddens and Philip W. Sutton (2017), Sociology, Atlantic Publishers & Distributors Pvt. Ltd; 8th Edition.

Reference Books

1. C.N. Shankar Rao (2019), Sociology: Principles of Sociology: With an Introduction to Social Thoughts, S Chand & Company Ltd.

2.	Haralmbos, M. & Holborn (2022), Sociology: Themes and Perspectives, Collins Publishers, 8th Edition.		
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
Recommended by Board of Studies	24-05-2022		
Approved by Academic Council	No.66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BHUM107L	Sustainability and Society	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To understand holistic and critical perspective on sustainability.
2. To provide with clear understanding of social development and sustainability.
3. To educate the students to think practically and strategically about sustainability.

Course Outcome:

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

1. Familiarize the conceptual aspects of protection and reconcile economic growth, environmental balance and social progress.
2. Develop understanding of the labour welfare and human rights.
3. Discuss social mobility and integration.
4. Analyze and resolve conflict in equal manner.
5. Demonstrate understanding of the importance of education and equality.
6. Evaluate the factors that influence the sustainable society, design, develop the policies to achieve SDGs.

Module:1	Understanding Social Sustainability	6 hours

Concept and Context of Sustainability: Definition – Brief History – Sustainable Development in India – 17 SDGs - Importance and Challenges.

Module:2	Education	5 hours

Role and Importance of Education in Sustainable Development – Education and Media for Sustainable Societies – Education for Climate Action.

Module:3	Labor Force and Reforms	6 hours

Green Tribunals – Green Economy – Problem of Industries and Sustainability - Role of Government Initiatives for Labor Welfare in India.

Module:4	Human Rights	6 hours

Human Rights: Migrants and Refugees – Human Trafficking – Children's Rights: Prevention and Protection Measures.

Module:5	Gender Equality	7 hours

Understanding Gender Equality and Inequality – Forms of Discrimination and Suppression - Education and Employment - Health and Well-being - LGBTQ and Sustainable Development.

Module:6	Social Hazards	7 hours

Challenges: Poverty - Water Scarcity – Worldwide and in Indian Scenario - Impact of Globalization - Rapid Urbanization and Slums –Preventive Measure to Control CO2 Emission - Programmes and Schemes.

Module:7	Integration of Indigenous Groups	6 hours

Demography and Definition of Indigenous Groups – Understanding Indigenous Knowledge and Health Practices - Challenges and Opportunities for Sustainability.

Module:8	Contemporary Issues	2 hours

Total Lecture Hours	45 hours

Text Book(s) :

1. Lintsen, H., Veraart, F., Smits, J. P., & Grin, J. (2018). Well-being, Sustainability and Social Development: The Netherlands 1850–2050. Springer Nature.
2. Kaltenborn, M., Krajewski, M., & Kuhn, H. (2020). Sustainable Development Goals and Human Rights. Springer Nature.

Reference Books :

1. Pandey, U. C., & Kumar, C. (2020), SDG5 - Gender Equality and Empowerment of Women and Girls.
2. García - TejeroIván Francisco, & Hugo DuránZuazo Victor. (2018), Water Scarcity and

	Sustainable Agriculture in Semiarid Environment: Tools, Strategies and Challenges for Woody Crops. Academic Press, an imprint of Elsevier.			
3	Beeson, G. (2020), A Water Story Learning from the Past, Planning for the Future, CSIRO Publishing.			
4	Anders B., Roy, K. (2020), Indigenous Knowledges and the Sustainable Development Agenda. United Kingdom: Taylor & Francis.			
Reading Material:				
1.	Mensah, J. (2019). Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. Congent Social Sciences, 5 (1), 1653531. https://doi.org/10.1080/23311886.2019.1653531			
2.	https://www.oecd.org/employment/emp/50318559.pdf			
3.	Aliber, Michael. (2002). Poverty-eradication and Sustainable Development.			
4.	https://www.unicef.org/sdgs#sdg1			
5.	https://sdgs.un.org/goals			
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies	24-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course code	Course Title	L	T	P	C
BHUM108L	Urban Community Development	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1.Provides the basic understanding on urban society and its way of living
2.Orient the students about urban community issues
3. Sensitize the students to know about various supporting agencies and its initiatives for urban development.

Course Outcome:

On completion of this course the students will be able to;
1. Explain the concepts and approaches of urban community development.
2. Analyze the key issues of urban community.
3. Familiarize the administrative and local bodies structure, power and function of urban community.
4. Describe the core agencies in addressing various problems of urban community
5. Evaluate the policies and programmes of urban governance and development.
6. Develop professional awareness and learning on various developmental initiatives Implemented in community.

Module:1	Urban Society	5 hours

Urban Society: Concept – Characteristics. City:Meaning – Classification -Rural Urban linkages and contrast:Urban Community Development:Concept -Objectives and Historical background.

Module:2	Urbanization and Urban Living	5 hours

Urbanisation: Concept – Definition- Theories of Urbanization. Urbanism: Characteristics - Urbanization trends in urbanization and Urban Development -Modernization and Urbanization.

Module:3	Urban Community Issues	7 hours

Urban Poverty and Inequality – Unemployment-Housing - Water – Sanitation-Waste Management – Health - Education-Drug Addiction - Juvenile Delinquency.

Module:4	Urban Administration and Local Bodies	4 hours

Town Panchayat – Municipalities – Corporations: Structures, Powers and Functions.

Module:5	Urban Development Agencies	7 hours

Non-Governmental Organisations (NGOs) - Voluntary Organisations - State Industrial Development Corporations (SIDCs) - Public Works Department (PWD)- Housing and Urban Development Corporation (HUDCO) -Metropolitan Development Authorities - Slum Clearance Board.

Module:6	Urban Development Policies and Programs	8 hours

Urban Development Policies: Urban Basic Services-Urban Development Policy in India-Urban Development Planning: Town and Country Planning Act, 1971. Urban Development Programmes: Five Year Plans and Urban Development-Urban Basic Services Programmes (UBSP), Jawaharlal Nehru National Urban Renewal Mission (JNNURM) - Nehru Rozgar Yojana (NRY) -Urban Renewal Programme - Problems in Implementation of Urban Community Development Programmes.

Module:7	Urban Growth and Challenges	7 hours

Smart Cities and Development - Urban Environment and Pollutions – Globalization-Urban Reforms -Disaster Management –Displacement –Migration -Population Growth and its Impact (social and physical) -Suitable Approaches and Strategies.

Module:8	Contemporary Issues	2 Hours
	Total Lecture Hours	45 Hours

Text Book(s)		
1.	Vanita Pandey (2021), Urban Sociology, Rawat Publication	
2	Sidhartha.K (2019), Cities Urbanisation and Urban Systems New edition Kitab Mahal Daryaganj Delhi	
Reference Books		
1.	Dr.Mohd Akhter Ali, M.Kamraju, Dr.Muzafar Ahmad Wani (2020), Urbanisation and Urban Systems, Rajesh Publication	
2	Talja Blokland (2017), Community As Urban Practice, Edited by Talja Blokland, Polity Press	
3.	Zacchaeus Ogunnika (2017), Critical Issues in Community Development: An Introduction to Rural and Urban Sociology, Trafford Publishing	
4.	Pablo Shiladitya Bose (2015), Urban Development in India Global Indians in the Remaking of Kolkata, Routledge	
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test.		
Recommended by Board of Studies	24-05-2022	
Approved by Academic Council	No. 66	Date 16-06-2022

Course code	Course Title	L	T	P	C
BHUM109L	**Social Work and Sustainability**	**3**	**0**	**0**	**3**
Pre-requisite	Nil	**Syllabus version**			
		1.0			

Course Objectives

1. To understand the working concept of sustainability at the micro, mezzo, and macro levels of Social Work practice.
2. To study the relationships among the concepts of environmental, economic, use of technology, and social sustainability.
3. To study the interconnectedness of sustainability with social work methods, values, and ethics.

Course Outcome

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

1. Describe various concepts of Social Work, sustainability and SDGs.
2. Attain a sense of responsibility in addressing sustainable goals in developing a better society.
3. Discuss the policies and programs from global perspectives.
4. Develop skills to work in the community with people of diversity.
5. Evaluate policies of social development and human welfare services.
6. Design, develop and implement programs and policies for the better world.

Module:1	**Social Work Education and Practice**	**5 hours**

Sustainability in the Social Work profession - Principles – Methods - Ethics – Values – Strategies for sustainable community development – Social theory –Social-Ecological practice Model.

Module:2	**Social Work, Ecology, and Social Justice**	**5 hours**

Social Work and Ecological Approaches - Human rights Violations – Rights-based approach - Restorative Approaches in Social Work - Case Studies - Role of the Social Worker in achieving sustainability.

Module:3	**Sustainability and Vulnerability**	**6 hours**

Introduction -Principles - Limitations - Challenges - Transdisciplinary approach to sustainability and vulnerability –Interlink of Sustainability and vulnerability.

Module:4	**Theories in Sustainability**	**8 hours**

Theories: Social Capital theory and Mobilization - Bottom of the pyramid approach - Humanistic sustainability theory – Social Economy theory.

Module:5	**Pillars of Sustainability**	**8 hours**

Pillars: Social – Economic – Environmental – Cultural - Political - Security aspects.

Module:6	**Sustainable Developmental Goals – I**	**6 hours**

Goal 1: No Poverty - Goal 2: Zero Hunger - Goal 3: Good Health and Well-Being - Goal 4: Quality Education - Goal 5: Gender Equality - Goal 6: Clean Water And Sanitation - Goal 7: Affordable And Clean Energy - Goal 8: Decent Work and Economic Growth.

Module:7	**Sustainable Developmental Goals – II**	**5 hours**

Goal 9: Industry, Innovation, And Infrastructure - Goal 10: Reduced Inequality - Goal 11: Sustainable Cities And Communities - Goal 12: Responsible Consumption And Production - Goal 13: Climate Action - Goal 14: Life Below Water - Goal 15: Life on Land - Goal 16: Peace and Justice Strong Institutions - Goal 17: Partnerships to achieve the goa.l

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

Text Book(s)

1. Dominelli, Lena, 2018, Green Social Work: From Environmental Crises to Environmental Justice: Rawat Publications, India

2.	Walter Leal Filho, UbiratãTortato, Fernanda Frankenberger (2021), Integrating Social Responsibility and Sustainable Development - Addressing Challenges and Creating Opportunities, springer publication.			
Reference Books				
1.	Parker, Jonathan (2021), Social Work Practice Assessment, Planning, Intervention and Review, 6th Edition, Sage Publication.			
2.	Heslop, Philip &Meredith, Cathryn (2020), Social Work Theory in Practice, SAGE Publications Ltd.			
3.	Rao, Bhaskara N (2019), Sustainable Good Governance, Development and Democracy, Sage Publication.			
4.	IFSW (2018), Social Work Statement of ethical principles. International Federation of Social Workers, Rheinfelden, Switzerland.			
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies		23-05-2022		
Approved by Academic Council		No. 66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BHUM110E	Cognitive Psychology	2	0	2	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1. To understand the higher order process in cognition.
2. To enable the students to identify and apply the different aspects of cognitive process.
3. To enable the students to administer various assessments for mental process.

Course Outcomes

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

1. Explain how information processing works.
2. Comprehend the various cognitive processes such as attention, perception, memory, imagery and meta cognition.
3. Adopt various strategies to enhance problem solving process.
4. Describe cognitive development and disorders.
5. Apply tools and techniques to understand the cognitive processes through psychometric assessment.
6. Conduct practical experiments to assess the cognitive skills.

Module:1	Cognitive Psychology	5 hours

Contemporary Cognitive Psychology, Approaches- Experimental Cognitive Psychology - Computational Cognitive Science- Cognitive Neuropsychology- Cognitive Neuroscience, Application of Cognitive Psychology.

Module:2	Perception and Attention	4 hours

Understanding perception, Visual and auditory- Gestalt laws of organization, Perceptual constancy - depth perception, size perception, perception of movement; Various sensory modalities; Extrasensory perception.

The nature and roles of attention- types of Attention: selective attention models of selective attention divided attention and multitasking, Endogenous and Exogenous Effects in Space.

Module:3	Thinking and Reasoning	4hours

Meaning and Definition- Nature- Types: Perceptual or concrete- Conceptual or abstract- Creative – Logical or reasoning - Convergent and Divergent Thinking. Thinking and intelligence: Alterations. Reasoning: Meaning- Inductive reasoning- Deductive reasoning- Abdicative reasoning.

Module:4	Creativity	3hours

Meaning and Aspects of Creativity - Stages of Creativity- Creativity and Intelligence- Measurement of Creativity.

Module:5	Memory	4hours

Introduction- Types- Sensory memory- Short-term memory- Working memory- Long-term memory- forgetting and false memory- Everyday memory: Autobiographical- Eyewitness testimony. Memory distortions: Reconstructive Retrieval- Encoding Distortions - Source Monitoring - Eyewitness Testimony. Meta cognition. Memory Enhancement Techniques.

Module:6	Problem Solving and Decision Making	4hours

Introduction- Steps, Barriers to Problem Solving: Mental Set and Functional Fixedness- Unnecessary Constraints- Irrelevant Information. Problem-Solving Strategies: Heuristic- Algorithm- Abstraction- Hypothesis testing- Means-ends analysis- Root-cause analysis- Trial and error. Decision making, hypothetical thinking and rationality. Decision-making styles.

Module:7	Cognitive Development and Disorders	4hours

Cognitive Development Theories- Piaget's cognitive development- Background and key concepts- Skills & Important Milestones. Cognitive disorders -Symptoms, Causes and Effects- Types- Developmental disorders, Motor skill disorders, Dementia - Confusion- poor motor co-ordination- Loss of memory- identity confusion- impaired judgement.

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

Text Book(s)

1. Galotti,K.M.(2017),Cognitive Psychology In and Out of the Laboratory, 6th Edition,Sage.
2. Kellogg, R.T. (2015), Fundamentals of Cognitive Psychology, 3rdEdition, Sage Publications.

Reference Books

1. Goswami, U. C. (2020), Cognitive Development and Cognitive Neuroscience: The Learning Brain. London; New York: Routledge, Taylor & Francis Group.
2. Whiteley, C. (2020), Cognitive Psychology, CGD Publishing, 2nd edition.
3. Eysenck, M. W., & Brysbaert, M. (2018), Fundamentals of Cognition. Milton: Taylor and Francis.
4. Stemberg, R.J., Stenberg, K. (2016), Cognitive Psychology, 7th Edition. Wadsworth.
5. Groome, D., & Eysenck, M. W. (2016), An introduction to Applied Cognitive Psychology, London; New York: Routledge, Taylor & Francis.

Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test

Indicative Experiments

1.	Assessment of Attention	3hours
2.	Assessment of Memory	3hours
3.	Assessment of Creativity	3hours
4.	Assessment of Perception (Auditory/Spatial/Visual)	3hours
5.	Assessment of Intelligence	3hours
6.	Assessment of Critical Thinking	3hours
7.	Assessment of Problem Solving/Decision Making	3hours
8.	Assessment of Logical Reasoning/Inductive Reasoning/Diagrammatic Reasoning	3hours
9.	Assessment of Error checking	3hours
10.	Assessment of Psycholinguistic Abilities	3hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Continuous Assessment Tests, Final Assessment Test

Recommended by Board of Studies	23-05-2022		
Approved by Academic Council	No.66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
BCLE214L	Global Warming	3	0	0	3
Pre-requisite	NIL	Syllabus version 1.0			

Course Objectives

The objectives of this course is to :

1. Learn atmospheric dynamics and transport of heat.
2. Evaluate climate changes using models and predict global warming.
3. Acquire the concept of mitigation measures for global warming.

Course Outcomes

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

1. Understand the principles of atmospheric dynamics and demonstrate the intimidations of global warming at global and regional level.
2. Understand the need for mitigation and vulnerability assessment of regional and global warming.
3. Critically evaluate the scientific insights of the IPCC, global policies on global warming and mitigation.
4. Develop climatic models to predict global warming.
5. Relate knowledge of science and engineering for mitigation of global warming.

Module:1	Introduction	5 hours

Introduction to global warming–Significance of ozone in environment–Depletion of ozone layer-Greenhouse gases-Vienna convention and Montreal protocol-Role of hydrological cycle with greenhouse gases-Carbon cycle.

Module:2	Characteristics of atmosphere and its effects	8 hours

Physical and chemical characteristics of atmosphere-Biogeochemistry-Atmospheric stability-Temperature profile of the atmosphere–Temperature inversion effects–Isobaric heating and cooling–Adiabatic lapse rates-Radiation, convection and advections-Sun & solar radiation–Energy balance–Terrestrial radiation and the atmosphere.

Module:3	Elements of global warming	7 hours

Total carbon dioxide emissions by energy sector–industrial, commercial, transportation, residential–Impacts–air quality, hydrology, green space–Causes of global and regional climate change–Changes in patterns of temperature, precipitation and sea level rise–Greenhouse effect.

Module:4	Impacts of global warming	7 hours

Roots of global warming-Temperature alteration in the atmosphere-Melting of ice Pole-sea level rise-Impacts on Ecosystem–Water Resources-Methods and Scenarios–Uncertainties in the impacts of global warming–Risk of irreversible changes –Vulnerability assessment.

Module:5	Forecasting global warming with climate change models	6 hours

Developing climate models–Climate system model–Climate simulation and drift–Evaluation of climate model simulation–Regional (RCM)–Global (GCM)–Global average response to warming–Climate change observed to date.

Module:6	Global Policies and regulations towards global warming	5 hours

National and national legislative frameworks–UNFCCC–IPCC–Kyoto protocol–Kyoto mechanisms, clean development mechanisms, IPCC details and actions–Carbon credits-International and Regional cooperation.

Module:7	Mitigation measures of global warming	5 hours

Carbon sequestration and Carbon capture and storage (CCS)-Clean development mechanism (CDM)–Carbon trading-Future clean technology–Renewable and alternative energy, Green building, eco-friendly plastic.		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture Hours		**45 hours**

Text Book(s)

1. Robin Moilveen, Fundamentals of weather and climate, 2010, Second Edition, Oxford University Press, UK.
2. Neelin David J, Climate Change and Climate Modelling, 2011, First Edition, Cambridge University Press, UK.

Reference Books

1. Thomas Stocker, Introduction to Climate Modelling, Advances in Geophysical and Environmental Mechanics and Mathematics. 2011, Springer, UK.
2. Robert T. Watson, Marufu C. Zinyowera, Impacts, Richard H. Moss, Adaptation and mitigation of climate change-Scientific Technical Analyses, 1996, Cambridge University Press, Cambridge, USA.
3. J.M. Wallace, P.V. Hobbs, Atmospheric Science, 2006, Second Edition, Elsevier / Academic Press, USA.

Mode of Evaluation: CAT, Assignment, Quiz, FAT.

Recommended by Board of Studies	24.02.2022		
Approved by Academic Council	No. 66	**Date**	16-06-2022

Course Code	Course Title	L	T	P	C
BCLE215L	Waste Management	3	0	0	3
Pre-requisite	NIL	Syllabus version 1.0			

Course Objectives

The objectives of this course is to :

1. Understand the different sources of the waste.
2. Analyse the socio-economic and environmental factors for waste management.
3. Imply the shift of waste management in the closed loop approach.

Course Outcomes

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

1. Understand the potential impacts of waste management.
2. Develop the environmental, social and economic framework towards sustainable development.
3. Apply sustainable development tools in regulating the waste management.
4. Implement life cycle analysis in waste management.
5. Involve in the concepts of closed loop approach and circular economy.

Module:1	Introduction to Waste Management	5 hours

Perspective of waste generation–Sources, impacts, characteristics, segregation and disposal of waste-Linear economy –Urbanization and new challenges in waste management–Problems associated with the waste-Relevant Regulations.

Module:2	Municipal Solid Waste Management	7 hours

Sources; composition; generation-Rates; collection of waste; separation-Transfer and transport of waste-Treatment and disposal options-Landfill-Bio-mining-Incineration-Biomedical waste-Source, generation and classification-Waste management and reduction techniques.

Module:3	Hazardous Waste Management	6 hours

Characterization of waste-Compatibility and flammability of chemicals-Storage-Transport-Secured Landfills-Treatment techniques-Fundamental concepts on fate and transport of chemicals-Health effects.

Module:4	Radioactive Waste Management	6 hours

Sources, measures and health effects-Nuclear power plants and fuel production-Waste generation from nuclear power plants–Low level and high level waste-Management-Radiation standard by ICRP and AERB-Regulatory framework.

Module:5	Wastewater Management	5 hours

Sources and characteristics of wastewater–Primary wastewater treatment–Secondary wastewater treatment–Sludge treatment alternatives–Industrial wastewater treatment–Zero Liquid Discharge–Wastewater disposal methods.

Module:6	Emerging waste	9 hours

Sources and Characteristics of Plastic waste, marine plastic waste, microplastic, E-waste, Agriculture waste, Glass waste, Metal waste, Oil and gas exploration and production of waste, Space waste, Construction material waste-Recycling non-biodegradable waste, Tyre recycling, End of life textiles, Recovery of value added products, Reuse of waste.

Module:7	Closed Loop Approach Towards Circular Economy	5 hours

Introduction to the Circular Economy-Transition from Linear to Circular Economy-Closed loop supply chain–Integrated waste refinery-Sustainable Development Goals (SDGs)-

Circular Economy policies towards Sustainable Development.		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture Hours		**45 hours**
Text Book(s)		
1. Salah M. El-Haggar, Sustainable Industrial Design and Waste Management Cradle-to-cradle for Sustainable Development, 2007, Elsevier Academic Press, USA.		
Reference Books		
1. Trevor M. Letcher and Daniel A. Vallero, Waste- A Handbook for Management, 2019, Second Edition, Elsevier Academic Press, USA. 2. Alexandros Stefanakis and Ioannis Nikolaou, Circular Economy and Sustainability Volume 2: Environmental Engineering, 2021, First Edition, Elsevier Academic Press, USA.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT.		
Recommended by Board of Studies	24.02.2022	
Approved by Academic Council	No. 66	**Date** 16-06-2022

Course Code	Course Title	L	T	P	C
BCLE216L	Water Resource Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The objectives of this course is to :

1. Acquire the basic principles of water resources and its planning and management.
2. Enhance the knowledge on recent technologies in assessing the water resources.
3. Identify the challenges facing water management in varied climate types around the world.

Course Outcomes

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

1. Understand the planning of water resources and need for water resource management.
2. Understand the water resource potential in global, India scenario and explore the water resources using different technologies.
3. Acquire a knowledge international and national water law and its policy.
4. Explain the concept of water in agricultural and economic aspects.
5. Predict the future trends of water demand and its management during crisis.

Module:1	Water, A Multi-Dimensional Resource	5 hours

Water resources planning-Multi-dimensional management-Water withdrawal and consumption by sector-Stress, international policy-Climate change, oceans, challenges and need for water resource management.

Module:2	Global and Indian Scenario for Water Resources	4 hours

Surface Water and Groundwater Global and Indian Scenario-Quality of water resources-Water use and sustainable reuse methods-Usable water resources by continent and country-Water footprint.

Module:3	Water Resources Assessment	5 hours

Network design-Stream flow gauging-Weir design-Gauges-Current gauging-Salt dilution-Geophysical exploration-Test drilling-Application of remote sensing techniques.

Module:4	Water in Agricultural Systems	7 hours

Water for food production, virtual water trade for achieving global water security, irrigation efficiencies, irrigation methods and current water pricing, water for livestock and processing, water pollution from agricultural production

Module:5	Water Economics	8 hours

Economic characteristics of water good and services-Nonmarket monetary valuation methods-Water economic instruments-Policy options for water conservation and sustainable use, pricing, distinction between values and charges-Private sector involvement in water resources management.

Module:6	Water Legal and Regulatory Settings	8 hours

National and International Framework for Water Law; Basic structure of water law- An overview of water law in India -Evolution of water law, key features of water law, evolving water law and policy-Water policy for Irrigation, decentralization and participation in irrigation management, and the policy measures proposed to establish water user associations. National level initiatives for regulation of groundwater, State groundwater laws and rainwater harvesting.

Module:7	**Demand Management**	**6 hours**
Balancing supply and demand-Economic theory of supply and demand-management by use of tariffs-Timing, long-term, operational time-frame-Crisis management-Cost of water-Future trends-Economic value of water-Loss control-Water harvesting.		
Module:8	**Contemporary issues**	**2 hours**
Total Lecture Hours		**45 hours**

Text Book(s)

1. David Stephenson, Water Resources Management, 2004, A. A. Balkema Publishers, Netherlands.

Reference Books

1. Louis Theodore, Ryan Dupont R., Water Resource Management Issues, Basic Principles and Applications, 2020, CRC Press, Taylor & Francis Group, New York.
2. Philippe Cullet and Sujith Koonan, Water Law in India- An Introduction to Legal Instruments, 2017. Second Edition, Oxford University Press, New Delhi.
3. Subramanya. K., Engineering Hydrology, 2020, Fifth Edition, McGraw Hill Education Pvt. Ltd., New Delhi.

Mode of Evaluation: CAT, Assignment, Quiz, FAT.

Recommended by Board of Studies	24.02.2022		
Approved by Academic Council	No. 66	**Date**	16-06-2022