NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

B.Tech. in

MATHEMATICS AND COMPUTING

SCHEME OF INSTRUCTION AND SYLLABI (TENTATIVE)
for B.Tech. Program

(Effective from 2023-24)

DEPARTMENT OF MATHEMATICS

VISION AND MISSION OF THE INSTITUTE

National Institute of Technology Warangal

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society.

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product-oriented research for establishing a self-sustaining and wealth creating center to serve the societal needs.

VISION AND MISSION OF THE DEPARTMENT

VISION

To be among the best mathematics departments in the country, to build an international reputation as a center of excellence in mathematics and computational research, training, and education, and to inculcate mathematical thinking in order to meet the challenges and growth of science and technology, as well as the needs of industry and society, with moral and ethical responsibility.

MISSION

- To attract motivated and talented students by providing a learning environment where they can learn and develop the mathematical and computational skills needed to formulate and solve real-world problems.
- To foster an environment conducive to quality research and to train principled and highly skilled researchers with clear thinking and determination capable of meeting the dynamic challenges of science and engineering.
- To keep up with the rapid advancements of technology while improving academic standards through innovative teaching and learning processes.
- To satisfy the country's human resource and scientific manpower requirements in mathematics through learner-centered contemporary education and research.

Department of Mathematics

Brief About the Department:

The Department of Mathematics is one of the highly reputed Departments in the institute which functions with excellence as its motto. The Department of Mathematics was established in 1959 along with other engineering departments, expanded in 1984 as Department of Mathematics & Humanities and bifurcated in 2009 as Department of Mathematics. The Department is established as a dynamic center for academic and research activities.

The Department offers basic courses in Mathematics for B.Tech. At post-graduate level, the Department offers well-designed diverse courses for all programs of MTech., M.C.A., M.B.A. and M.Sc. Tech (Engg. Physics) and also offers open electives for all UG, PG and Ph.D. Programmes.

The Department offers two P.G. Programs, M.Sc. (Applied Mathematics) started in the year 1970, M.Sc. (Mathematics and Scientific Computing) started in 2001 and Integrated M.Sc. (Mathematics) started in 2022. The programs are designed with one laboratory course in each semester in addition to the regular rigorous theory courses. They inculcate a spirit of practical application of mathematical concept and also instill enthusiasm for research activity. Special emphasis is laid on promoting team spirit and improving the oral communication skills of the students, which enables all-round development of the students.

The Department since its inception in 1959 is known to be an active research center in Mathematics. The frontier areas of research of the department are Fluid Mechanics, Computational Fluid Mechanics, Bio-mechanics, Numerical Analysis, Finite Element Method, Optimization Techniques, Coding Theory, Cryptography, Differential Equations etc., The Department offers Ph.D. program in Mathematics on regular basis, part-time and also under Quality Improvement Program (QIP) and the Department is the only QIP center for Mathematics in India. So far about 115 Ph.Ds. have been awarded and several research papers have been published in national and international journals.

The Department has a full-fledged computational laboratory to meet the requirements of the M.Sc. students, research scholars and the faculty. The Department has a well-stocked library for immediate reference of the faculty and students.

The Department was recognized as a National Resource Centre in Mathematics by MoE, Govt. of India to conduct Online Refresher Courses for all Mathematics Faculty members (irrespective of their seniority and designation) of all Institutions in the Country.

The department organized international conferences and Gian Initiate Academic Network (GIAN) programs with faculty from USA, UK, Slovakia, Taiwan and Russia. Several national conferences, summer, refresher courses and workshops were also organised. The Department has successfully completed several research projects funded by various organizations like BRNS, MHRD, AICTE, UGC, CSIR and DST.

List of Programs offered by the Department:

Program	Title of the Program
B.Tech.	Mathematics and Computing
Integrated M.Sc. (5-year program)	Integrated M.Sc. Mathematics
M.Sc. (2-year PG Program)	M.Sc. (Applied Mathematics)
	M.Sc. (Mathematics and Scientific Computing)
Minor	Applied and Computational Mathematics
Ph.D. (Full time, Part-time and QIP)	Mathematics

Note: Refer to the following weblink for Rules and Regulations of B.Tech. program: https://www.nitw.ac.in/media/uploads/2021/08/27/btech_rules-and-regulations-2021-22.pdf

B. Tech. – Mathematics and Computing

Program Educational Objectives (PEO)

PEO-1	Provide sufficient understanding of the fundamentals of mathematics with computational techniques, and program core to address challenges faced in mathematics and other related interdisciplinary fields.
PEO-2	Facilitate as a deep learner and progressive careers in teaching, academia, research organizations, national/international laboratories and industry.
PEO-3	Communicate effectively with team members, engage in applying technologies and lead teams in industry.
PEO-4	Assess the computing systems from the view point of quality, security, privacy, cost, utility, etiquette and ethics.
PEO-5	Engage in lifelong learning, career enhancement and adapt to changing professional and societal needs.

Program Articulation Matrix

PEO / Mission Statements	PEO1	PEO2	PEO3	PEO4	PEO5
To attract motivated and talented students by providing a learning environment where they can learn and develop the mathematical and computational skills needed to formulate and solve real-world problems.	2	3	2	3	2
To foster an environment conducive to quality research and to train principled and highly skilled researchers with clear thinking and determination capable of meeting the dynamic challenges of science and engineering.	3	3	3	2	2
To keep up with the rapid advancements of technology while improving academic standards through innovative teaching and learning processes	2	3	2	2	2
To satisfy the country's human resource and scientific manpower requirements in mathematics through learner-centered contemporary education and research.	3	2	3	3	3

1-Slightly; 2-Moderately; 3-Substantially

B.Tech. – Mathematics and Computing

Program Outcomes (POs)

PO1	**Mathematical knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and computer science and engineering to the solution of complex engineering problems
PO2	**Problem analysis:** Identity, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/Development of solutions:** Design solutions for complex computer science and engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling to complex computer science and engineering activities with an understanding of the limitations
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics:** Apply ethical principles and commit to the engineering practice's professional ethics, responsibilities, and norms.
PO9	**Individual and team work:** Function effectively as an individual and as a member or leader in diverse groups and multidisciplinary settings
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes

PSO1	Design algorithms for real-world computational problems and analyse their complexities.
PSO2	Develop a broad theoretical foundation in mathematics as well as design and develop interfaces among subsystems of computing.
PSO3	Analyse large data samples and discover knowledge to provide solutions to engineering problems.
PSO4	Analyse, create and develop algorithms and computing systems applying mathematical approaches in interdisciplinary applications.

Note: Refer to the following weblink for Rules and Regulations of B.Tech. program:
https://www.nitw.ac.in/media/uploads/2021/08/27/btech_rules-and-regulations-2021-22.pdf

SCHEME OF INSTRUCTION

B.Tech. (Mathematics and Computing) - Course Structure

1st Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA111	Calculus	3	0	0	3	BSC
2.	MA112	Algebraic Structures	3	0	0	3	BSC
3.	CS131	Problem Solving and Computer Programming	3	0	0	3	ESC
4.	HS132	English for Technical Communication	2	0	2	3	HSC
5.	PH131	Applied Physics	3	0	0	3	BSC
6.	ME102	Design Thinking	0	1	4	3	ESC
7.	CS132	Problem Solving and Computer Programming lab	0	0	2	1	ESC
8.	PH135	Applied Physics lab	0	0	2	1	BSC
9.	IC001	Induction Program*	0	0	2	0	MNC
10.	IC101	Extra Academic Activity – I*	0	0	2	0	MNC
		Total	**17**	**0**	**10**	**20**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

2nd Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA161	Ordinary Differential Equations	3	0	0	3	BSC
2.	MA162	Computational Linear Algebra	3	0	0	3	BSC
3.	MA163	Data Structures	3	0	0	3	ESC
4.	BT171	Biological Computation	3	0	0	3	ESC
5.	ME151	Design Studio	0	0	3	1.5	ESC
6.	EC131	Basic Electronic Engineering	3	0	0	3	ESC
7.	MA164	Data Structures Lab	0	0	3	1.5	ESC
8.	IC151	Extra Academic Activity – II*	0	0	2	0	MNC
		Total	**17**	**0**	**4**	**18**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

SCHEME OF INSTRUCTION

B.Tech. (Mathematics and Computing) - Course Structure

3rd seemster

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA211	Real and Complex Analysis	3	0	0	3	PCC
2.	MA212	Fourier Series and Partial Differential Equations	3	0	0	3	BSC
3.	MA213	Probability and Statistics	3	0	0	3	PCC
4.	MA214	Discrete Mathematics	3	0	0	3	PCC
5.	MA215	Object Oriented Programming	3	0	0	3	PCC
6.	EE131	Basic Electrical Engineering	3	0	0	3	ESC
7.	SM231	Economics and Financial Analysis	3	0	0	3	HSC
8.	MA216	Probability and Statistics Lab	0	0	2	1	PCC
9.	MA217	Object Oriented Programming with JAVA Lab	0	0	2	1	PCC
10.	IC201	Mandatory Non-Credit Course *	0	0	2	0	MNC
		Total	**18**	**0**	**12**	**23**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

4th Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA261	Multivariate calculus and Measure Theory	3	0	0	3	PCC
2.	MA262	Computer Oriented Numerical Methods	3	0	0	3	PCC
3.	EC262	Signals and Systems	3	0	0	3	PCC
4.	MA264	Applied Statistical Methods	2	0	2	3	PCC
5.	MA265	Graph Theory	3	0	0	3	PCC
6.	MA266	Database Management Systems	3	0	0	3	PCC
7.	MA267	Computer Oriented Numerical Methods Lab	0	0	2	1	PCC
8.	MA268	Database Management Systems Lab	0	0	2	1	PCC
9.	MA269	Design and Analysis of Algorithms	3	0	0	3	ESC
		Total	**20**	**0**	**6**	**23**	

SCHEME OF INSTRUCTION

B.Tech. (Mathematics and Computing) - Course Structure

5th Semester

S. No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA311	Operations Research	3	0	2	4	PCC
2.	MA312	Computational Number Theory	3	0	0	3	PCC
3.	CS331	Computer Architecture	3	0	0	3	PCC
4.	MA313	Theory of Computation	3	0	0	3	PCC
5.	CS332	Operating Systems	3	0	0	3	PCC
6.	MA315	Mathematics of Machine Learning	3	0	0	3	PCC
7.	CS333	Operating Systems Lab	0	0	2	1	PCC
8.		Department Elective – 1	3	0	0	3	PEC
9.	IC301	Mandatory Non-Credit Course *	0	0	2	0	MNC
		Total	**21**	**0**	**6**	**23**	

* MNC weblink: https://www.nitw.ac.in/media/uploads/2021/10/22/mnc_1st-year.pdf

6th Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	MA361	Cryptography and Security	3	0	0	3	PCC
2.	MA362	Functional Analysis	3	0	0	3	PCC
3.	MA363	Deep Learning	3	0	0	3	PCC
4.	MA364	Computational Methods for Optimization	3	0	0	3	PCC
5.		Department Elective – 2	3	0	0	3	PEC
6.	MA365	Deep Learning Lab	0	0	2	1	PCC
7.	MA366	Computational Methods for Optimization Lab	0	0	2	1	PCC
8.	CS371	Computer Networks	3	0	0	3	PCC
9.		Open Elective - 1	3	0	0	3	OEC
		Total	**21**	**0**	**4**	**23**	

SCHEME OF INSTRUCTION

B.Tech. (Mathematics and Computing) - Course Structure

7th Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.	CS433	Big Data Analytics	3	0	0	3	PCC
2.	CS435	High Performance Computing	2	0	0	2	PCC
3.		Department Elective – 3	3	0	0	3	PEC
4.		Department Elective – 4	3	0	0	3	PEC
5.		Department Elective – 5	3	0	0	3	PEC
6.		Open Elective – 2	3	0	0	3	OEC
7.	CS436	High Performance Computing Lab	0	0	2	1	PCC
8.	MA449	Summer Internship/EPICS				2	PCC
		Total	**17**	**0**	**2**	**20**	

8th Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1.		Linear Systems Theory (Online/Conventional)	2	0	0	2	PCC
2.		Department Elective – 6 (Online/Conventional)	3	0	0	3	PEC
3.	MA498	Seminar	0	0	2	1	SEM
4.	MA499	Project Work@	0	0	8	4	PW
		Total	**5**	**0**	**10**	**10**	

@ NOTE: Refer to the following link for the guidelines to prepare dissertation report:
https://www.nitw.ac.in/media/uploads/2021/08/27/ug_project-report-format_55vW5pL.pd

Note:

BSC – Basic Science Courses
ESC – Engineering Science Courses
PCC – Professional Core Courses
PEC – Professional Elective Courses
OEC – Open Elective Courses
HSC – Humanities and Social Science Courses
MNC – Mandatory Non-credit Courses
SEM – Seminar

PW – Project Work

Credits in Each Semester

Cat. Code	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Sem-VII	Sem-VIII	Total
BSC	10	6	0	3	0	0	0	0	**19**
ESC	7	12	3	3	0	0	0	0	**25**
PCC	0	0	17	17	20	17	8	2	**81**
PEC	0	0	0	0	3	3	9	3	**18**
OEC	0	0	0	0	0	3	3	0	**6**
HSC	3	0	3	0	0	0	0	0	**6**
MNC	0	0	0	0	0	0	0	0	**0**
Project	-	-	-	-	-	-	-	4	**4**
Seminar	-	-	-	-	-	-	-	1	**1**
Internship	-	-	-	-	-	-	-	-	**-**
Total	**20**	**18**	**23**	**23**	**23**	**23**	**20**	**10**	**160**

Professional Elective Courses:

Department Elective - I (III Year, I Semester)		
Sl. No	**Course Code**	**Course Title**
1.	MA321	Numerical Simulation of Differential Equations
2.	MA322	Fluid Dynamics
3.	MA323	Algebraic Coding theory
Department Elective - II (III Year, II Semester)		
Sl. No	**Course Code**	**Course Title**
1.	MA371	Elliptic Curves
2.	MA372	Game Theory
3.	MA373	Elements of Data Science
Department Elective – III, IV, V (IV Year, I Semester)		
Sl. No	**Course Code**	**Course Title**
1.	MA421	Time Series Analysis and Forecasting
2.	MA422	Fuzzy Mathematics
3.	MA423	Symbolic Computing
4.	MA426	Data Mining
5.	MA427	Applied Measure Theory
6.	MA428	Finite Element Method
7.	EC431	Digital Electronics and Microcontrollers
8.	MA429	Wavelets and Applications
9.	MA430	Evolutionary Optimization
10.	EE435	Digital Signal Processing
11.	MA471	Cyber Security
12.	EE436	Microprocessors and Microcontrollers
13.	CS335	Web Technologies
14.	CS437	Reinforced Learning

15.	CS426	Cloud Computing
16.	CS432	Computer Vision (Image and Video Processing)
17.	CS472	Block Chain Technologies
18.	BT424	Bio-Informatics

Department Elective - VI (IV Year, II Semester)		
Sl. No	**Course Code**	**Course Title**
1.	MA471	Real Time Systems
2.	MA472	Algebraic Codes for Data Transmission and Storage
3.	MA473	Applied Analysis
4.	MA474	Finite Volume Method
5.	MA475	Computational Fluid Dynamics
6.	MA476	Advanced Algorithms
7.	CS475	Internet of Things
8.	CS476	Quantum Computing
9.	CS477	Risk Management

DETAILED SYLLABUS

B.Tech.
Mathematics and Computing

Course Code: MA111	Calculus	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Find the Taylors series expansion of a function
CO2	Find the maxima and minima of functions of several variables
CO3	Identify the convergence of an improper integral
CO4	Evaluate the surface area and volume of a solid of revolution
CO5	Compute the surface area and volume of regions using multiple integration

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-
CO2	3	2	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-
CO4	3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-
CO5	3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Differential Calculus: Taylor's theorem with remainders, Taylor's and Maclaurin's expansions, Curvature and Evolutes, Asymptotes, Curve tracing.

Functions of Several variables - Partial differentiation, Total differentiation, Euler's theorem and generalization, Change of variables – Jacobians.

Integral Calculus: Convergence of Improper integrals, Beta and Gamma integrals, Elementary properties of Beta and Gamma integrals, Differentiation under integral sign. Double and triple integrals, Computation of surface areas and volumes using multiple integration, Change of variables in double and triple integrals.

Vector Calculus: Vector differentiation - Scalar and vector valued point functions, Derivatives, Curves, Tangents and length, Level surfaces, Gradient of a scalar field and its geometrical interpretation, Directional derivative, Divergence and Curl of a vector field and their applications, Vector identities; Vector integration - Line integrals, Path independence, Green's theorem in the plane, Surfaces and surface integrals, Divergence theorem of Gauss, Stoke's theorem, Verification and problems based on these theorems.

Learning Resources:

Text Books:

1. Differential Calculus, **Shanti Narayanan,** S. Chand and Co., 2021.
2. Integral Calculus, **Shanti Narayanan**, S. Chand and Co., 2021.
3. A Textbook of Vector Calculus, **Shanti Narayan & PK Mittal**, S Chand & Co Ltd, 2005.
4. Calculus, **George Thomas, J., Ross L. Finney**, Pearson, 1996, 9th Edition.

Reference Books:

1. A Course in Multivariable Calculus and Analysis, **Sudhir R. Ghorpade and B.V. Limaye,** Springer, 2009.
2. Vector Analysis: An Introduction to Vector-Methods and Their Various Applications to Physics and Mathematics, **Joseph George Coffin**, John Wiley & Sons, 2018.
3. Calculus, **G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas,** Pearson Education, 2009

Course Code: MA112	Algebraic Structures	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Discover the binary operations as basic entities which give specific mathematical structures to a set
CO2	Understand the group structure and possible subgroups
CO3	Analyze the structure of rings and fields
CO4	Classify groups, rings, fields using isomorphisms between the respective mathematical structures
CO5	Adapt with mathematical abstractness

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-	1	-	-	-	1	1	1	1	2	3	2	2
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	3	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	3	-	1
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	3	2	1
CO5	2	2	1	2	1	3	2	2	2	2	2	2	3	3	2	3

Syllabus:

Groups: Binary operations, Groups, subgroups, cyclic groups – definition, examples, results; dihedral groups, symmetric groups, the quaternion group as special examples; Equivalence Relations and Partitions; Cosets of a group; Lagrange's Theorem and its consequences on finite groups; a counting principle; Normal Subgroups and Quotient Groups; Centralizers, Normalizers, Centre of a group

Mappings between Groups: Homomorphism between groups, kernel of a group, fibres of homomorphisms, isomorphism, fundamental theorem of isomorphism on groups; Groups of permutations and Cayley's Theorem; Orbits, cycles and the alternating groups

Rings and Fields: Definition of rings and various examples; Units and zero divisors of a ring; Integral domains, Fields, Fermat's and Euler's Theorems; homomorphisms on rings; Ideals and Quotient rings; Rings of polynomials; Factorization of polynomials

over fields.

Learning Resources:

Text Books:

1. A First Course in Abstract Algebra, **John B. Fraleigh**, Pearson, 2013, Seventh Edition
2. Topics in Algebra, **I. N. Herstein**, Wiley, 1975, Second Edition

Reference Books:

1. Contemporary Abstract Algebra, **Joseph A. Gallian**, Cengage Learning, 2013, Eight Edition
2. A Course in Abstract Algebra, **Vijay K. Khanna & S. K. Bhambri**, Vikas Publishing House, 2013, Fourth Edition
3. Abstract Algebra, **David S. Dummit & Richard M. Foote**, Wiley, 2004, Third Edition

Course Code: MA144	Problem Solving and Computer Programming	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object-oriented features in developing programs to solve real world problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	2	-	-	2	-	-	-	3	2	-	-
CO2	3	3	2	2	-	2	-	2	2	-	-	-	3	2	-	-
CO3	3	3	2	2	-	-	-	2	2	-	-	-	3	2	-	-
CO4	2	3	2	1	-	2	-	-	2	-	-	-	3	2	-	-
CO5	2	3	2	2	-	2	-	--	2	-	-	-	3	1	-	-
CO6	2	3	2	2	-	2	-	-	2	-	-	-	3	3	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Fundamentals of Computers: Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Number systems and data representation: Basics of C++, Basic data types, Numbers, Digit separation, Reverse order, writing in words, Development of Elementary School Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of control constructs.

Conditional statements: If-else, Switch-case constructs, Loops - while, do-while, for.

Functions: Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion,
Introduction to Pointers and Arrays: Sorting and searching algorithms, Large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions, Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays.

String processing, File operations.

Structures and Classes: Declaration, member variables, member functions, access modifiers, function overloading, Problems on Complex numbers, Date, Time, Large Numbers.

Learning Resources:

Text Books:
1. Problem Solving with C++, **Walter Savitch,** Pearson, 2014, Ninth Edition.
2. Big C++, **Cay Horstmann**, Wiley, 2009, Second Edition.

Reference Books:
1. How to Solve it by Computer, **R.G. Dromey**, Pearson, 2008.

Online Resources:
1. https://nptel.ac.in/courses/106/105/106105151/
2. https://onlinecourses.nptel.ac.in/noc21_cs38/preview

Course Code: HS132	English for Technical Communication	Credits 2-0-2: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Understand basic grammar principles
CO2	Write clear and coherent passages
CO3	Write effective letters for job application and complaints
CO4	Prepare technical reports and interpret graphs
CO5	Enhance reading comprehension
CO6	Comprehend English speech sound system, stress and intonation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO2	-	2	-	2	-	1	-	-	-	3	-	1	-	-	-	-
CO3	-	2	-	2	-	1	-	-	-	3	-	1	-	-	-	-
CO4	-	2	-	2	-	1	-	-	-	3	-	1	-	-	1	1
CO5	-	2	-	2	-	1	-	-	-	3	-	1	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts.
2. Effective Sentence Construction - strategies for bringing variety and clarity in sentences- removing ambiguity - editing long sentences for brevity and clarity.
3. Reported speech - contexts for use of reported speech - its impact on audiences and readers- active and passive voice- reasons for preference for passive voice in scientific English.
4. Paragraph-writing: Definition of paragraph and types- features of a good paragraph - unity of theme- coherence- linking devices- direction- patterns of development.
5. Note-making - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc.
6. Letter-Writing: Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises
7. Reading techniques: Definition- Skills and sub-skills of reading- Skimming and Scanning - their uses and purposes- examples and exercises. Department of
8. Reading Comprehension - reading silently and with understanding- process of

comprehension- types of comprehension questions. (technical paper reading, patents)
9. Features of Technical English - description of technical objects and process- Report- Writing- definition- purpose -types- structure- formal and informal reports- stages in developing report- proposal, progress and final reports-examples and exercises.
10. Book Reviews- Oral and written review of a chosen novel/play/movie- focus on appropriate vocabulary and structure - language items like special vocabulary and idioms used.

Language laboratory:

1. English Sound System -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises-
2. Stress and Intonation –word and sentence stress - their role and importance in spoken English
3. Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.- use of intonation in daily life-exercises
4. Introducing oneself in formal and social contexts- Role plays - their uses in developing fluency and communication in general.
5. Oral presentation - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.
6. Listening Comprehension - Challenges in listening, good listening traits, some standard listening tests- practice and exercises.
7. Debate/ Group Discussions - Concepts, types, Do's and don'ts- intensive practice.

Learning Resources:

Text Books:

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2) Orient Blackswan, 2010.
2. Effective Technical Communication, **Ashraf, M Rizvi,** Tata McGraw-Hill, 2006
3. Technical Communication: Principles and Practice, **Meenakshi Raman and Sangeetha Sharma**, Oxford University Press, 2011, Second Edition

Software:

1. Clear Pronunciation – Part-1 Learn to Speak English.
2. Clear Pronunciation – Part-2 Speak Clearly with Confidence
3. Study Skills
4. English Pronunciation Online

Resources:

1. https://onlinecourses.nptel.ac.in/noc20_hs56/preview
2. https://nptel.ac.in/courses/109/106/109106094/
3. https://freevideolectures.com/course/3430/communication-skills
4. https://onlinecourses.swayam2.ac.in/cec21_lg13/preview

Course Code: PH131	Applied Physics	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Apply the concepts of wave and particle nature of matter and energy for solving problems
CO2	Understand the applications of Interference, diffraction, optical fibers, holography and lasers in engineering
CO3	Understand the basics of semiconductors, magnetism, super conductivity, Nano-materials and their applications in engineering.
CO4	Comprehend sensing technologies and their applications in computer science and engineering

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2								1		1	1
CO2	2	1	1	1	1											
CO3	2	1	1	1	1											
CO4	2	1	1	1	1											

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Wave Optics and Modern Physics:

Interference: Concept of Interference of Light-Division of Amplitude and Wave front with examples- Michelson and Fabry perot Interferometers- Applications

Diffraction: Fraunhofer's Class of Diffraction at Single, Double and Multiple Slits-Gratings and Applications.

Polarization: Production and Detection of Polarised Light—Wave Plates- Optical Activity-Laurent's. half shade polarimeter

Lasers: Interaction of Radiation with Matter-Spontaneous and Stimulated Emissions-Basic requirements for the construction of Lasers-Construction and working of He-Ne, CO2, Nd-YAG and Semiconductor Lasers, Holography and HNDT

Optical Fibers: Principle and working of optical Fiber, structure, Classification and advantages of optical fiber, Light guiding mechanism in Optical Fibers -Numerical Aperture, Signal Degradation, Attenuation, Absorption, Inter and intra modal Dispersions. Fiber optics sensors and optical fiber communications

Quantum Physics (8 Classes)

Quantum Mechanics - Introduction to quantum theory, concepts and experiments led to the discovery, wave particle duality-Davisson-Germer experiment, Heisenberg uncertainty principle, Schrodinger time independent wave equation, the free particle

problem - particle in an infinite and finite potential well, quantum mechanical tunnelling – applications; Hydrogen Atom Wave Functions, Angular Momentum Operators, Identical Particles, Quantum Optics - Introduction to quantum optics and Quantum Imaging.

Engineering Materials (14 Classes)
Magnetic Materials: Weiss Theory of Ferromagnetism –Properties – Domains – Curie Transition - Hard and soft magnetic materials – Ferrites – Structure, Classification, Applications in Computers. Superconductors: Introduction to superconductivity, Meissner effect - Type-I and Type-II Superconductors – Applications in Computers.
Semiconductor Materials and Devices: Types of semiconductor materials, temperature and concentration effects on band gap, Hall effect, PN junction diode, photodiode, LED, junction transistor, phototransistor.
Nanomaterials – Introduction to Nanomaterials and Nano technology, Nano computers

Sensors and Sensing Technologies (5 Classes)
Introduction, The Human Body as a Sensor System, Passive and Active sensors, the sensor as part of a measurement system, sensor properties, Classification of Sensors – Infrared Sensor, Bio Sensors, Piezoelectric Sensors, Thermal Sensors, Quantum Sensors and Applications in Computer Science and Engineering.

Text Books / Reference Books / Online Resources:

1. Optics, **Ajoy K. Ghatak,** Tata McGraw Hill, 2017, Sixth Edition.
2. Optical Fiber communications, **Gerd Keiser,** McGraw Hill, 2011, Fourth Edition.
3. Concepts of Modern Physics, **Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury**, McGraw Hill Publications, 2009, Sixth edition.
4. A Text Book of Engineering Physics, **M.N. Avadhanulu, P.G. Khirsagar,** 2011, Ninth edition.
5. Introduction to Sensors, **John Vetelino and Aravind Reghu,** CRC Press, 2010, First Edition.
6. Physics for Computer Science Students, **Narciso Garcia, Arthur Damask and Steven Schwarz,** Springer, 2012, Second Edition.
7. Understanding Lasers: An Entry-Level Guide, **Jeff Hecht,** Wiley Publications, 2018, Fourth edition.
8. University Physics with Modern Physics, **Hugh D. Young, Roger A. Freedman,** Pearson Education, 2014.
9. https://nptel.ac.in/courses/122/107/122107035

Course Code: ME102	Design Thinking	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Identify user needs
CO2	Define problems to stimulate ideation
CO3	Ideate on problems to propose solutions by working collaboratively
CO4	Test aspects of proposed solutions
CO5	Improve solutions by gaining user feedback

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3	3	2	2	3	3	2	3	2	2	3	3
CO2	2	2	2	3	3	3	2	2	3	3	2	3	2	2	3	3
CO3	2	2	2	3	3	3	2	2	3	3	2	3	2	2	3	3
CO4	2	2	2	3	3	3	2	2	3	3	2	3	2	2	3	3
CO5	2	2	2	3	3	3	2	2	3	3	2	3	2	2	3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Introduction to Engineering: “Engineering” as a vehicle for social and economic development; impact of science/engineering our day to day lives; process of engineering a product; various career options.

Introduction and identifying the need: Understanding the unique needs of the user - empathize - define - ideate - prototype - test. Case Studies - Develop appreciation for the design process and its application in specific settings (Guest lectures, Videos, Field visits, Interplay lectures of design-based movies).

Problem Formulation: Framing a problem statement neutrally using adequate checks. Case studies.

Concept Generation: Generate multiple concepts using various creativity tools and thinking styles.

Prototyping: select from ideas and make quick prototypes (mock-ups) using available material.

Evaluation: Iterative process of ideation, prototyping and testing-Take the mock-ups to users for feedback and iterate process till users feel delighted.

Activities: Some of the activities which are undertaken as a part of this course include:

- Field Visits
- Case Studies on innovation, failures etc.
- Guest lecture
- Group Discussions
- Presentation by student

- Experiential learning workshops

Learning Resources:

Reference Books:

1. Design Thinking: A guide to creative problem solving for everyone, **Andrew Pressman,** Routledge Taylor and Francis group, 2019, 1st edition.
2. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, **Tim Brown**, Harper Business, 2019.
3. Engineering Design, **George E. Dieter, Linda C. Schmidt,** McGraw-Hill Education, 2019, Fifth edition.
4. Product design and development, **Ulrich, K., Eppinger, S. and Yang, M.,** 2020, 7th edition.

Online Resources:

1. https://www.arvindguptatoys.com/
2. https://honeybee.org/
3. https://dschool.stanford.edu/resources/getting-started-with-design-thinking
4. https://designthinking.ideo.com/.

Course Code:	System Thinking	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Acquire a critical understanding of systems thinking, and develop concepts and tools for dealing with complexity
CO2	Understand the complexity of system dynamics to identify and describe the relationships among system entities
CO3	Design strategies and create network models based on entity-relationships catering to specific goals of the system
CO4	Identify how system thinking is applied in technical environments such as logistics & transportation, and computation
CO5	learn to “view from above” practices, a continuous zoom in zoom out technique to navigate in complexity - physically and theoretically

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2		3		2	2							3	3
CO2	2	2	2				2	2							3	3
CO3	2	2	2			3	2	2							3	3
CO4	2	2	2		3		2	2							3	3
CO5	2	2	2		3		2	2							3	3

1 - Slightly; 2 - Moderately; 3 – Substantially

Unit – 1: logic of system thinking, examples, develop a critical understanding of systems thinking. Variables and variations, entity-relationships, environment and boundary of a system. Basic rules of system thinking.

Unit-2: Loop diagrams of every system, zooming in on what matters most. Number game simulation. Stocks and flows, The Problem with Modelling in Systems Thinking, causal loops.

Unit-3: Systems Thinking for the Control of Phenomena, control strategy, multi-level control, multi-objective control policies, human aspects of control.

Unit-4: Systems Thinking Applied to Problem Solving, decision making process. From Linear Diagrams to Causal Loops. Circularity: Designing circular flows across systems scales. Few test cases.

Learning Resources:

Reference Books:

1. Piero Mella, Systems Thinking, Intelligence in Action, Springer, 2012.
2. Horst Czichos, Introduction to Systems Thinking and Interdisciplinary Engineering, Springer, 2022.
3. Nic J. T. A. Kramer, Jacob de Smit, Systems thinking, Concepts and notions, AartinustJliihoff Social Sciences Division, Leiden 1977.
4. Handbook of Systems Thinking Methods. Paul M. Salmon, Neville A. Stanton, Guy H. Walker, Adam Hulme, Natassia Goode, Jason Thompson Gemma J. M. Read, CRC-2023.
5. Jamshid Gharajedaghi, Systems Thinking:Managing Chaos and Complexity. A Platform for Designing Business Architecture, Third Edition, Morgan Kaufmann, 2011.
6. Anthony J. Masys, Applications of Systems Thinking and Soft Operations Research in Managing Complexity From Problem Framing to Problem Solving. Springer, 2016.

Course Code: MA145	Problem Solving and Computer Programming Lab	Credits 0-0-2: 1

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object-oriented features in developing programs to solve real world problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	-	2	-	-	2	-	-	-	3	2	-	-
CO2	3	3	2	2	-	2	-	2	2	-	-	-	3	2	-	-
CO3	3	3	2	2	-	-	-	2	2	-	-	-	3	2	-	-
CO4	2	3	2	1	-	2	-	-	2	-	-	-	3	2	-	-
CO5	2	3	2	2	-	2	-	--	2	-	-	-	3	1	-	-
CO6	2	3	2	2	-	2	-	-	2	-	-	-	3	3	-	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.

Learning Resources:

Text Books:

1. Problem Solving with C++, **Walter Savitch**, Pearson, 2014, Ninth Edition.
2. Big C++, **Cay Horstmann**, Wiley, 2009, Second Edition.

Reference Books:

1. How to Solve it by Computer, **R.G. Dromey**, Pearson, 2008.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105151/
2. https://onlinecourses.nptel.ac.in/noc21_cs38/preview

Course Code: PH187	APPLIED PHYSICS LABORATORY	Credits 0-0-2: 1

Pre-Requisite : NIL

Course Outcomes

CO1	Understand the use of lasers and optical instruments for experimentation
CO2	Apply the concepts of interference, diffraction, and polarization in engineering measurements
CO3	Demonstrate quantum nature of radiation using photoelectric effect
CO4	Determine acceptance angle and numerical aperture of an optical fiber

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		3					3	2			2	2
CO2	3	2		3					3	2			2	2
CO3	3	2		3					3	2			2	2
CO4	3	2		3					3	2			2	2

List of Experiments:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser - Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of Numerical aperture, loss, Acceptance angle of optical fiber.
6. Determination of plank constant by photo electric effect.
7. Determination of I – V characteristics of photo diode.
8. Diffraction grating by normal incidence method.

Learning Resources:

Text Books:

1. Physics Laboratory Manual by Physics Department, NIT Warangal, 2021.
2. Practical Physics by P.R. Sasi Kumar, PHI publications, first edition, 2011

Reference Books:

1. Practical Physics by G.L. Squire, Cambridge University press, fourth edition, 2001.
2. Engineering Physics Practical by Dr.S.K. Gupta Krishna Prakashan Publications, ninth edition, 2010

Online Resources:

1. NPTEL Courses: https://nptel.ac.in/courses/115/105/115105110
2. Amrita virtual labs.

Course Code: MA161	Ordinary Differential Equations	Credits 3-0-0:3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Analyse the existence, uniqueness of solutions for initial value problems
CO2	The General Solution of the Homogeneous second order Equations
CO3	Find power series solutions to differential equations
CO4	Analyse Homogeneous Linear Systems with Constant Coefficients
CO5	Identify Critical Points and Stability for Linear Systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-	2	-	-	-	-	-	-	-	1	2	2	-
CO2	3	2	1	-	2	-	-	-	-	-	-	-	1	2	2	-
CO3	3	2	1	-	2	-	-	-	-	-	-	-	1	2	2	-
CO4	3	2	1	-	2	-	-	-	-	-	-	-	1	2	2	-
CO5	3	2	1	-	2	-	-	-	-	-	-	-	1	2	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

First Order Equations: Homogeneous Equations, Exact Equations, Integrating Factors, Linear Equations, Reduction of Order, The Method of Successive Approximations, Picard's Theorem (without proof).

Higher Order Linear Equations: The General Solution of the Homogeneous Equation, Equation with Constant Coefficients, The Method of Undetermined Coefficients, The Method of Variation of Parameters.

Systems of First Order Equations: General Remarks on Systems, Linear Systems, Homogeneous Linear Systems with Constant Coefficients, Nonlinear Systems. Volterra's Prey-Predator Equations.

Special Functions: Ordinary and Regular Singular Points, Power Series Solutions, Series solution of Bessel and Legendre's differential equations – Bessel function of first kind, Recurrence formulae, generating function, Orthogonality of Bessel functions - Legendre polynomial, Rodrigues's formula, Generating function, Recurrence formula, Orthogonality of Legendre polynomials

Learning Resources:

Text Books:

1. Differential Equations with Applications and Historical Notes, **G.F. Simmons**, McGraw Hill, 2017, Second edition.
2. An Introduction to Ordinary Differential Equations, **E.A. Coddington**, PHI Learning, 1999
3. Advanced Engineering Mathematics, **Erwin Kreyszig,** Wiley, 2011, Tenth edition.

Reference Books:

1. Ordinary Differential Equations, **P. Hartman**, Birkhaeuser, 1982.
2. Differential Equations and Dynamical Systems, **L. Perko**, Springer-Verlag, 1991.

Course Code: MA162	Linear Algebra and Applications	Credits 3-0-0: 3

Pre-Requisites: Nil

Course Outcomes:

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

CO1	Determine the consistency of the system of linear equations
CO2	Demonstrate the knowledge of vector space and subspaces.
CO3	Illustrate the concept of inner products and orthogonalization.
CO4	Solve eigenvalue problems.
CO5	Apply the SVD of a matrix in finding pseudoinverse and optimal solution of a linear system of equations

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO4	2	1	1	-	1	-	-	-	-	-	-	-	1	-	-	1
CO5	3	2	1	-	2	-	-	-	-	-	-	-	3	-	-	1

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Systems of Linear Equations: Basic definitions and notations, possible number of solutions of linear equations, elementary row operations, equivalent systems, existence and uniqueness questions.

Vector Spaces: Vector spaces, Subspaces, Linear combinations and subspaces spanned by a set of vectors, Linear dependence and Linear independence, Spanning Set and Basis, Finite dimensional spaces, Dimension, Simple systems, Homogeneous and Nonhomogeneous systems, Gaussian elimination, Null Space and Range, Rank and nullity, Consistency conditions in terms of rank, General Solution of a linear system, Elementary Row and Column operations, Row Reduced Form, Triangular Matrix Factorization.

Orthogonality: Inner product, Inner product Spaces, Cauchy – Schwarz inequality, Norm, Orthogonality, Gram – Schmidt orthonormalization, Orthonormal basis, Expansion in terms of orthonormal basis – Fourier series, Orthogonal complement, Decomposition of a vector with respect to a subspace and its orthogonal complement.

Eigenvalues and Eigenvectors: Eigenvalue, Eigenvector pairs – applications, characteristic equation, Algebraic multiplicity, Eigenspaces and geometric multiplicity, Diagonalization criterion, The diagonalizing matrix, Cayley-Hamilton theorem,

Annihilating polynomials, Minimal Polynomial, Diagonalizability and Minimal polynomial, Projections, Decomposition of the matrix in terms of projections.

Singular Value Decomposition: The matrices AA^T and A^TA, Rank, Nullity, Range and Null Space of AA^T and A^TA, Strategy for choosing the basis for the four fundamental subspaces, Singular Values, Singular Value Decomposition, Pseudoinverse and Optimal solution of a linear system of equations, The Geometry of Pseudoinverse.

Learning Resources:

Text Books:

1. Linear algebra and its applications, **David C. Lay, Steven R. Lay, Judi J. McDonald**, Pearson, 2016, Fifth edition.
2. Numerical Linear Algebra and Applications, **Biswa Nath Datta**, Prentice Hall India/SIAM, 2013/2010, Second Edition.

Reference Books:

1. Linear Algebra, **K. Hoffman and R. Kunze**, Prentice Hall of India, New Delhi, 2003.
2. First Course in Linear Algebra, **P.G. Bhattacharya, S.K. Jain and S.R. Nagpaul**, Wiley Eastern Ltd., New Delhi, 1991.
3. Linear Algebra: A geometric approach, **S. Kumaresan**, Prentice Hall of. India, 2000.

Course Code: MA163	Data Structures	Credits 3-0-0: 3

Pre-Requisites: MA144: Problem-Solving and Computer Programming

Course Outcomes:

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

CO1	Identify appropriate data structures to solve problems
CO2	Develop and analyse algorithms for stacks
CO3	Implement operations on queues
CO4	Implement sorting and searching algorithms
CO5	Implement linked lists using pointers

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	2	2	-	2	-	-	-	1	-	-	2	1	-	2	-
CO2	1	-	2	-	2	1	-	-	2	-	1	1	-	-	1	1
CO3	1	-	2	-	2	1	-	-	2	-	1	-	-	2	1	-
CO4	1	2	2	1	2	1	1	1	2	-	1	2	2	-	-	1
CO5	1	2	1	1	2	1	1	1	2	-	1	1	-	2	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Stack: Definition, Array implementation of the stack (static stack): Operations PUSH, POP, and TRAVERSE. Applications of Stack: Infix, Prefix, Postfix representation and conversion using stack, Postfix expression evaluation using stack, use of stack in recursion implementation.

Queue: Definition, array implementation of the queue (static queue): Operations INSERT, DELETE, TRAVERSE. Applications of queue, Comparisons of array, stack, and queue data structures. Introduction to Circular queue, priority queue, Double ended queue, and multiple queues.

Linked list: Singly and Doubly Linear link lists, Singly and doubly circular linked list: Definitions, operations INSERT, DELETE, TRAVERSE on all these lists. (Insertion operation includes –insertion before a given element, insertion after a given element, insertion at a given position, insertion in a sorted linked list), Implementations of Stack and Queue using linked list (Dynamic stack).

Applications of linked list: String representation and string operations like string length,

string reverse, string comparison, string concatenation, string copying, converting upper-case to lower and vice-versa, substring using linked list. Polynomial representation and addition of two polynomials using a linked list.

Learning Resources:

Text Books:

1. Data Structures (Schaum's Outline series), **S. Lipchitz,** Tata McGraw Hill, 2015.
2. Handbook of Data Structures and Applications, **Dinesh P. Mehta and Sartaj Sahni,** Chapman and Hall/CRC, 2018.

Reference Books:

1. Data Structures and Algorithm in C++, **Adam Drozdek Thomson**, Vikas Publications, 2013.
2. Data Structures & Algorithms, **Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman,** Pearson, 2002.

Course Code: BT171	Biological Computation	Credits 2-0-0: 2

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Realize the significance of biology for biological computation
CO2	Identify difference between conventional and unconventional computation
CO3	Understand topics at the interface of biology and computation
CO4	Analyse the concepts of system biology for molecular computation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
CO5															

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Biological Computation: The influence of biology on mathematics – historical examples, biological introduction, modern science simulations, Cellular Automata: biological background, the “game of life”, general definition of cellular automata, one-dimensional automata, examples of cellular automata, comparison with a continuous mathematical model, computational universality, self-replication, summary and exercises.

Evolutionary Computation: Evolutionary biology and evolutionary computation, genetic algorithms, example applications, analysis of the behavior of genetic algorithms, Lamarckian evolution, genetic programming, a second look at the evolutionary process. Artificial Neural Networks: biological background, learning, artificial neural networks, the perceptron, learning, in a multi-layered network, associative memory, unsupervised learning, summary and exercises.

Molecular Computation: Biological background, computation using DNS, enzymatic computation, the never-ending story: additional topics at the interface between biology and computation, swarm intelligence, artificial immune systems, artificial life, systems biology, Dynamic modelling of biological systems using ODE and PDE, Fibonacci series application, rhythmic phenomena modelling, prey predatory models, summary

and exercises.

Learning Resources:

Text Books/Reference Book/Online Resources:

1. Biological Computation, **Ehud Lamm, Ron Unger,** CRC Press, 2011, first edition.
2. Biology for Engineers, **G.K. Suraishkumar,** Oxford University Press, 2019, first edition.
3. Nature Inspired Optimization Algorithms, **Xin-She Yang,** Elsevier, 2014, first edition.
4. Mathematical modeling in systems biology: An Introduction, **Brian P Ingalls,** MIT Press, 2022, first edition.

Course Code: EE131	Basic Electrical Engineering	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Analyze electric and magnetic circuits.
CO2	Identify the type of electrical machines for a given application.
CO3	Understand the ratings of electrical apparatus.
CO4	Identify meters for measuring electrical quantities

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	2	1	1	1	1	2	1	1	1	3	
CO2	3	3	2	2	2	2	1	1	1	1	2	1	1	1	3	
CO3	3	3	2	2	2	2	1	1	1	1	2	1	1	1	3	
CO4	3	3	2	2	2	2	1	1	1	1	2	1	1	1	3	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

DC Circuits: Kirchoff's voltage and current laws, Superposition theorem, star-delta transformations.

AC Circuits: Complex representation of impedance, phasor diagrams, power and power factor, solution of 1-phase series and parallel circuits.

Magnetic Circuits: Fundamentals and solution of magnetic circuits, concepts of self and mutual inductances, coefficient of coupling.

Single Phase Transformers: Principle of operation, EMF equation, phasor diagram, equivalent circuit, determination of equivalent circuit parameters, calculation of regulation and efficiency.

DC Machines: Principle of operation, classification, EMF and torque equations, characteristics of generators and motors, speed control methods.

AC Machines: 3-Phase induction motor, principle of operation, torque, speed characteristics, slip-ring induction motor, introduction to synchronous machine (qualitative), applications of electrical machines.

Electrical Measuring Instruments: Moving coil and moving iron ammeters, voltmeters. wattmeter, digital multimeter (qualitative).

Electric Heating: Principles of resistance heating, induction heating and dielectric heating. (qualitative).

Learning Resources:
Text Books:

1. Electrical & Electronic Technology, **Edward Hughes**, Pearson Education, 2016, 12th Edition.
2. Electrical Engineering Fundamentals, **Vincent Del Toro,** Pearson Education, 2015, 2nd Edition.
3. Electrical Machinery - Theory, Performance & Applications, **P.S. Bimhbra,** Khanna Publishers 2014, 7th Edition.
4. Basic Electrical Engineering, **V N Mittle and Arvind Mittal**, Tata McGraw Hill, 2005, 2nd Edition.

Reference Books:

1. Basic Electrical Engineering, **U Bakshi & A. Bakshi,** Technical Publications, 2019, 1st Edition.
2. Principles of Electrical & Electronics Engineering, **V. K Mehtha,** S. Chand Publications, New Delhi, 2010, 3rd Edition.
3. Electrical Machines, **A Fitzgerald, Charles Kingsley, Stephen Umans**, McGraw Hill Education, 2017, 6th Edition.
4. Electric Machinery, **Stephen. J. Chapman**, McGraw Hill International Edition, 2017, 4th Edition.

Online Resources:

1. https://nptel.ac.in/courses/108/108/108108076\

Course Code: ME151	DESIGN STUDIO	Credits 0-0-3: 1.5

Pre-Requisites: NIL

Course Outcomes:

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

CO1	Express Product Design Ideas using 2D or 3D sketches
CO2	Model the components with geometric specifications and appropriate materials
CO3	Develop prototype of the product
CO4	Evaluate the entire product

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1																
CO2																
CO3																
CO4																

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Sketching: 2D and 3D sketching: Students will sketch the concept on drawing sheets/ digital screens. The drawings will contain the specifications of the geometric form.

3D Modelling: Develop the 3D model features including free form surfaces, final product design specifications, Parametric design.

Physical Component Development: Development of components: fabrication of actual components of the product using the materials and tools available in the lab, Iterations.

Iterative improvement of the product and Report writing: Development of assemblies/mock-up models/ working models/ prototypes/functional models/products, Testing and design review, Report writing.

Learning Resources:

Text Books:

1. The design studio method: creative problem solving with UX sketching, Sullivan, Brian, Focal Press, 2016.
2. Autodesk Fusion 360 Black Book, Verma G., CADACAMCAE Works, 2021, 2nd edition.

Online Resources:

1. Self-Paced Tutorials https://help.autodesk.com/view/fusion360/ENU/courses/
2. Product Documentation https://help.autodesk.com/view/fusion360/ENU/?guid=GUID1C665B4D-7BF7-4FDF-98B0-AA7EE12B5AC2

Resources:

1. https://nptel.ac.in/courses/108/104/108104139/
2. https://nptel.ac.in/courses/108/106/108106172/

Course Code: EC131	Basic Electronic Engineering	Credits 3-0-0

Pre-Requisites: Nil

Course Outcomes:

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

CO1	Comprehend the characteristics of semiconductor devices, and operational amplifiers.
CO2	Describe the working principles of amplifiers.
CO3	Design simple combinational and basics of sequential logic circuits.
CO4	Explain the principles of electronic measuring instruments and transducers.
CO5	Apply the principles of electronic communication.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	3	-	-	-	-	-	-	-	-	-	-	1	-	-	
CO2	-	3	-	-	-	-	-	-	-	-	-	-	1	-	-	
CO3	-	-	3	-	-	-	-	-	-	-	-	-	1	-	-	
CO4	-	-	-	3	-	-	-	-	-	-	-	-	1	-	-	
CO5	1	-	-	-	2	2	-	-	-	-	-	-	1	-	-	

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT (Bipolar Junction Transistor) Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: Open loop and closed loop systems, Negative and positive feedback, merits and demerits, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers – characteristics and linear applications.

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DACs), Introduction to microprocessors and microcontrollers. Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscopes (CROs).

Electronics Instrumentation: Measurement, Sensors, principles of LVDT, strain gauge and thermocouples. Introduction to data acquisition system.

Principles of Communication: Need for Modulation, Definitions of various Modulation and Demodulation techniques, AM radio transmitter and receiver, brief understanding of FM and mobile communications.

Text Books:

1. Electronic Devices and circuits, **S. Salivahanan, N Suresh Kumar,** McGraw Hill publications, 2022, 3rd Edition,
2. Basic Electronics & Linear Circuits, **Bhargava N. N., D C Kulshreshtha and S C Gupta,** Tata McGraw Hill, 2013, 2nd Edition.
3. Digital Computer electronics, **Malvino and Brown,** Mcgraw Hill, 2017, 3rd Edition.
4. Electronic Communication Systems, **Keneddy and Davis,** McGraw Hill, 2006, 4th Edition.
5. Modern Electronic Instrumentation and Measurement Techniques, **Helfrick and Cooper,** PHI, 2011.

Reference Books:

1. Electronics A Systems Approach, **Neil Storey,** Pearson Education Publishing Company Pvt Ltd, 2009, 4th Edition.

Course Code: MA164	Data Structures Lab	Credits 0-0-3: 1.5

Pre-Requisites: MA144: Problem-Solving and Computer Programming

Course Outcomes:

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

CO1	Develop ADT for stack applications
CO2	Develop ADT for queue applications
CO3	Able to implement the various linked lists
CO4	Able to implement Binary Search Tree operations
CO5	Implement and analyse internal and external sorting algorithms

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	2	2	-	2	-	-	-	-	-	-	2	1	-	2	-
CO2	1	-	2	-	2	1	-	-	2	-	1	1	-	-	-	1
CO3	1	-	2	-	2	1	-	-	2	-	1	-	-	2	1	
CO4	1	2	2	1	2	1	1	1	2	-	1	2	2	-	-	1
CO5	1	2	1	1	2	1	1	1	2	-	1	1	-	2	2	-

1 - Slightly; 2 - Moderately; 3 – Substantially

Syllabus:

1. Write a program to implement stack using arrays.
2. Write a program to evaluate a given postfix expression.
3. Write a program to implement a circular queue using arrays.
4. Write a program to implement a double-ended queue (de queue) using arrays.
5. Write programs for applications based on stacks and queues.
6. Write programs to implement the Single linked list data structure and their applications.
7. Write programs to implement the Double linked list data structure and their applications.
8. Write programs to implement a stack using linked lists.
9. Write programs to implement a queue using linked lists.
10. Write a program to create a binary search tree (BST) by considering the keys in the given order and performing the following operations on it: (a) Minimum key (b) Maximum key (c) Search for a given key.
11. Implement the following sorting algorithms: (a) Insertion sort (b) Merge sort (c) Quick sort (d) Heap sort (e) Radix sort (f) Selection sort.

Learning Resources

Text Books

1. Introduction to Algorithms, **Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein,** PHI, 2009.
2. Data Structures and Algorithm Analysis in C++, **Mark Allen Weiss,** Pearson Education, 2006, Third Edition.

Reference Books:

1. Computer Algorithms, **Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran.**, Universities Press, 2011.
2. Algorithm Design: Foundations, Analysis and Internet Examples, **Michael T. Goodrich and Roberto Tamassia,** India, 2006, Second Edition.