RAMAIAH
Institute of Technology

CURRICULUM

Outcome Based Education
(Academic Year 2023 – 2024)

COMPUTER SCIENCE AND ENGINEERING

III & IV SEMESTER B.E.

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 17 UG programs and 11 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A+' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute has also been conferred autonomous status for Ph.D. program since 2021. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 67% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation. **Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 107 & world ranking 600 for the year 2022.**

The Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology is recognized by Atal Ranking of Institutions on Innovation Achievements (ARIIA), MoE, Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. The Institute is a member of DELNET, CMTI and VTU E-Library Consortium. The Institute has a modern auditorium, recording studio, and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, Ramaiah Institute of Technology has achieved 78th rank among 1314 top Engineering Institutions & 23rd Rank among 105 School of Architecture in India for the year 2023.

About the Department

Year of Establishment	1984
Names of the Programmes offered	UG: B.E. in Computer Science and Engineering PG: M.Tech. in Computer Science and Engineering PG: M.Tech. in Computer Networks and Engineering Ph.D M.Sc.(Engg.) by Research

The Department of Computer Science and Engineering (CSE) has eminent emeritus professors, 15 faculties with the doctorate degree and 15 pursuing the doctoral studies. The faculty has been publishing research papers in refereed journals and in conference proceedings. The department also conducts vocational courses and proficiency courses on fundamental and new programming languages and computer science concepts. These courses are conducted beyond college hours'/summer semester by the faculty of the department. Some of the faculty are involved in institutional level activities and actively involved in interdisciplinary research activities. The department has state of the art laboratories like SAP, IBM Centre of Excellence. Technical seminars, workshops and hackathons are conducted regularly for UG & PG students. The department encourages the students to conduct and participate in extra- curricular/sports activities. The alumni network is very active and regular meeting are conducted by the department. The department is accredited by Nation Board of Accreditation (NBA). The department has MoUs with leading IT Industries like SAP, IBM and HP. The department conducts subjects with more of hands- on sessions and encourages students to take up MOOC based online courses in NPTEL, IIT Bombay, Coursera, Udacity and edX.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M S Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To build a strong learning and research environment in the field of Computer Science and Engineering that promotes innovation towards betterment of the society

MISSION OF THE DEPARTMENT

1. To produce Computer Science graduates who, trained in design and implementation of computational systems through competitive curriculum and research in collaboration with industry and research organizations.
2. To educate students in technology competencies by providing professionally committed faculty and staff.
3. To inculcate strong ethical values, leadership abilities and research capabilities in the minds of students so as to work towards the progress of the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

A B.E (Computer Science & Engineering) graduate of Ramaiah Institute of Technology should, within three to five years of graduation

PEO1 Pursue a successful career in the field of Computer Science & Engineering or a related field utilizing his/her education and contribute to the profession as an excellent employee, or as an entrepreneur

PEO2 Be aware of the developments in the field of Computer Science & Engineering, continuously enhance their knowledge informally or by pursuing graduate studies

PEO3 Be able to work effectively in multidisciplinary environments and be responsible members / leaders of their communities.

PROGRAM OUTCOMES (POs):

The Outcomes of the Bachelor of Engineering in Computer Science & Engineering Programme are as follows:

Engineering Graduates must be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the 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 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 professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in 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 own 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 (PSOs):

PSO1: Understand the principles, architecture and organization of computers, embedded systems, and computer networks.

PSO2: Apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems that include both hardware and software.

PSO3: Apply software design and development practices to develop software applications in emerging areas such as IoT, Data Analytics, Social Networks, Cloud and High-Performance Computing.

Semester wise Credit Breakdown for B.E Degree Curriculum
Batch 2022-26

Semester / Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Sciences (BSC)	08	08	03	03	--	--	--	--	22
Engineering Sciences (ESC)	09	08	--	--	--	--	--	--	17
Humanities, Social Sciences and Management (HSMC)	02	02	--	--	03	03	--	--	10
Ability Enhancement Course (AEC)	01	02	01	01	01	--	03	--	09
Universal Human Values (UHV)	--	--	02	--	--	--	--	--	02
Professional Core Courses (PCC)	--	--	11	12	12	06	04	--	45
Integrated Professional Core Course (IPCC)	--	--	04	04	03		04	--	15
Professional Elective Courses (PEC)	--	--	--	--	03	06	03	--	12
Institutional Open Elective Courses (IOE)	--	--	--	--	--	03	03	--	06
Internship (INT)	--	--	--	Yes	--	--	--	05	05
Mini Project / Project Work (PW)	--	--	--	--	--	04	03	10	17
Non Credit Mandatory Courses (NCMC)	--	--	Yes	--	Yes	--	--	Yes	--
Total Credits	20	20	21	20	22	22	20	15	160

SCHEME OF TEACHING III SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week
					L	T	P	Total	
1	CS31	Linear Algebra and Laplace Transforms	Mathematics	BSC	2	1	0	3	4
2	CS32	Digital Design and Computer Organization	CSE	IPCC	3	0	1	4	5
3	CS33	Data Structures	CSE	PCC	3	0	0	3	3
4	CS34	Object Oriented Programming	CSE	PCC	3	0	0	3	3
5	CS35	Discrete Mathematical Structures	CSE	PCC	2	1	0	3	4
6	CSL36	Data Structures Laboratory	CSE	PCC	0	0	1	1	2
7	CSL37	Object Oriented Programming Laboratory	CSE	PCC	0	0	1	1	2
8	UHV38	Universal Human Values	CSE	UHV	2	0	0	2	2
9	CSAEC39/310	Ability Enhancement Course-III	CSE	AEC	1	0	0	1	1
				Total	16	2	3	**21**	**26**
10	PE83	Physical Education		NCMC	All students have to register compulsorily for any one of the courses with the concerned coordinator (Yoga Teacher/ Physical Education Director/ NSS Coordinator) in the beginning of the III semester. Attending the registered course from III to VIII semesters. Qualifying is mandatory for the award of the degree.				
	YO83	Yoga							
	NS83	NSS							
11	AM31	Additional Mathematics - I *****		NCMC	0	0	0	0	3

Nomenclature: BSC: Basic Science Course**, IPCC:** Integrated Professional Core Course**, PCC:** Professional Core Course**, HSMC:** Humanity and Social Science & Management Courses**, AEC–**Ability Enhancement Courses**, UHV:** Universal Human Value Course, **NCMC**: Non-credit Mandatory Course

L –Lecture, T – Tutorial, P- Practical/ Drawing

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with practical of the same course. Credit for IPCC is 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 1). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated only by CIE (no SEE). However, questions from the practical part of IPCC can be included in the SEE question paper.

The Non Credit Mandatory Course, Physical Education (Sport and Athletics)/Yoga/National Service Scheme (NSS):

1. Student shall select any one of the NCMC's namely, Physical Education (Sport and Athletics)/Yoga/ NSS prescribed for VIII semesters and shall attend the course from the III semesters and upto end of VIII semesters to complete all the formalities of the course and appear for the SEE. Marks scored in SEE shall be included in the VIII semester grade card.
2. The above mentioned NCMC's shall not be considered for vertical progression as well as for the calculation of SGPA/CGPA but completion of the courses shall be mandatory for the award of degree.
3. SEE marks will be allotted by the concerned course teacher based on attendance and performance in the practice sessions/field in the ratio of 50:50. Maximum CIE marks are 50. SEE should be awarded by the course teacher every semester (III to VIII) for 50 marks and marks scored by the student are scaled down to 50 in the VIII semester.
4. The students who take a course on Physical Education and Yoga, he/she has to take up the semester end practical examination prescribed for 100 marks. The students who opt for NSS course have to submit report and attend viva-voce examination. The marks of the report shall be 50 marks and for the presentation/viva-voce 50 marks. SEE scale down to 50 marks.
5. In case, any student fails to secure the minimum 40% of the prescribed marks, he/she shall be deemed to have secured **'F'** grade.

***Lateral Entry Students:**

The Non-Credit Mandatory Course, Inter/Intra Institutional Internship: All the students admitted under the lateral entry category shall have to undergo a mandatory summer Internship of 02 weeks which is an NCMC course, during the intervening vacation of the III and IV semesters. Summer Internship shall include Inter / Intra Institutional activities. A Viva-voce examination shall be conducted during the IV semester. The internship shall be considered as a head of passing and shall be considered for vertical progression and for the award

of the degree. Those, who do not take up / complete the internship shall be declared fail and shall have to complete during subsequent examination after satisfying the internship requirements during subsequent semesters.

*** Lateral Entry Students:**

The Non-Credit Mandatory Course, Additional Mathematics I is prescribed for III Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other III semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured **'F'** grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. Incase student fails to register for the said course/ falls short of attendance, he/she will repeat the course whenever it is offered next. Additional Mathematics I shall have CIE component only and no SEE component. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

Ability Enhancement Course - III

Sl. No	Name of the Course
1	Mastering Office
2	Unix Shell Programming

SCHEME OF TEACHING IV SEMESTER

Sl. No.	Subject Code	Subject	Teaching Department	Category	Credits				Total contact hours /week
					L	T	P	Total	
1	CS41	Numerical Techniques and Probability Models	Mathematics	BSC	2	1	0	3	4
2	CS42	Microcontrollers and IoT	CSE	IPCC	3	0	1	4	5
3	CS43	Design and Analysis of Algorithms	CSE	PCC	3	0	0	3	3
4	CS44	Data Communication and Networking	CSE	PCC	3	0	0	3	3
5	CS45	Finite Automata and Formal Languages	CSE	PCC	2	1	0	3	4
6	CSL46	Design and Analysis of Algorithms Laboratory	CSE	PCC	0	0	1	1	2
7	CSL47	Data Communication and Networking Laboratory	CSE	PCC	0	0	1	1	2
8	CSL48	Data visualization with python Lab	CSE	PCC	0	0	1	1	2
9	CSAEC49/410	Ability Enhancement Course - IV	CSE	AEC	1	0	0	1	1
10	INT411	Inter/ Intra Institutional Internship		NCMC	0	0	0	0	-
				Total	14	2	4	**20**	**26**
11	AM41	Additional Mathematics II *****	Mathematics	NCMC	0	0	0	0	-

Nomenclature: BSC: Basic Science Course**, IPCC:** Integrated Professional Core Course**, PCC:** Professional Core Course**, INT –**Internship**, HSMC:** Humanity and Social Science & Management Courses**, AEC–**Ability Enhancement Courses, **NCMC**: Non-credit Mandatory Course

L –Lecture, T – Tutorial, P- Practical/ Drawing

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with practical of the same course. Credit for IPCC is 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 1). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated only by CIE (no SEE). However, questions from the practical part of IPCC can be included in the SEE question paper.

*** Lateral Entry Students:**

The Non-Credit Mandatory Course, Additional Mathematics II is prescribed for IV Semester Lateral Entry Diploma students admitted to III Semester of BE Program. The student shall register for this course along with other IV semester courses. The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. Incase student fails to register for the said course/ falls short of attendance, he/she will repeat the course whenever it is offered next. Additional Mathematics II shall have CIE component only and no SEE component. This Course shall not be considered for vertical progression, but completion of the course shall be mandatory for the award of the degree.

AICTE Activity Points to be earned by students admitted to BE program (For more details refer to Chapter 6, AICTE, Activity Point Program, Model Internship Guidelines):

Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. Students entering 4 years' degree program through lateral entry are required to earn 75 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the course. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. Incase student fail to earn the prescribed activity points; VIII semester grade card shall be

issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

Ability Enhancement Course - IV

Sl. No	Name of the Course
1	AngularJs
2	Data Analysis with R

III SEMESTER

LINEAR ALGEBRA & LAPLACE TRANSFORMS	
Course Code: CS31	**Credits: 2:1:0**
Pre – requisites: Calculus and Basics of Linear Algebra	**Contact Hours: 28L+14T**
Course Coordinator: Dr. Govindaraju M V and Dr. R Suresh Babu	

Course Content

Unit I

Laplace Transforms: Definition, transforms of elementary functions, properties of Laplace transforms, existence conditions, transform of derivatives, integrals, multiplication by t^n, division by t, evaluation of integrals by Laplace transforms. Transform of Periodic function.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105134/ https://nptel.ac.in/courses/111/105/111105035/
- Impartus recording: https://a.impartus.com/ilc/#/course/119640/593 https://a.impartus.com/ilc/#/course/59742/295

Unit II

Application of Laplace Transforms: Unit–step function, Unit–impulse function. Inverse transforms, Convolution Theorem, Solution of linear differential equations and Simultaneous linear differential equations using Laplace transforms. Engineering applications.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105134/ https://nptel.ac.in/courses/111/105/111105035/
- Impartus recording: https://a.impartus.com/ilc/#/course/119640/593 https://a.impartus.com/ilc/#/course/59742/295

Unit III

Linear Transformation: Introduction to vector spaces, Linear combination and span, Linearly independent and dependent vectors, Basis and Dimension, Linear

transformations, Composition of matrix transformations, Rotation about the origin, Dilation, Contraction and Reflection, Kernel and Range, Change of basis.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105035/ https://nptel.ac.in/courses/111/102/111102152/
- Impartus recording: https://a.impartus.com/ilc/#/course/621524/1030 https://a.impartus.com/ilc/#/course/619570/1030

Unit IV

Vector Space: Vector Spaces, The Null space of A, Solving Ax = 0 and Rx = 0, The Complete Solution to Ax = b, Dimensions of the Four Subspaces, Orthogonality of the Four Subspaces, Projections. Orthonormal Bases and Gram-Schmidt Method, QR-Factorization, Least-Squares Approximations.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105035/ https://nptel.ac.in/courses/111/102/111102152/
- Impartus recording: https://a.impartus.com/ilc/#/course/621524/1030 https://a.impartus.com/ilc/#/course/619570/1030

Unit V

Applications of Eigenvalue Decomposition: Introduction to Eigenvalues and Eigenvectors, Similarity and Diagonalization. Symmetric Matrices, Complex Matrices, Hermitian and Unitary Matrices, Positive Definite Matrices, The singular value decomposition (SVD), Principal Component Analysis (PCA), Applications to Linear Recurrence Relations, Markov Chains, Quadratic Forms and Conic Sections.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105035/ https://nptel.ac.in/courses/111/102/111102152/
- Impartus recording: https://a.impartus.com/ilc/#/course/621524/1030 https://a.impartus.com/ilc/#/course/619570/1030

Text Books:

1. B. S. Grewal - Higher Engineering Mathematics- Khanna Publishers – 44th edition - 2017.

2. David C. Lay, Steven R. Lay and Judi J. Mc. Donald – Linear Algebra and its Applications – Pearson – 5th edition – 2015.
3. Gilbert Strang, Linear Algebra and its Applications, 5th edition (2016).

Reference Books:

1. Peter V. O'Neil – Advanced Engineering Mathematics – Cengage learning – 7th edition – 2011.
2. Gareth Williams – Linear Algebra with Applications, Jones and Bartlett Press– 9th edition – 2017.
3. Erwin Kreyszig - Advanced Engineering Mathematics - Wiley-India publishers-10th edition - 2015.

Course Outcomes (COs):

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

1. Evaluate Laplace Transforms of given function and understand their properties (PO-1, PO-2, PSO-2, PSO-3)
2. Obtain inverse Laplace transforms and use it to solve system of ODE's. (PO-1, PO-2, PSO-2, PSO-3)
3. Obtain matrix of linear transformation. (PO-1, PO-2, PSO-2, PSO-3)
4. Solve the system of equations by Least-Squares method. (PO-1, PO-2, PSO-2, PSO-3)
5. Obtain Eigen value decomposition of a matrix and use it to study the concepts of SVD and PCA. (PO-1, PO-2, PSO-2, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

DIGITAL DESIGN AND COMPUTER ORGANIZATION	
Course Code: CS32	**Credits: 3:0:1**
Pre – requisites: Nil	**Contact Hours: 42L+14P**
Course Coordinator: Chandrika Prasad	

Course Content

Unit I

Optimized implementation of logic function and combinational circuits

Synthesis of logic circuits with SOP and POS, K-map, Strategy for minimization, Minimization of SOP and POS forms, incompletely specified functions. Tabular method for minimization of Boolean functions, Combinational circuits: Half adder, full adder (realization using NAND gates), multiplexers, decoders, encoders and code converters.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/117105078
- Lab Component / Practical Topics: Implement Half and Full Adder in VHDL
- Implement 8:1 MUX in VHDL

Unit II

Flip-flops, registers and counters

Basic latch, gated SR latch, gated D latch, T FF, JK FF, truth table, characteristics equation and excitation tables of all the four types of FFs. Registers: Shift registers, parallel access registers. Study of asynchronous counters: Up, down counters. Study of synchronous sequential circuits: Design of a counter using sequential circuits approach using different FFs for different modulo values and design of random counters.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/117105078
- Lab Component / Practical Topics: Design a JK flip-flop (with preset and clear) in VHDL
- Design and develop the VHDL code for mod 8 up counter

Unit III

Introduction to functional units and addressing modes

Functional units, bus structures, performance, **Overflow in integer arithmetic**: Numbers, Arithmetic operations and characters, Memory locations and addresses, Memory operations, instructions and instruction sequencing, Addressing modes, Encoding of machine instructions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/117105078
- Lab Component / Practical Topics: Instruction execution using Marie simulator
- Execution of Assembly language programs using ARMSim simulator

Unit IV

Processor

Arithmetic unit: Multiplication of two numbers, A signed operand multiplication, Booth algorithm, Bit pair recoding and CSA, IEEE standard for floating point numbers. **The Processor:** Fundamental concepts, Execution of complete instruction, Multiple bus organization, **Pipelining**: Basic concepts, Data hazards, Instruction hazards.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/117105078
- Lab Component / Practical Topics: ALU design using Logisim and Pipelining demonstration using CPU-OS Simulator

Unit V

Memory and I/O Units

Memory unit: Basic concepts, Cache mapping techniques, **Input Output Unit:** Accessing I/O devices, **Interrupts**: Interrupt hardware, Enabling and disabling of interrupts, handling multiple devices, Controlling device requests.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/117105078
- Lab Component / Practical Topics: Memory operation using Logisim simulator

Suggested Learning Resources

Text Books:

1. Stephen Brown, Zvonko Vranesic: Fundamentals of Digital Logic Design with VHDL, Tata McGraw Hill, 3rd Edition, 2012.
2. C Hamacher, Z Vranesic, S Zaky: Computer Organization, Tata McGraw Hill, 5th Edition, 2018.

Reference Book:

1. David A. Patterson, John L. Hennessy: Computer Organization and Design, M.K Publishers, 4th edition, 2010

Course Outcomes (COs):

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

1. Interpret the working of various digital combinational circuits and apply various techniques to minimize Boolean functions. (PO-1, PO-2, PSO-2)
2. Examine the characteristics of flip flop sand design asynchronous and synchronous sequential circuits. (PO-1, PO-2, PO-5, PSO-2)
3. Demonstrate basic functional units, instruction sequencing and various addressing modes. (PO-1, PO-2, PO-5, PSO-2)
4. Appraise different techniques used to perform multiplication and describe the organization of processing unit & pipelining. (PO-1, PO-2, PO-3, PO-5, PSO-2)
5. Illustrate cache memory mapping techniques, data transfer between the devices using interrupts and direct memory access mechanism (PO-1, PO-2, PO-3, PO-5, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Lab Test	10	CO1, CO2
Simulation based learning	10	CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Quiz-II		
Semester End Examination (SEE):		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

DATA STRUCTURES	
Course Code: CS33	**Credits: 3:0:0**
Pre – requisites: C Programming Course	**Contact Hours: 42L**
Course Coordinator: Dr. Parkavi A	

Course Content

Unit I

Basic Concepts: Pointers and Dynamic Memory Allocation, Algorithm Specification, Data Abstraction. Arrays and Structures: Arrays, Dynamically Allocated Arrays, Structures and Unions, Polynomials, Sparse Matrices, Representation of Multidimensional Arrays, Strings.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Usage of Pointers, Structures, Implementing Polynomials, Sparse Matrices
- Links: https://www.youtube.com/watch?v=55laZ7_F24&list=PLBlnK6fEyqRjoG6aJ4FvFU1tlXbjLBiOP

Unit II

Stacks and Queues: Stacks, Stacks Using Dynamic Arrays, Queues, Circular Queues Using Dynamic Arrays, Evaluation of Expressions, Multiple Stacks and Queues.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Variations of Stacks and Queues
- Links: https://www.youtube.com/watch?v=rS-ZKTqwi90
- https://www.youtube.com/watch?v=poNr0Z4PcM

Unit III

Linked Lists: Singly Linked lists and Chains, Representing Chains in C, Linked Stacks and Queues, Polynomials, Additional List operations, Sparse Matrices, Doubly Linked Lists.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Variations of Linked Lists and their Applications
- Links: https://www.youtube.com/watch?v=R9PTBwOzceo

Unit IV

Trees: Introduction, Binary Trees, Binary Tree Traversals, Additional Binary Tree Operations, Threaded Binary Trees, Heaps, Binary Search Trees, Selection Trees, Forests, Representation of Disjoint Sets, Counting Binary Trees.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Binary Trees
- Links: https://www.youtube.com/watch?v=oSWTXtMglKE

Unit V

Graphs: The Graph Abstract Data Type, Elementary Graph Operations. Priority Queues: Single- and Double-Ended Priority Queues, Leftist Trees. Efficient Binary Search Trees: AVL Trees.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Graph Operations and traversals.
- Links: https://www.youtube.com/watch?v=gXgEDyodOJU

Suggested Learning Resources

Text Book:

1. Horowitz, Sahni, Anderson - Freed: Fundamentals of Data Structures in C, 2nd Edition, Universities Press, 2008.

Reference Books:

1. Narasimha Karumanchi: Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles, Career monk Publications, 5th Edition, 2016
2. Yedidyah, Augenstein, Tannenbaum: Data Structures Using C and C++, 2nd Edition, Pearson Education, 2003.
3. Data Structures, Seynour Lipschutz and GAV Pai, Schaum's Outlines, McGraw Hill, 2008.
4. Richard F. Gilberg and Behrouz A. Forouzan: Data Structures- A Pseudocode Approach with C, Cengage Learning, 2005

Course Outcomes (COs):

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

1. Solve real time problems using concepts of dynamic memory allocation, structures, and strings. (PO-1, PO-2, PO-3, PSO-2)
2. Implement storage and retrieval of ordered data using stacks and queues as well as select appropriate data structures as applied to specified problem definition (PO-1, PO-2, PO-3, PSO-2)
3. Implement dynamic storage, retrieval and search operations of unordered data using linked list and its variants. (PO-1, PO-2, PO-3, PSO-2)
4. Implement hierarchical based solutions using different tree traversal techniques. (PO-1, PO-2, PO-3, PSO-2)
5. Develop solutions for problems based on graphs. (PO-1, PO-2, PO-3, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Programming Competition / Hackathon / Codathon	20	CO1, CO2, CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Assignment		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

OBJECT ORIENTED PROGRAMMING	
Course Code: CS34	**Credits: 3:0:0**
Pre – requisites: C Programming Course	**Contact Hours: 42L**
Course Coordinator: Pradeep Kumar	

Course Content

Unit I

The Object Model and Introduction to Java Programming

The Object Model: Foundations of the Object Model, Object-Oriented Programming, Object-Oriented Design, Object- Oriented Analysis. Elements of the Object Model: Abstraction, Encapsulation, Modularity, Hierarchy, Typing, Concurrency, Persistence Applying the Object Model.

Introduction to Java Programming: Java Buzzwords, Overview of Java Data types, Variables, arrays, Control statements.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105191
- Lab Component / Practical Topics: Java Programs on data types, operators, static methods and arrays

Unit II

Java Programming Fundamentals

Java Programming Fundamentals: Object-Oriented Programming, The Three OOP Principles, Class Fundamentals, Declaring Objects, Assigning Object Reference Variables, Introducing Methods, Constructors, The this Keyword, Garbage Collection, The finalize( ) Method, Overloading Methods, Using Objects as Parameters, A Closer Look at Argument Passing, Returning Objects, Introducing Access Control, Understanding static, Introducing final, Introducing Nested and Inner Classes.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105191
- Lab Component / Practical Topics: Java Programs on classes, constructors, method overloading, method overriding and nested classes

Unit III

Inheritance, Packages & Interfaces

Inheritance, Packages & Interfaces: Inheritance Basics, Using super, Creating a Multilevel Hierarchy, When Constructors Are Called, Method Overriding, Dynamic

Method Dispatch, Using Abstract Classes, Using final with Inheritance, Packages, Access Protection, Importing Packages, Interfaces, String and String Buffer Handling.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105191
- Lab Component / Practical Topics: Java Programs on Inheritance, abstract classes, packages, interfaces and string methods

Unit IV

Exception Handling & Multithreaded Programming

Exception Handling: Exception-Handling Fundamentals, Exception Classes, Exception Types, Uncaught Exceptions, Using try and catch, Multiple catch clauses, Nested try Statements, throw, throws, finally.

Multithreaded Programming: Java Thread Classes, The Java Thread Model, The Main Thread, Creating a Thread, Creating Multiple Threads, Using is Alive() and join(), Thread Priorities, Synchronization, Suspending, Resuming and Stopping Threads.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105191
- Lab Component / Practical Topics: Java Programs on Exception handling and Multithreaded programming

Unit V

Event Handling, Swings & Lambda Expressions

Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Event Model, Adapter Classes, Inner Classes.

Swing: Introducing Swing.

Lambda Expressions: Fundamentals, Block Lambda expressions, Passing Lambda Expressions as Argument, Lambda Expressions and Exceptions, Method References.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105191
- Lab Component / Practical Topics: Java Programs on GUI programming, event handling and lambda expressions

Suggested Learning Resources

Text Books:

1. Object-Oriented Analysis and Design With applications, Grady Booch, Robert A Maksimchuk, Michael W Eagle, Bobbi J Young, 3rd Edition, 2013, Pearson Education, ISBN :97881317228793.

2. The Complete Reference-Java, Herbert Schildt, 12th Edition, 2021, TMH Publications, ISBN: 9781260463415.

Reference Book:

1. Head First Java, Kathy Sierra and Bert Bates, 2nd Edition, 2014, Oreilly Publication, ISBN :978817366602

Course Outcomes (COs):

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

1. Examine the fundamental elements of object model and identify classes and objects for object oriented programming. (PO-2, PO-3, PO-5, PSO-3)
2. Explore the OOP principles and basic constructs of Java language. (PO-2, PO-3, PO-5, PSO-3)
3. Develop java programs using inheritance, interfaces and packages. (PO-2, PO-3, PO-5, PSO-3)
4. Explore the exception handling mechanism and thread synchronization. (PO-2, PO-3, PO-5, PSO-3)
5. Design the GUI application using swings and handle the interactions. (PO-2, PO-3, PO-5, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz –I	10	CO1, CO2, CO3
Quiz –II	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Quiz-II		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

DISCRETE MATHEMATICAL STRUCTURES	
Course Code: CS35	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 28L+14T**
Course Coordinator: Dr. Geetha J	

Course Content

Unit I

Logics and Proofs: The laws of Logic, Logical implication, Rules of inference, Quantifiers, Proofs of theorems.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs123

Unit II

Relations: Relations, Properties of relations, Computer Recognition- Zero-one Matrices and directed Graphs, Equivalence Relations and partitions. POSETS, Hasse Diagrams, Lattices.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs123

Unit III

Combinatorics: Fundamentals of counting, permutation, combination, Combination with repetition, Binomial Coefficient, Pigeon hole principle. The Principle of Inclusion and Exclusion: The Principle of Inclusion and Exclusion, Generalizations of the Principle, Derangements – Nothing is in its Right Place, Rook Polynomials.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs123

Unit IV

Graph Theory: Introduction to Graph theory- Definitions, sub graphs, complements, and graph isomorphism, Euler's trails and circuits, Hamilton paths and Cycles. Planar graphs, Euler's Theorem, Graph Coloring.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs123

Unit V

Applications of Graphs and Trees: Network flow problems, flows and source/sink cuts, Ford Fulkerson algorithm, Max- flow min-cut theorem, Definitions, Properties, and Examples, Routed Trees, Trees and Sorting, Weighted Trees and Prefix Codes. Applications of Graphs and Trees.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs123

Suggested Learning Resources

Text Books:

1. Ralph P. Grimaldi: Discrete and Combinatorial mathematics, 5th Edition, PHI/ Pearson Education, 2015.
2. Kenneth H. Rosen: Discrete Mathematics and its Applications, 7th Edition, McGraw Hill publications.
3. Douglas B. West, Introduction to Graph Theory, Second Edition, Prentice-Hall.

Reference Book:

1. Thomas Koshy: Discrete Mathematics with Applications, Elsevier, 1st Edition, 2011.

Course Outcomes (COs):

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

1. Apply the notion of mathematical logic & proofs in problem solving. (PO-1, PO-2, PO-4, PSO-2, PSO-3)
2. Solve problems which involve discrete data structures such as relations (PO-1, PO-2, PO-4, PO-10, PSO-2)
3. Apply basic counting techniques and combinatorics in the context of discrete probability. (PO-1, PO-2, PO-4, PO-10, PSO-2)
4. Demonstrate knowledge of fundamental concepts in graphs (PO-1, PO-2, PO-3, PO-10, PSO-2)
5. Demonstrate knowledge of trees and its properties using various modelling techniques. (PO-1, PO-2, PO-4, PO-10, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Tutorial Session	10	CO1, CO2, CO3,CO4, CO5
ChatGPT Based Assignments	10	CO1, CO2, CO3,CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Tutorial session +Assignment		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

DATA STRUCTURES LABORATORY	
Course Code: CSL36	**Credits: 0:0:1**
Pre – requisites: C Programming Course	**Contact Hours: 14P**
Course Coordinator: Dr. Sangeetha J	

Course Content

Sl. No.	Topics Covered
1.	Illustrating Pointers for data operations
2.	Examining Dynamic memory allocations
3.	Managing Structures in applications
4.	Organizing Stacks in programs
5.	Constructing Queues for applications
6.	Implement circular queues
7.	Implement Multiple stacks and queues
8.	Usage of doubly linked list in applications
9.	Setting up Linked lists for data set operations
10.	Binary Tree traversals
11.	Graphs representation and traversals
12.	Developing applications to solve Graph based problems

Note: Each Lab Session is of two hours duration/week

Suggested Learning Resources

Text Book:

1. Horowitz, Sahni, Anderson-Freed: Fundamentals of Data Structures in C, 2nd Edition, Universities Press, 2008.

Reference Books:

1. Narasimha Karumanchi: Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles, Career monk Publications, 5th Edition, 2016
2. Yedidyah, Augenstein, Tannenbaum: Data Structures Using C and C++, 2nd Edition, Pearson Education, 2003.
3. Data Structures, Seynour Lipschutz and GAV Pai, Schaum's Outlines, McGraw Hill, 2008.
4. Richard F. Gilberg and Behrouz A. Forouzan: Data Structures- A Pseudocode Approach with C, Cengage Learning, 2005

Course Outcomes (COs):

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

1. Develop programming solutions for real time problems using dynamic memory allocation, structures, and strings. (PO-1, PO-2, PO-3, PSO-2)
2. Develop programming solutions for real time applications using stack, Queues and linked lists (PO-1, PO-2, PO-3, PSO- 2)
3. Design hierarchical based programming solutions using different tree traversal techniques and graph theory (PO- 1, PO-2, PO-3, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation-Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)		
Course End Examination (One full question from the Lab Question Bank, Programs will be coded using C and executed)	50	CO1, CO2, CO3

OBJECT ORIENTED PROGRAMMING LABORATORY	
Course Code: CSL37	**Credits: 0:0:1**
Pre – requisites: C Programming Course	**Contact Hours: 14P**
Course Coordinator: Pradeep Kumar	

Course Contents

Sl. No.	Topics Covered
1.	Primitive Data type and Operators
2.	Control Statements and Arrays
3.	Classes, objects, static variables
4.	Method overloading, method overriding
5.	Dynamic method dispatch, abstract classes
6.	Inheritance
7.	Interfaces & Packages
8.	String handling
9.	Exception Handling
10.	Multi-threading
11.	Synchronizing the threads
12.	Event Handling
13.	Programs on Swings
14.	Lambda Expressions

Note: Each Lab Session is of two hours duration/week

Suggested Learning Resources

Reference Books/ Web Links:

1. The Complete Reference - Java, Herbert Schildt, 12th Edition, 2021, TMH Publications, ISBN: 9781260463415.
2. Head First Java, Kathy Sierra and Bert Bates, 3rd Edition, 2022, O'Reilly Publication, ISBN:9781491910771

Course Outcomes (COs):

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

1. Develop Java applications using OOP principles. (PO-2, PO-3, PO-5, PSO-3)
2. Design real world applications using multi-threading and exception handling mechanism. (PO-2, PO-3, PO-5, PSO-3)
3. Develop interactive GUI applications using Swings. (PO-2, PO-3, PO-5, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation-Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)		
Course End Examination (One full question from the Lab Question Bank, Programs will be coded using C and executed)	50	CO1, CO2, CO3

UNIVERSAL HUMAN VALUES	
Course Code: UHV38	**Credits: 2:0:0**
Pre – requisites: -	**Contact Hours: 28L**
Course Coordinator: Veena G S	

Course Content

Unit I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Understanding the need, basic guidelines, content and process for Value Education
2. Self-Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfill the above human aspirations: understanding and living in harmony at various levels

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Holistic Development and Role of Education https://youtu.be/sGZtTPe-lhQ

Unit II

Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
2. Understanding the needs of Self ('I') and 'Body' - *Sukh* and *Suvidha*
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of 'I' and harmony in 'I'
5. Understanding the harmony of I with the Body: *Sanyam* and *Swasthya*; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure *Sanyam* and *Swasthya*

Practice Exercises and Case Studies will be taken up in Practice Sessions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Harmony in Human Being- Self and Body https://youtu.be/0ERSMkRPQBM
- Links: Harmony in Human Being- Self https://youtu.be/83oGJ4oDeIg
- Links: Harmony between Self and Body Prosperity https://youtu.be/aJ_BU2OgpKs

Unit III

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. *Understanding Harmony in the family – the basic unit of human interaction*
2. Understanding values in human-human relationship; meaning of *Nyaya* and program for its fulfillment to ensure *Ubhay-tripti*;
3. Trust (*Vishwas)* and Respect (*Samman)* as the foundational values of relationship
4. Understanding the meaning of *Vishwas*; Difference between intention and competence
5. Understanding the meaning of *Samman*, Difference between respect and differentiation; the other salient values in relationship
6. Understanding the harmony in the society (society being an extension of family):
7. *Samadhan, Samridhi, Abhay, Sah-astitva* as comprehensive Human Goals
8. Visualizing a universal harmonious order in society- Undivided Society (*Akhand Samaj),* Universal Order (*Sarvabhaum Vyawastha)*- from family to world family!

Practice Exercises and Case Studies will be taken up in Practice Sessions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Harmony in Family- Trust https://youtu.be/F2KVW4WNnS8
- Links: Harmony in family- Respecthttps://youtu.be/iLqNRPuv0_8
- Links: Harmony in family- Other Feeling Justice https://youtu.be/TcYJB7reKnM
- Links: Harmony in the Society https://youtu.be/BkWgFinrnPw

Unit IV

Understanding Harmony in the Nature and Existence - Whole existence as Co-existence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfillment among the four orders of nature-recyclability and self-regulation in nature
3. Understanding Existence as Co-existence (*Sah-astitva*) of mutually interacting units in all-pervasive space
4. Holistic perception of harmony at all levels of existence

Practice Exercises and Case Studies will be taken up in Practice Sessions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration
- Links: Harmony in Nature: https://youtu.be/K1Jpd_ojydw
- Links: Harmony in Existence: https://youtu.be/mormUeZ_RUE

Unit V

Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics:
  - A. Ability to utilize the professional competence for augmenting universal human order
  - B. Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems,
  - C. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order:
  1. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
  2. At the level of society: as mutually enriching institutions and organizations

Suggested Learning Resources:

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab component / Practical Topics: Survey/polls for self-exploration

Text Book:

1. **R.R Gaur, R Sangal, G P Bagaria**, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

Reference Books:

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
7. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
8. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
9. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
2. https://www.youtube.com/watch?v=P4vjfE-YnVk&list=PLWDeKF97v9SP7wSlapZcQRrT7OH0ZlGC4
3. **Course handouts:**
   https://drive.google.com/drive/folders/1zioX_4L2fCNX4Agw282PN86pcZZT3Osr?usp=sharing
4. **Presentation slides:**
   https://drive.google.com/drive/folders/1rMUKh1s0HPRBlpp_b1mpS-duNRcwS6YH?usp=sharing

Course Outcomes (COs):

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

1. Apprehend the need of Value Education over Human aspirations (PO-6)
2. Assimilate Harmony over the physical needs and to overcome the self- needs for a prosperous life. (PO-6)
3. Recognize the need of Harmony in the Family and Society for a better World. (PO-6)
4. Explain the need of mutual understanding for Holistic Harmony in all the Levels of Human Existence. (PO-6)
5. Explain the Holistic understanding of Harmony and Professional Ethics at Individual Level and Society. (PO-6, PO-8)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE)		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests will be taken for 30 marks.		
Other components		
• Assignment • Quiz • Presentation • Model / mini project • Any other	20 (10 + 10)	CO1, CO2, CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

MASTERING OFFICE	
Course Code: CSAEC39	**Credits: 1:0:0**
Pre – requisites: Nil	**Contact Hours: 14L**
Course Coordinator: -	

Course Content

Unit I

MS-Word -Working with Files, Text – Formatting, Moving, copying and pasting text, Styles – Lists – Bulleted and numbered lists, Nested lists, Formatting lists. Table Manipulations. Graphics – Adding clip Art, add an image from a file, editing graphics, Page formatting - Header and footers, page numbers, Protect the Document, Mail Merge, Macros – Creating & Saving web pages, Hyperlinks.

- Pedagogy /Course delivery tools: Chalk and board, Active Learning, practical based learning

Unit II

MS-Excel- Modifying a Worksheet – Moving through cells, adding worksheets, rows and columns, Resizing rows and columns, selecting cells, Moving and copying cells, freezing panes - Macros – recording and running. Linking worksheets - Sorting and Filling, Alternating text and numbers with Auto fill, Auto filling functions. Graphics – Adding clip art, add an image from a file, Charts – Using chart Wizard, Copy a chart to Microsoft Word.

- Pedagogy / Course delivery tools: Active Learning, Demonstration, presentation

Unit III

MS-Power Point -Create a Presentation from a template- Working with Slides – Insert a new slide, applying a design template, changing slide layouts – Resizing a text box, Text box properties, delete a text box - Video and Audio effects, Color Schemes & Backgrounds Adding clip art, adding an image from a file, Save as a web page.

- Pedagogy / Course delivery tools: Demonstration, presentation preparation for case studies

Unit IV

MS-Access - Using Access database wizard, pages and projects. Creating Tables – Create a Table in design view. Datasheet Records – Adding, Editing, deleting records,

Adding and deleting columns Resizing rows and columns, finding data in a table & replacing, Print a datasheet. Queries - MS-Access.

- Pedagogy / Course delivery tools: Chalk& board, Practical based learning.

Unit V

Microsoft Outlook- Introduction, Starting Microsoft Outlook, Outlook Today, Different Views In Outlook, Outlook Data Files.

- Pedagogy / Course delivery tools: Chalk& board, Practical based learning.

Course Outcomes (Course Skill Set):

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

1. Know the basics of computers and prepare documents, spreadsheets, make small presentations with audio, video and graphs and would be acquainted with internet.
2. Create, edit, save and print documents with list tables, header, footer, graphic, spellchecker, mail merge and grammar checker
3. Attain the knowledge about spreadsheet with formula, macros spell checker etc.
4. Demonstrate the ability to apply application software in an office environment.
5. Use Google Suite for office data management tasks

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE) : 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1,CO2, and CO3
Internal Test-II CIE-II)	30	CO4, and CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1,CO2, and CO3
Assignment -I	10	CO4, and CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Assignment -I		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3 CO4 and CO5

UNIX SHELL PROGRAMMING	
Course Code: CSAEC310	**Credits: 1:0:0**
Pre – requisites: C Programming	**Contact Hours: 14L**
Course Coordinator: Dr. Shilpa Chaudhari	

Course Content

Unit I

(3 Lectures)

Introduction to UNIX - Architecture of UNIX, Features of UNIX, Introduction to UNIX file system, vi editor, file handling utilities, security by file permissions, Basic UNIX commands (PATH, man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip.)

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics-Basic Linux commands execution on terminal

Unit II

(3 Lectures)

Introduction to Shells. UNIX Session, UNIXutilities - process utilities, disk utilities, networking commands, Text processingutilities,backup utilities.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics: Linux command related to process/disk/text processing execution on terminal

Unit III

(3 Lectures)

Standard Streams. Redirection. Pipes. Tee Command. Command Execution. Command-Line Editing. Quotes. Command Substitution. Job control. Aliases. Variables. Predefined Variables. Shell/Environment Customization.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics: Customization of Linux shell environment and redirection commands

Unit IV

(2 Lectures)

FILTERS. Filters and Pipes. Concatenating Files. Display Beginning and End of Files. Cut and Paste. Sorting. Translating Characters. Files with Duplicate Lines. Count Characters, Words, or Lines. Comparing Files.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics: Linux commands execution related to filters on terminal

Unit V

(3 Lectures)

Regular Expressions. Atoms. Operators, grep. Operation. grepFamily. Searching for File Content. Sed. Scripts. Operations. Addresses. Commands. Applications. grep and sed. awk. Execution. Fields and Records. Scripts. Operations. Patterns. Actions. Associative Arrays. String Functions. Mathematical Functions. User-Defined Functions. Using System Commands in awk. Applications.

- Pedagogy/ Course delivery tools:Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics:Linux commands execution related to regular expression, sed and awk on terminal

Suggested Learning Resources

Text Books:

1. UNIX and shell Programming- Behrouz A. Forouzan, Richard F. Gilberg.Thomson, 2003.
2. C Hamacher, Z Vranesic, S Zaky: Computer Organization, Tata McGraw Hill, 5th Edition, 2018.

Course Outcomes (COs):

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

1. Elaborate the structure of UNIX environment and basic commands. (PO-1,PO-2, PO-4,PO-5,PO-12)
2. Discuss the interpretive nature of the shell, Unix Process, File structure, Directories and their associated system calls. (PO-1,PO-2,PO-3,PO-4,PO-5,PO-12)

3. Develop Shell programs with customization of environmental variables. (PO-1,PO-2,PO-3,PO-4,PO-5, PO-9, PO-10, PO-12)
4. Design a shell script for specific tasks using filters and pipes. (PO-1,PO-2,PO-3,PO-4,PO-5, PO-9, PO-10, PO-12)
5. Discuss the use of regular expression in various types of filtering (PO-1,PO-2,PO-3,PO-4,PO-5, PO-9, PO-10, PO-12)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) : 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1,CO2, and CO3
Internal Test-II CIE-II)	30	CO4, and CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1,CO2, and CO3
Assignment -I	10	CO4, and CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Assignment -I		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3 CO4 and CO5

PHYSICAL EDUCATION	
Course Code: PE83	**Credits: NCMC**
Pre – requisites: Nil	
Course Coordinator: Dr. Kiran Kumar H K	

Course Learning Objectives:

1. To introduce students to the importance of physical fitness for success in any career.
2. To instill in them concepts of team spirit and team building
3. To develop positive thinking, goal setting and decision-making abilities under duress.
4. To harness values and skills like leadership, communication and sacrifice.
5. To inculcate in students, the ability to handle success and failures with equanimity.

Selection Process: A Student shall select any one of the following Sports based on his/her interest and the facility available. The details **of Sports Facilities available (both indoor and outdoor) at institute campus** are as below:

Outdoor Games		**Indoor Games**		**Athletics**	
Games	**No. of Students**	**Games**	**No. of Students**	**Events**	**No. of Students**
Volleyball	12 x 4 = 48	**Badminton**	30	**Sprint** - 100mt, 200mt, 400mt	60
Basketball	12 x 4 = 48	**Table Tennis**	30	**Middle distance running** – 800mt, 1,500mt	
Kabaddi	12 x 4 = 48	**Chess**	30	**Long distance running** – 5,000mt, 10,000mt	
Kho Kho	12 x 4 = 48	**Weight Training [Gym]**	35	**Jumping Events** – Long Jump Triple Jump High Jump	30
Throw ball	12 x 4 = 48			**Throwing Events** Shot Put Discuss Javelin	30
Football	16 x 4 = 64	**Note: Students should bring their own sports attires**			
Hockey	16 x 4 = 64				
Cricket	16 x 4 = 64				

Contact Sessions: A student shall abide by the following during the sessions scheduled in the semester.

Session 1

Fundamentals of Physical Education, value addition to personality through fitness education, discipline and team building activities, Orientation towards particular sports and skill training

Session 2

Formation of teams based on student's orientation and preference. Team practice and skill enhancement.

Session 3

Conduction of matches in all sporting events registered by Students. Evaluation of each student shall be based on their performance either in team or individual. The student representing the Institute at University/State/National/International Level will be awarded additional marks during evaluation.

Course Outcomes (COs):

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

1. Develop interest and skill in playing particular sports.
2. Understand the process of organizing sporting events.
3. Appreciate the role of fitness for a better lifestyle.
4. Derive lessons from sports activities for effective planning and discipline in Life.
5. Analyze situations and optimize end results.

Course Assessment & Evaluation:

1. A committee consisting of Sports Director and Coaches of respective Sports will be formed to observe and evaluate the students for CIE in each semester.
2. Students shall follow the schedules, rules and regulations as prescribed by the Committee.
3. Students shall mandatorily have 85% attendance to be eligible for evaluation.
4. All the Sessions and evaluation process will be common for all semesters of the academic year.
5. The final result will be reflected on the grade card of 8^{th} Semester.
6. The final marks shall be calculated after scaling down CIE to 50 marks & combining with 50 marks for SEE.

YOGA	
Course Code: YO83	**Credits: NCMC**
Pre – requisites: Nil	
Course Coordinator: Dr. Hari Chandra B P & Dr. Parimala P	

Course Learning Objectives:

1. To introduce to the students, the fundamental theoretical aspects of yoga.
2. To inculcate in students a habit of practicing yoga.
3. To be able to demonstrate basic yoga asanas.
4. To be able to practice fundamental breathing practices and mudras.
5. To understand the relevance of yoga and research in modern times.

Course Content

Introduction: Definition of yoga, benefits, astangas of yoga, Relevance of yoga and yoga-research in modern times.
Asanas: Kriyathmakachalanas, Suryanamaskar, Superbrain yoga, Vrikshasana, Trikonasana, Veerabhadrasana, Paschimotasana, Purvothanasana, Bharadwajasana, Amruthasana, Parivruttha Trikonasana, Parsvakonasana, Ustrasana, Padmasana, Jaaanushirshasana, Navasana, Ardhachakrasana, Ardhakatichakrasana, Jataraparivarthanasana, Sethubandasana, Sarvangasana, Mathyasana, Dhanurasana, Shirshasana.
Pranayamas: Anuloma-Viloma, Suryanuloma, Chandranuloma, Brahmari, Suryanbedhana, Chandrabedhana, Sheetali, Seethkari, Sadantha, bastrika.
Mudras: Chinmudra-Jnanamudra, Praana mudra, panchaprana mudras, panchabhoota mudras, Pruthvi mudra, Shoonya mudra, Surya mudra, Jalodharanashaka mudra, Kundalini mudra, shoonyavaayu mudra, shakti mudra, sandhi mudra, vajra mudra and garuda mudra.

Course Outcomes (COs):

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

1. Understand the fundamental and theoretical aspects of yoga.
2. Develop a habit of practicing yoga.
3. Demonstrate basic yoga asanas.
4. Demonstrate fundamental breathing practices.
5. Understand the relevance of yoga and its research in modern times.

Reference Books:

1. Light on yoga, B K S Iyengar, Publisher -Thorsons, UK, 2006
2. Light on pranayama, B K S Iyengar, Publisher - Element; First Edition

3. The Essential Yoga Mudras for Healing, Dr. Aasoori K. Rangaraja Iyengar, Saranga Publishing; First Edition 2021

Pedagogy:

- Chalk and talk, demonstration, videos, ppt.

Contact Sessions:

There would be one introduction class, and five contact classes in each semester.
The candidates shall practice yoga on a daily basis, or in the worst case on alternate days at their place of residence and maintain a short diary in the format provided by yoga teacher. The same shall be brought to the classes.

Online Reference Sources:

- Yoga for beginners part 1: https://www.youtube.com/watch?v=VwPeThpwfWI
- Yoga for beginners part 2: https://www.youtube.com/watch?v=s_pnJTcOp8A
- Suryanamaskar: https://www.youtube.com/watch?v=nUdlucNd6go&t=133s
- Yoga for anxiety and stress: https://www.youtube.com/watch?v=hJbRpHZr_d0
- Common yoga protocol: https://www.youtube.com/watch?v=Av5ib_XRKT4
- Relevance of yoga in modern times: www.youtube.com/watch?v=HUzBCts7BTo

Course Assessment & Evaluation:

1. A committee consisting of Yoga Instructors will be formed to observe and evaluate the students for CIE in each semester.
2. Students shall follow the schedules, rules, and regulations as prescribed by the Committee.
3. Students shall mandatorily have 85% attendance to be eligible for evaluation.
4. All the Sessions and evaluation processes will be common for all semesters of the academic year.
5. The final result will be reflected on the grade card of 8th Semester.
6. The final marks shall be calculated after scaling down CIE to 50 marks & combining it with 50 marks for SEE.

Scheme of SEE:

Practical Demonstration	30 marks
Write-up	10 marks
Viva	10 marks
Total	**50 marks**

NATIONAL SERVICE SCHEME	
Course Code: NS83	**Credits: NCMC**
Pre – requisites: Nil	
Course Coordinator: Dr. Puttabore Gowda & Dr. Siddaraju C	

Course Learning Objectives:

1. To introduce students to the importance of national service
2. To harness values and skills like leadership, teamwork and sacrifice.
3. To serve society through educational services and health
4. To work towards rural and local development through technological services
5. To inculcate in students, the ability to handle socially relevant projects.

Students shall involve in activities related to national and regional technical and non-technical services, as listed below.

- Serving society by bringing awareness on education and cleanliness.
- Blood donation camps
- Developing technologies for rural masses.
- Conduction and participation in camps for a social cause.
- Educating towards health and well-being of individuals/society.
- Cultural and educational programs for society.
- Contributing towards the improvement of civil services and bringing certain shortcomings to the notice of higher authorities for suitable remedial actions.
- Contribution towards traffic management and other public services.
- Clean up and development of water sources around public places.
- Services during a disaster or other needy situations.
- Camps for the rejuvenation of lakes and water bodies.
- Serving nature and agriculture.
- Awareness programs on health and food adulteration.
- Presenting papers/talks in various fora on the above topics.
- Developing technologies for rural masses beyond academic requirements.
- Plantation programs.
- Conducting programs for self-sustainability, and human and national development.
- Contribution towards orphans and challenged individuals through well-recognized organizations.
- Carrying out designated activities in villages.

- Development and implementation of strategies for solid waste, E-waste etc.
- Education towards pollution control and traffic management.
- Production of documentaries and short films/videos for motivating people on any of the above causes.

Course Outcomes (COs):

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

1. Understand the importance of national service.
2. Gain skills like leadership and teamwork.
3. Volunteer towards educational services and health.
4. Contribute to rural and local development through technical services.
5. Comprehend socially relevant projects

Contact Sessions:

The students shall attend the review and contact sessions as scheduled by the course coordinator.

Course Assessment & Evaluation:

1. The candidates shall maintain a record of activities in a Diary, and get them endorsed during the contact sessions at least 3 times in a semester.
2. A detailed project report should be submitted during the last fortnight of the semester
3. Evaluation will be done during each semester based on the nature of the contribution.
4. The final marks shall be calculated after scaling down CIE to 50 marks & combining with 50 marks for SEE

ADDITIONAL MATHEMATICS - I	
Course Code: AM31	**Credits: 0:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Shashi Prabha Gogate S	

Course Content

Unit I

Differential Calculus: Successive differentiation, nth derivatives of some standard functions, Leibnitz theorem, Polar curves. Angle between the radius vector and the tangent, angle between curves, length of the perpendicular from pole to the tangent, pedal equations. Taylor's and Maclaurin's expansions.

- Pedagogy/Course delivery tools: Chalk and Talk
- Links: https://nptel.ac.in/courses/111/105/111105121/ https://nptel.ac.in/courses/111/104/111104144/
- Impartus recording: https://a.impartus.com/ilc/#/course/107625/1030

Unit II

Integral Calculus: Introduction, Reduction formula, Reduction formula for $\int Sin^n x\ dx$, $\int Cos^n x\ dx$ and $\int Sin^n x\ Cos^m x\ dx$. Evaluation of double and triple integrals.

- Pedagogy/Course delivery tools: Chalk and Talk
- Links: https://nptel.ac.in/courses/111/105/111105121/
- https://a.impartus.com/ilc/#/course/107625/1030

Unit III

Vector Algebra: Scalar and vectors. Vector addition and subtraction. Multiplication of vectors (Dot and Cross products). Scalar and vector triple product-simple problems. Vector functions of a single variable. Derivative of a vector function, geometrical interpretation. Velocity and acceleration.

- Pedagogy/Course delivery tools: Chalk and Talk
- Links: https://nptel.ac.in/courses/111/105/111105134
- Impartus recording: https://a.impartus.com/ilc/#/course/107625/1030

Unit IV

Vector Differentiation: Scalar and vector fields, gradient of a scalar field, directional derivative, divergence of a vector field, solenoidal vector, curl of avector field,

irrotational vector. Laplace's operator. Vector identities connected with gradient, divergence and curl.

- Pedagogy/Course delivery tools: Chalk and Talk
- Links: https://nptel.ac.in/courses/111/105/111105134
- Impartus recording: https://a.impartus.com/ilc/#/course/107625/1030

Unit V

First Order Differential Equations: Solution of first order and first degree differential equations, variable separable methods, homogeneous equations, linear and Bernoulli's equations, exact differential equations.

- Pedagogy/Course delivery tools: Chalk and talk, Power Point Presentation
- Links: https://nptel.ac.in/courses/111/105/111105121/
- Impartus recording: https://a.impartus.com/ilc/#/course/59742/295

Text Books:

1. **B.S. Grewal** – Higher Engineering Mathematics, Khanna Publishers, 44th edition, 2017.
2. **Erwin Kreyszig** – Advanced Engineering Mathematics – Wiley Publication, 10th Edition, 2015.

Reference Books:

1. **H. K. Dass** – Higher Engineering Mathematics – S Chand Publications, 1998.
2. **V. Ramana** – Engineering Mathematics – Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008.

Course Outcomes (COs):

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

1. Solve problems related to nth derivative to some standard functions, polar curves and power series expansions.
2. Apply the concept of reduction formula to determine the length, area, volume of revolution of an arc of the curve.
3. Solve the problems related to velocity and acceleration.
4. Apply vector differentiation to identify solenoidal and irrotational vectors.
5. Apply the concept of various methods to solve first order first degree differential equations.

IV SEMESTER

NUMERICAL TECHNIQUES AND PROBABILITY MODELS	
Course Code: CS41	**Credits: 2:1:0**
Pre – requisites: Calculus and Basic Probability	**Contact Hours: 28L+14T**
Course Coordinator: Dr. Govindaraju M V and Dr. R Suresh Babu	

Course Content

Unit I

Finite Differences and Interpolation: Forward and backward differences, Interpolation, Newton-Gregory forward and backward interpolation formulae, Lagrange's interpolation formula and Newton's divided difference interpolation formula (no proof).

Numerical Differentiation and Numerical Integration: Derivatives using Newton-Gregory forward and backward interpolation formulae, Newton-Cotes Quadrature formula, Trapezoidal rule, Simpson's $1/3^{rd}$ rule and Simpson's $3/8^{th}$ rule.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105134/ https://nptel.ac.in/courses/111/106/111106101/
- Impartus recording: https://a.impartus.com/ilc/#/course/96127/452 https://a.impartus.com/ilc/#/course/132243/636 https://a.impartus.com/ilc/#/course/119635/59

Unit II

Statistics: Curve fitting by the method of least squares, fitting linear, quadratic and geometric curves, Correlation, Regression and Multiple Regression.

Discrete Probability Distributions: Random Variables, Binomial distribution, Poisson distribution

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105035/
- Impartus recording: https://a.impartus.com/ilc/#/course/96127/452 https://a.impartus.com/ilc/#/course/132243/636 https://a.impartus.com/ilc/#/course/119635/593

Unit III

Continuous Probability Distributions: Uniform distribution, Exponential distribution, Gamma distribution and Normal distribution.

Joint probability distribution: Joint probability distribution (both discrete and continuous), Conditional probability, Conditional expectation.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105035/ https://nptel.ac.in/courses/111/107/111107119/
- Impartus recording: https://a.impartus.com/ilc/#/course/96127/452 https://a.impartus.com/ilc/#/course/119635/593

Unit IV

Markov Chain: Introduction to Stochastic Process, Probability Vectors, Stochastic matrices, Regular stochastic matrices, Markov chains, Higher transition probabilities, Stationary distribution of Regular Markov chains and absorbing states, Markov and Poisson processes.

Queuing theory: Introduction, Symbolic representation of a queuing model, Single server Poisson queuing model with infinite capacity (M/M/1 : ∞ /FIFO), when $\lambda_n = \lambda$ and $\mu_n = \mu$ $(\lambda < \mu)$, Performance measures of the model, Single server Poisson queuing model with finite capacity (M/M/S : N/FIFO), Performance measures of the model, Multiple server Poisson queuing model with infinite capacity (M/M/S : ∞ /FIFO), when $\lambda_n = \lambda$ for all n, $(\lambda < S\mu)$, Multiple server Poisson queuing model with finite capacity (M/M/S : N/FIFO), Introduction to M/G/1 queuing model.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111103022
- Impartus recording: https://a.impartus.com/ilc/#/course/96127/452 https://a.impartus.com/ilc/#/course/119635/593

Unit V

Sampling and Statistical Inference: Sampling distributions, Concepts of standard error and confidence interval, Central Limit Theorem, Type I and Type II errors, Level of significance, One tailed and two tailed tests, Z-test: for single mean, for single proportion, for difference between means, Student's t –test: for single mean, for difference between two means, F – test: for equality of two variances, Chi-square test: for goodness of fit, for independence of attributes.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/111/105/111105035/
  https://nptel.ac.in/courses/111/107/111107119/

Text Books:

1. R.E. Walpole, R. H. Myers, R. S. L. Myers and K. Ye – Probability and Statistics for Engineers and Scientists – Pearson Education – Delhi – 9th edition – 2012.
2. B.S. Grewal - Higher Engineering Mathematics - Khanna Publishers – 44th edition-2017.
3. T. Veerarajan- Probability, Statistics and Random processes – Tata McGraw-Hill Education – 3rd edition -2017.

Reference Books:

1. Erwin Kreyszig - Advanced Engineering Mathematics-Wiley-India publishers-10th edition-2015.
2. Sheldon M. Ross – Probability models for Computer Science – Academic Press, Elsevier– 2009.
3. Murray R Spiegel, John Schiller & R. Alu Srinivasan – Probability and Statistics – Schaum's outlines -4th edition-2012.
4. Kishore S. Trivedi – Probability & Statistics with Reliability, Queuing and Computer Science Applications – John Wiley & Sons – 2nd edition – 2008.
5. Johnson/Miller: Miller & Freund's Probability and Statistics for Engineers, Eighth Edition, Pearson Education India -2015

Course Outcomes (COs):

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

1. Find functional values, derivatives, areas and volumes numerically from a given data. (PO-1, PO-2, PSO-2, PSO-3)
2. Fit a least squares curve to the given data and analyze the given random data and its Probability distributions. (PO-1, PO-2, PSO-2, PSO-3)
3. Find parameters of Continuous Probability distributions and calculate the marginal and conditional distributions of bivariate random variables. (PO-1, 2 & PSO-2, 3)
4. Predict future events using Markov chain and in queuing models. (PO-1, PO-2, PSO-2, PSO-3)
5. Choose an appropriate test of significance and make inference about the population from a sample. (PO-1, PO-2, PSO-2, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 marks		
Assessment Tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO1, CO2, CO3
Internal test-II	30	CO3, CO4, CO5
Average of the two internal tests shall be taken for 30 marks.		
Other components		
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination (SEE)	100	CO1, CO2, CO3, CO4, CO5

MICROCONTOLLERS & IOT	
Course Code: CS42	**Credits: 3:0:1**
Pre – requisites: Electronics	**Contact Hours: 42L+14P**
Course Coordinator: Veena G S	

Course Content

Unit I

Introduction to Microcontrollers and IOT

Introduction to Cortex M0: General discussion on Microcontrollers, Cortex-M0 Technical Overview, System Features, implementation Features, Debug Features, Programming model, Operation Modes and States, Architecture, Registers and Special Registers Behaviors of the Application Program Status Register (APSR), Memory System Overview. Introduction to Cortex-M0 Programming, Stack memory operation.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Introduction to keil software, Use of simulation

Unit II

Instruction Set: Cortex M0

Instruction Set: Instruction Set, Instruction Usage Examples, implementation of various structures like loop, switch, functions, and subroutines. Memory System, Exceptions and Interrupts.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Lab Component / Practical Topics: Introduction to keil software, Use of simulation

Unit III

Smart Objects

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Workflow of a Sensor in a typical system, Classification of Sensors, Sampling DAC and ADC conversion. Introduction to Actuators: Workflow of an Actuator in a typical system, Classification of Actuators. Types of Sensors.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs53/
- Lab Component / Practical Topics: C-Programming-One and Two-dimensional arrays, character arrays, and strings

Unit IV

IoT Network and Transport layer handling

IoT Access Technologies. IP as the IoT Network Layer, The Business Case for IP, The need for Optimization Low Bandwidth Wireless Networks: FSK, LoRa modulation basics, LoRaWAN basics. Optimizing IP for IoT: HTTP, AMQP, MQTT and STOMP.

- Pedagogy / Course delivery tools: Power point presentation, Demo of Sensor and actuator utility.
- Links: https://onlinecourses.nptel.ac.in/noc22_cs53/
- Lab Component / Practical Topics: Use of Node MCU and NodeRed

Unit V

Programming IoT Physical Devices and Endpoints

Programming IoT Physical Devices and Endpoints – Raspberry Pi: Introduction to Raspberry Pi, About the Raspberry Pi Board: Hardware Layout, Operating Systems on Raspberry Pi, Configuring Raspberry Pi, Programming Raspberry Pi with Python, Connecting Raspberry Pi via SSH, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.

- Pedagogy / Course delivery tools: Power point presentation, Demo using Raspberry pi board and sensors
- Links: https://onlinecourses.nptel.ac.in/noc22_cs53/
- Lab Component / Practical Topics: Usage of raspberry pi with MQTT, HTTP, Ethernet and Wi-Fi for IoT Projects

Laboratory Experiments
(Each Session is of 2 Hours Duration/Week)

Session No.	Topics Covered
1.	Study of simple GPIO programs to use the ports.
2.	Study of simple GPIO programs to use the ports.
3.	Study use of interrupts and peripherals like LCD 16x2.
4.	Study use of interrupts and peripherals like Keyboard
5.	Study of ADC programs Keyboard, seven segments.
6.	Study of ADC programs and graphical LCD 128x64.
7.	Study use of PWM
8.	Study of Rasberry Pi features and program to light led using GPIO
9.	Study of Rasberry Pi with SSH
10.	Study use of Timer with interrupt
11.	Study of Node MCU wireless features.
12.	Study of Node MCU wireless features
13.	Project IOT/ECS
14.	Project IOT/ECS

Suggested Learning Resources

Text Books:

1. Joseph Yiu, "The Definitive Guide to the ARMCortex-M0",1st edition, Newnes – an imprintt of Elsevier, 2011.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN:978-8173719547)
3. Srinivasa K G, Siddesh G.M and Hanumantha Raju R ―Internet of Things, CENGAGE Leaning India, 2017. (ISBN:978-93-868-5895-5).

Reference Books:

1. Designing the Internet of Things by Adrian McEwen Smart Cities, Software above the level of a single device, Ebooks on IoT by O'Reilly
2. Sentilo middlewarehttp://www.sentilo.io/xwiki/bin/view/Sentilo.About.Product/Whatis
3. Mosquitto broker https://mosquitto.org/
4. Getting started with raspberry pihttps://www.raspberrypi.org/resources/learn/
5. Wired peripheral protocolshttp://www.comm.pub.ro/dicm/C7_Serial_Bus.pdf
6. LoRa Modulationhttp://www.semtech.com/images/datasheet/an1200.22.pdf

Course Outcomes (COs):

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

1. Evaluate microcontroller architecture, (cortexM0 Overview), evaluate operation Modes and States using special purpose registers. (PO-1, PO-2, PO-3, PO-4, PSO-1)
2. Evaluate cortex M0 in assembly instructions and be able program in assembly level programs using CMSIS features. (PO-3, PO-4, PO-5, PO-12, PSO-2)
3. Compare and contrast the deployment of smart objects and the technologies to connect them to network. (PO-3, PO-4, PO-5, PO-12, PSO-2)
4. Use of Various network and application protocols for IoT (PO-3, PO-4, PO-5, PO-12, PSO-2)
5. Developing a perspective for IoT Applications in various domains. (PO-3, PO-4, PO-5, PO-12, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Laboratory Test and Laboratory datasheet evaluation	10	CO1, CO2, CO3
Quiz	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Laboratory Test +Marks scored in Quiz		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

DESIGN AND ANALYSIS OF ALGORITHMS	
Course Code: CS43	**Credits: 3:0:0**
Pre – requisites: Data Structures & Programming Language	**Contact Hours: 42L**
Course Coordinator: Pradeep Kumar	

Course Content

Unit I

Introduction and Basics of algorithm analysis

Introduction: Some Representative Problems. A First Problem: Stable Matching, Five Representative Problems. **Basics of Algorithm Analysis**: Computational Tractability, Asymptotic Order of Growth, Implementing the Stable Matching Algorithm Using Lists and Arrays, A Survey of Common Running Times. (T1: Chapter 1 & 2). Mathematical Analysis of Non-recursive and Recursive Algorithms. (T2: Chapter 2)

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106106131
- Lab Component / Practical Topics: Asymptotic notation, computing running time of the algorithms

Unit II

Graphs & Divide and Conquer

Graphs: Graph Connectivity and Graph Traversal: Breadth-First Search, Exploring a Connected Component, Depth-First Search, Implementing Graph Traversal Using Queues and Stacks, Testing Bipartiteness: An Application of Breadth-First Search, Connectivity in Directed Graphs, Directed Acyclic Graphs and Topological Ordering (T1: Chapter3).

Divide and Conquer: A First Recurrence: The Merge sort Algorithm, Counting Inversions (T1: Chapter 5), Quick sort (T2: Chapter 5).

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106106131
- Lab Component / Practical Topics: Programs on BFS, DFS, Merge sort, Counting inversion, Quicksort

Unit III
Greedy Algorithms

Greedy Algorithms: Interval Scheduling: The Greedy Algorithm Stays Ahead, Scheduling to Minimize Lateness: An Exchange Argument, Optimal Caching: A more Complex Exchange Argument, Shortest Paths in a Graph, The Minimum Spanning Tree Problem, Prims & Kruskal algorithms, Huffman Codes and Data Compression (T1: Chapter4).

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106106131
- Lab Component / Practical Topics: Programs on Prims, Kruskal, Dijkstra's algorithms

Unit IV
Dynamic Programming

Dynamic Programming: Weighted Interval Scheduling: A Recursive Procedure: Designing a Recursive Algorithm, Subset Sums and Knapsacks: Adding a Variable: The Problem, Designing the Algorithm, Shortest Paths in a Graph: The Problem, Designing the Algorithm, The Maximum-Flow Problem and the Ford-Fulkerson Algorithm: The problem, Designing the Algorithm, Survey Design: The problem, Designing the Algorithm, Analyzing the Algorithm, Airline Scheduling: The problem, Designing the Algorithm, Analyzing the Algorithm (T1: Chapter 6 & 7).

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106106131
- Lab Component / Practical Topics: Programs on Weighted interval scheduling, Knapsack, Subset sum and Belman ford algorithm

Unit V
NP and Computational Intractability

NP and Computational Intractability: Polynomial-Time Reductions A First Reduction: Independent Set and Vertex Cover, Reducing to a More General Case: Vertex Cover to Set Cover, NP-Complete Problems: Circuit Satisfiability: A First NP-Complete Problem, General Strategy for Proving New Problems NP-Complete, Sequencing Problems: The Traveling Salesman Problem, The Hamiltonian Cycle Problem (T1: Chapter 8). Backtracking: n-Queens Problem (T2: Chapter 12)

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106106131
- Lab Component / Practical Topics: Programs on Traveling salesman problem and n-Queens problem

Text Books:

1. Jon Kleinberg and Eva Tardos: Algorithm Design, Pearson, 1st Edition (2013).
2. Anany Levitin: Introduction to the Design & Analysis of Algorithms, 3rd Edition, Pearson Education, 2012. ISBN:9780132316811

Reference Book:

1. Ellis Horowitz, Sartaj Sahni and S Rajasekaran: Fundamentals of Computer Algorithms, 2nd Edition, Universities Press, 2017. ISBN: 9788173716126

Video Lectures (e-Resources):

1. https://a.impartus.com/ilc/#/course/270273/452

Course Outcomes (COs):

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

1. Define the basic concepts and analyze worst-case running times of algorithms using asymptotic analysis. (PO- 1, PO-2, PO-3, PO-4, PO-12, PSO-2)
2. Illustrate the design techniques for graph traversal and analyze their complexity. (PO-1, PO-2, PO-3, PO-4, PO-12, PSO-2)
3. Illustrate the design techniques for divide and conquer algorithms and analyze their complexity by solving recurrence relations. (PO-1, PO-2, PO-3, PO-4, PO-12, PSO-2)
4. Illustrate Greedy paradigm and Dynamic programming paradigm using representative algorithms. (PO-1, PO-2, PO-3, PO-4, PO-12, PSO-2)
5. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete and examine the techniques of proof by contradiction, mathematical induction and recurrence relation, and apply them to prove the correctness of the algorithms. (PO-1, PO-2, PO-3, PO-4, PO-12, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1, CO2, CO3
Quiz -II	10	CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Quiz-II		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit- Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

DATA COMMUNICATION AND NETWORKING	
Course Code: CS44	**Credits: 3:0:0**
Pre – requisites: Nil	**Contact Hours: 42L**
Course Coordinator: Dr. Shilpa Chaudhari	

Course Content

Unit I

Data Communications, Networks, Network Types, Network Models: TCP/IP Protocol Suite, The OSI Model.

Application Layer: The Web and HTTP: Overview of HTTP, Non-Persistent and Persistent Connections, HTTP Message Format, User-Server Interaction-Cookies, Web Caching, The Conditional GET. File Transfer- FTP: FTP Commands and Replies, Electronic Mail in the Internet: SMTP, Comparison with HTTP, Mail Access Protocols. DNS—The Internet's Directory Service: Services Provided by DNS, Overview of How DNS Works, DNS Records and Messages, Peer-to Peer Applications: P2P File Distribution.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105082
- Lab Component / Practical Topics: Wireshark Exercise on HTTP

Unit II

Transport layer: Multiplexing and Demultiplexing, Connectionless Transport-UDP: UDP Segment Structure, UDP Checksum, Go-Back-N, Selective Repeat, Connection-Oriented Transport-TCP: The TCP Connection, TCP Segment Structure, Round-Trip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, TCP congestion control.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://nptel.ac.in/courses/106105082
- Lab Component / Practical Topics: Socket Programming

Unit III

Network Layer: Internet Protocol Version 4: IPv4 Addressing, Main and Auxiliary protocols,

Routing Algorithms: Distance-Vector (DV) Routing, Link-State Routing, Unicast Routing Protocols: Internet Structure, Routing Information Protocol, Open Shortest Path First.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_ee61/preview
- Lab Component / Practical Topics: Wireshark Exercise on IP, ICMP, DHCP

Unit IV

Data-Link Control: Framing: Character-Oriented Framing, Bit-Oriented Framing. Error Control: Types of Errors, Block Coding: Error Detection, Hamming Distance, Linear Block Codes: Parity-Check Code. Cyclic Codes: Cyclic Redundancy Check, Point-to-Point Protocol, Media Access Control – Random Access- CSMA, CSMA/CD, CSMA/CA, Controlled access.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_ee61/preview
- Lab Component / Practical Topics: Error detection and correction using CRC and Hamming Code.

Unit V

Local Area Network: Ethernet: Standard Ethernet, WIFI, IEEE 802.11 project-architecture, MAC sub layer, addressing mechanism.

Physical layer: Signals - Analog signals, Digital signals. Signal Impairment - Attenuation and Amplification, Distortion, Data Rate Limits, Performance. Digital Transmission - Digital-to-Digital Conversion, Analog-to-Digital Conversion. Analog Transmission- Digital-to-Analog Conversion, Analog-to-Analog Conversion. Multiplexing: Frequency-Division Multiplexing, Time-Division Multiplexing.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation, Videos.
- Links: https://onlinecourses.nptel.ac.in/noc22_ee61/preview
- Lab Component / Practical Topics: Multiplexing concepts.

Suggested Learning Resources

Text Books:

1. Data Communications and Networking with TCP/IP Protocol Suite, Behrouz A. Forouzan, McGraw Hill, 6th Edition, 2021.
2. James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach, 8th edition, Addison-Wesley, 2021.

Reference Books:

1. Data and Computer Communication, William Stallings, 10th Edition, Pearson Education, 2017.
2. Larry L. Peterson and Bruce S Davie: Computer Networks: A Systems Approach, Fifth Edition, Elsevier, 2011.
3. Tanenbaum: Computer Networks, 4th Ed, Pearson Education/PHI, 2018.

Video Lectures (e-Resources):

- https://a.impartus.com/ilc/#/course/132166/636

Course Outcomes (COs):

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

1. Describe the fundamentals of data communications and various application layer protocols used by TCP/IP reference model. (PO-1, PO-2, PO-3, PO-4, PO-10, PSO-1)
2. Differentiate between connection oriented and connection less services of transport layer (PO-1, PO-2, PO-3, PO-4, PO-10, PSO-1)
3. Solve problems of IP addressing and routing using various routing protocols and algorithms. (PO-1, PO-2, PO-3, PO-4, PO-10, PSO-1)
4. Illustrate error control and media access control protocols of data link layer (PO-1, PO-2, PO-3, PO-4, PO-10, PSO-1)
5. Discuss different types of data transmission techniques. (PO-1, PO-2, PO-3, PO-4, PO-10, PSO-1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1, CO2, CO3
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1, CO2
Assignment	10	CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Assignment		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

FINITE AUTOMATA AND FORMAL LANGUAGES	
Course Code: CS45	**Credits: 2:1:0**
Pre – requisites: Nil	**Contact Hours: 28L+14T**
Course Coordinator: Dr. Jayalakshmi DS	

Course Content

Unit I

Introduction to Finite Automata

Introduction to Finite Automata: Structural representations, automata and complexity, the central concepts of automata theory; deterministic finite automata, nondeterministic finite automata, an application of finite automata, finite automata with epsilon transitions.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation.
- Links: https://nptel.ac.in/courses/106105196

Unit II

Regular Expressions

Regular Expressions: Finite automata and regular expressions, applications of regular expressions, proving languages not to be regular, closure properties of regular languages, equivalence and minimization of automata.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation.
- Links: https://nptel.ac.in/courses/106105196

Unit III

Context–free grammars

Context–free grammars: Parse trees, applications, ambiguity in grammars and languages, definition of the pushdown automata, the languages of a PDA, Equivalence of PDA's and CFG's: CFG for PDA

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation.
- Links: https://nptel.ac.in/courses/106105196

Unit IV

Deterministic Pushdown Automata

Deterministic Pushdown Automata: Normal forms for CFGs-eliminating useless symbols, eliminating eplison - production, eliminating unit production, Chomsky Normal form, the pumping lemma for CFGs, Closure properties of CFLs

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation.
- Links: https://nptel.ac.in/courses/106105196

Unit IV
Turing Machine

The Turing machine: Notation for Turing Machine, Instantaneous Description for Turing Machine, Transition Diagrams of a Turing Machine, The Language of a Turing Machine, Turing Machines and Halting, Programming techniques for Turing Machines. Extensions to the basic Turing machine.

- Pedagogy / Course delivery tools: Chalk and talk, Power point presentation.
- Links: https://nptel.ac.in/courses/106105196

Tutorial Sessions
(Each Session is of 2 Hours Duration/Week)

Session No.	Topics Covered
1.	Problems on Deterministic Finite Automata
2.	Problems on Non- deterministic Finite Automata
3.	Problems on Conversion from NFA to DFA
4.	Problems on Regular expressions, conversion from RE to FA
5.	Problems on Conversion from FA to RE
6.	Problems on Equivalence and minimization of Automata
7.	Problems on CFG, parse trees, and ambiguity in CFG
8.	Problems on Push down automata
9.	Problems on Conversion from PDA to CFG
10.	Problems on Deterministic PDA
11.	Problems on Chomsky normal form for CFG
12.	Problems on Turing Machines
13.	Problems on Turing Machines variants
14.	Revision

Suggested Learning Resources

Text Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman: Introduction to Automata Theory, Languages and Computation, 3rd Edition, Pearson Education, 2011.

Reference Books:

1. John C Martin: Introduction to Languages and Automata Theory, 3rd Edition, Tata McGraw-Hill, 2007.
2. Michael Sipser: Introduction to the Theory of Computation, 3rd Edition, Thompson Course Technology, Boston, MA and Cengage Learning India Pvt.Ltd., 2014.

Video Lectures (e-Resources):

1. https://a.impartus.com/ilc/#/course/81462/295

Course Outcomes (COs):

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

1. Demonstrate the principal and construction of various representation of regular languages including finite automata and egular expressions. (PO-1, PO-2, PO-3, PSO-2)
2. Prove the various closure and decision properties of regular languages. (PO-1, PO-2, PSO-2)
3. Write CFGs and PDAs Corresponding to CFLS and demonstrate the irequivalence. (PO-1, PO-2, PO-3, POS-2)Prove the various closure and decision properties of CFLs. (PO-1, PO-2, PSO-2)
4. Demonstrate the principles and construction of Turing Machine and it's variants. (PO-1, PO-2, PO-3, PSO-2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1, CO2
Internal Test-II CIE-II)	30	CO3, CO4, CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1, CO2
Quiz -II	10	CO3, CO4, CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Quiz-II		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4, CO5

DESIGN AND ANALYSIS OF ALGORITHMS LAB	
Course Code: CSL46	**Credits: 0:0:1**
Pre – requisites: Data Structures & Java Programming	**Contact Hours: 14P**
Course Coordinator: Pradeep Kumar	

Course Contents

Sl. No.	Topics Covered
1.	Asymptotic bounds and functions
2.	Sorting and searching algorithms with Brute Force technique
3.	Stable matching algorithm
4.	Breadth first search
5.	Depth first search
6.	Merge sort algorithm
7.	Counting inversion algorithm
8.	Quick sort algorithm
9.	Prim's and Kruskal algorithm
10.	Dijkstra's algorithm
11.	Weighted interval scheduling with Dynamic Programming approach
12.	Knapsack problem & Subset sum problem
13.	Belman Ford algorithm
14.	Branch and Bound Techniques

Suggested Learning Resources

Reference Books/ Web Links:

1. Algorithm Design - Jon Kleinberg and Eva Tardos, Pearson, 1st Edition (2013).
2. Anany Levitin: Introduction to the Design & Analysis of Algorithms, 3rd Edition, Pearson Education, 2012. ISBN:9780132316811

Course Outcomes (COs):

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

1. Define the basic concepts and analyze worst-case running times of algorithms using asymptotic analysis. (PO-1, PO-4, PO-10, PSO-2)
2. Recognize the design techniques for graph traversal, divide and conquer, greedy and dynamic programming paradigm using representative algorithms. (PO-1, PO-2, PO-3, PO-5, PO-7, PO-9, PO-10, PSO-3)
3. Illustrate Branch and bound paradigm through NP complete problems. (PO-1, PO-3, PO-4, PO-10, PO-12, PSO-2, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation-Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)		
Course End Examination (One full question from the Lab Question Bank, Programs will be coded using C and executed)	50	CO1, CO2, CO3

DATA COMMUNICATION AND NETWORKING LABORATORY	
Course Code: CSL47	**Credits: 0:0:1**
Pre – requisites: Data Communication and Networking Course	**Contact Hours: 14P**
Course Coordinator: Dr. Shilpa Chaudhari	

Course Contents

Sl. No.	Topics Covered
	Cycle I
1.	Trace Hypertext Transfer Protocol using packet sniffer and packet analyser.
2.	Trace Domain Name Server using packet sniffer and packet analyser.
3.	Trace Internet Protocol and Internet Control Message Protocol using packet sniffer and packet analyser.
4.	Trace Dynamic Host Configuration Protocol using packet sniffer and packet analyser.
5.	Write a program for error detection using CRC-CCITT (16-bits).
6.	Write a program to find the shortest path between vertices using bellman-ford algorithm.
7.	Write a program for congestion control using leaky bucket algorithm.
	Cycle II
8.	Using TCP/IP sockets, write a client – server program where the client send the file name and the server send back the contents of the requested file if present.
9.	Write a program for Time Division Multiplexing Simulator. Show how the time division multiplexing technique works.
10.	Design and simulate a wired network with duplex links between ‘n’ nodes with CDR over UDP. Set the queue size vary the bandwidth and find the number of packets dropped.
11.	Design and simulate a four node point-to-point network, and connect the links as follows: n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP agent between n1-n3. Apply relevant applications over TCP and UDP agents by changing the parameters and determine the number of packets sent by TCP/UDP.
12.	Design and simulate simple Extended Service Set with transmitting nodes in wireless LAN and determine the performance with respect to transmission of Packets.
13.	Design and simulate infrastructure less network, generate two traffic flows between nodes and analyse its performance.

14.	Design a wired network with 'n' nodes to observe the performance of two TCP variants (Reno and Tahoe). Simulate the designed network and observe the network performance.

Note: Each Lab Session is of two hours duration/week

Suggested Learning Resources

Reference Books/ Web Links:

1. James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach, 5th edition, Addison- Wesley, 2009.
2. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff: Unix Network programming, The sockets networking API, Addison-Wesley Professional, 2004
3. Wireshark, "Wireshark", 2021 https://www.wireshark.org/
4. Ns-3, "ns-3manual," 2022 https://www.nsnam.org/docs/manual/html/index.html

Course Outcomes (COs):

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

1. Analyse the performance of various application layer protocols using packet sniffer and packet analyser. (PO-1, PO-2, PO-3, PO-4, PO-5, PSO-1)
2. Develop an understanding of computer networking basics using programming languages like C/C++/Java / Python. (PO-1, PO-2, PO-3, PO-4, PO-5, PSO-1)
3. Design and simulate the network scenarios using NS3. (PO-1, PO-2, PO-3, PO-4, PO-5, PSO-1)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes addressed**
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO2, CO3
Weekly Evaluation-Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)		
Course End Examination (One full question from the Lab Question Bank, Programs will be coded using C and executed)	50	CO1, CO2, CO3

DATA VISUALIZATION WITH PYTHON LAB	
Course Code: CSL48	**Credits: 0:0:1**
Pre – requisites: Nil	**Contact Hours: 14P**
Course Coordinator: Dr. Sushma	

Course Contents

Sl. No.	Topics Covered
1.	Python Basics
2.	Control Structures
3.	Functions
4.	Strings, lists, list comprehensions
5.	Tuples and Dictionaries
6.	Modules and packages
7.	Object Oriented Concepts
8.	Regular Expression
9.	Programs on File I/O, Exceptions
10.	Python for Data Science
11.	Numpy and Pandas
12.	Data wrangling Application working with time series data
13.	Data Visualization

Note: Each Lab Session is of two hours duration/week

Suggested Learning Resources

Reference Books/ Web Links:

1. Mark Lutz: Learning Python, 5th Edition, Orielly Publications 2013. ISBN978-1-4493-5573-9
2. John Zelle: Python Programming: An Introduction to Computer Science, 2nd Edition. 2009 ISBN 978-1-8879- 0299-1
3. Paul Barry, Head First Python, O'Reilly Publication, 2nd Edition 2016. ISBN978-1-4919-1953-8
4. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython by WesMcKinny, O'Reilly Media, 2nd Edition2017. ISBN978-9-3521-3641-4

Course Outcomes (COs):

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

1. Use internal and external Python libraries, data structures, functions inherent to Python in-order to handle data. (PO-1, PO-2, PO-3, PO-5 PSO-2, PSO-3)
2. Develop real-world applications using oops, files and exception handling provided by python (PO-1, PO-2, PO-3, PO-5 PSO-2, PSO-3)
3. Apply Python as a scripting language to analyze huge datasets, apply data science related statistics on datasets (PO-1, PO-2, PO-3, PO-5 PSO-2, PSO-3)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Lab Test-I	10	CO1, CO2
Lab Test-II	10	CO3
Weekly Evaluation-Lab Record	30	CO1, CO2, CO3
The Final CIE out of 50 Marks = Marks of Lab Record + Marks scored in Lab Test-I + Marks scored in Lab Test-II		
Semester End Examination (SEE)		
Course End Examination (One full question from the Lab Question Bank, Programs will be coded using C and executed)	50	CO1, CO2, CO3

DATA ANALYSIS USING R	
Course Code: CSAEC49	**Credits: 1:0:0**
Pre – requisites: Nil	**Contact Hours: 14L**
Course Coordinator: -	

Course Content

Unit I

Introduction to R programming: What is R? - Installing R and R Studio – R Studio Overview - Working in the Console - Arithmetic Operators - Logical Operations - Using Functions - Getting Help in R and Quitting R Studio- Installing and loading packages. Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics:https://cran.r-project.org/doc/contrib/Owen-TheRGuide.pdf

Unit II

Data Visualization using R: Scatter Plots - Box Plots - Scatter Plots and Boxand-Whisker Plots Together -Customize plot axes, labels, add legends, and add colours.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics:https://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/R/R-Manual/R-Manual2.html

Unit III

Descriptive statistics in R: Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group.

- Pedagogy/Course delivery tools:Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics: https://smac-group.github.io/ds/

Unit IV

Testing of Hypothesis using R: T-test, Paired Test, correlation, Chi Square test, Analysis of Variance and Correlation.

- Pedagogy/Course delivery tools:Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics:https://www.geeksforgeeks.org/predictive-analysis-in-rprogramming/#:~:text=Predictive%20analysis%20in%20R%20Language,are%20used%20in %20predictive%20analysis /

Unit V

Data querying: SQL and R: Writing SQL statements in R • Using the Select, From, Where, Is, Like, Order By, Limit, Max, Min SQL functions

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos
- Lab Component / PracticalTopics: https://www.geeksforgeeks.org/predictive-analysis-in rprogramming/#:~:text=Predictive%20analysis%20in%20R%20Language,are%20used%20in %20predictive%20analysis /

Suggested Learning Resources

Text Books:

1. Crawley, M. J. (2006), "Statistics - An introduction using R", John Wiley, London 32.
2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), "Statistics using R", second edition. Narosa Publishing House, New Delhi.
3. Shahababa B. (2011) , "Biostatistics with R", Springer, New York.
4. Braun & Murdoch (2007), "A first course in statistical programming with R", Cambridge University Press, New Delhi.

Course Outcomes (COs):

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

1. Apply R programming and understand different data sets
2. Apply R Programming and construct graphs and charts
3. Analyze the data and know descriptive statistics by using R Programming
4. Apply R Programming to test the hypothesis of the study
5. Apply R functions within SQL queries to enhance analytical capabilities.

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE) : 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1,CO2 and CO3
Internal Test-II CIE-II)	30	CO4 and CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1,CO2 and CO3
Assignment -I	10	CO4 and CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Assignment -I		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3, CO4 and CO5

INTRODUCTION TO ANGULARJS	
Course Code: CSAEC410	**Credits: 1:0:0**
Pre – requisites: Nil	**Contact Hours: 14L**
Course Coordinator: -	

Course Content

Unit I

Overview of AngularJS: Introduction to web technologies (HTML, CSS, JavaScript): Overview of client-server architecture, Basics of front-end and back-end development, Understanding the need for frameworks, Overview of AngularJS and its features, Setting up the development environment, Creating a basic AngularJS project.

- Pedagogy/Course delivery tools:Chalk and talk, Power point presentation,Videos

Unit II

Data Binding: Implementing data binding and expressions, working with controllers and scopes Interpolation (One-Way Binding): Syntax and usage of double curly braces {{ }}. Displaying variables and expressions in the view, **Two-Way Data Binding:** Understanding the [(ngModel)] syntax Bidirectional communication between the component and the view.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos

Unit III

Services and DI: Overview of the built-in AngularJS services, understanding services and dependency injection Creating custom services Implementing services in controllers using angular's $http and $resource services, Promises, Service registration and injection, using services to build a service, injecting services, Build: Create a twitter search service: Submit simple search, Set result size.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos

Unit IV

Templates and Routing: Linking and images,The routing API,PushState, hasbangs and SEO, Build: Using templates with iteration: Create a template for each tweet in the

list, Build: Using templates and routing for master/details navigation ,Create a details page for a tweet

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation,Videos

Unit V

Directives: Simple directives, Using templates, Working with controllers, Transclusion, Directive scope and isolate scope,Build: Tweet Directive: Add a timer that updates tweet time continuously, Add a marquee news ticker that can accept data from the incoming tweets, Bonus: Use D3 to chreat a chart of something

- Pedagogy/Course delivery tools:Chalk and talk, Power point presentation,Videos

Suggested Learning Resources

Text Books:

1. Crawley, M. J. (2006), "Statistics - An introduction using R", John Wiley, London 32.
2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), "Statistics using R", second edition. Narosa Publishing House, New Delhi.
3. Shahababa B. (2011) , "Biostatistics with R", Springer, New York.
4. Braun & Murdoch (2007), "A first course in statistical programming with R", Cambridge University Press, New Delhi.

Course Outcomes (COs):

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

1. Understand the fundamentals of web development and the role of AngularJS
2. Build a basic AngularJS application with data binding and controllers
3. Understand the role of services in AngularJS applications.
4. Implement dynamic routing based on user input or external data
5. Explore how directives enhance the functionality of HTML elements

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) : 50 Marks		
Assessment Tools	**Marks**	**Course Outcomes (COs) addressed**
Internal Test-I (CIE-I)	30	CO1,CO2 and CO3
Internal Test-II CIE-II)	30	CO4 and CO5
Average of the two CIE will be taken for 30 marks		
Other Components		
Quiz -I	10	CO1,CO2 and CO3
Assignment -I	10	CO4 and CO5
The Final CIE out of 50 Marks = Average of two CIE tests for 30 Marks+ Marks scored in Quiz-I +Marks scored in Assignment -I		
Semester End Examination (SEE)		
Course End Examination (Answer One full question from each Unit-Internal Choice)	100	CO1, CO2, CO3 ,CO4 and CO5

ADDITIONAL MATHEMATICS - II	
Course Code: AM41	**Credits: 0:0:0**
Pre – requisites: Nil	**Contact Hours: 42**
Course Coordinator: Dr. Veena B N	

Course Content

Unit I

Differential Calculus- I: Partial differentiation, Euler's theorem, total differential coefficient, differentiation of composite and implicit functions.

- Pedagogy/Course delivery tools: Chalk and talk
- Online tools: Use of open source software's to demonstrate methods and solve problems on interpolation
- Links: https://nptel.ac.in/courses/111/105/111105121/
- Impartus recording: https://a.impartus.com/ilc/#/course/107625/1030

Unit II

Differential Calculus- II: Jacobian and Properties. Taylor's theorem for function of two variables, maxima and minima for functions of two variables.

- Pedagogy/Course delivery tools: Chalk and talk
- Online tools: Use of open source software's to demonstrate methods and solve problems on numerical differentiation and integration.
- Links: https://nptel.ac.in/courses/111/105/111105121/
- Impartus recording: https://a.impartus.com/ilc/#/course/107625/1030
- https://a.impartus.com/ilc/#/course/59742/295

Unit III

Vector Integration: Line integrals, surface integrals and volume integrals. Green's theorem, Stokes' and Gauss divergence theorem (without proof) and problems, orthogonal curvilinear coordinates.

- Pedagogy/Course delivery tools: Chalk and talk
- Links: https://nptel.ac.in/courses/111/105/111105134/
- Impartus recording: https://a.impartus.com/ilc/#/course/619570/1030

Unit IV

Higher Order Differential Equations: Higher order linear differential equations, method of variation of parameters, Cauchy's and Legendre's homogeneous differential equations.

- Pedagogy/Course delivery tools: Chalk and talk
- Links: https://nptel.ac.in/courses/111/105/111105121/
- Impartus recording: https://a.impartus.com/ilc/#/course/96127/452
- https://a.impartus.com/ilc/#/course/59742/295

Unit V

Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability- illustrative examples. Bayes theorem – examples.

- Pedagogy/Course delivery tools: Chalk and talk
- Links: https://nptel.ac.in/courses/111/107/111107119/
- https://nptel.ac.in/courses/111/107/111107119/
- Impartus recording: https://a.impartus.com/ilc/#/course/283623/703

Text Books:

1. **B.S. Grewal** – Higher Engineering Mathematics, Khanna Publishers, 44th edition, 2017.
2. **Erwin Kreyszig** – Advanced Engineering Mathematics – Wiley Publication, 10th Edition, 2015.

Reference Books:

1. **H. K. Dass** – Higher Engineering Mathematics – S Chand Publications, 1998
2. **B. V. Ramana** – Engineering Mathematics – Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2008.

Course Outcomes (COs):

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

1. To carryout differentiation of function of several variables.
2. Solve the problems related to Jacobians, the extreme values of a function and Taylors series.
3. Exhibit the interdependence of line, surface and volume integrals using integral theorems.
4. Find the solution of second and higher order ODEs with constant and variable coefficients.
5. Solve the problems on conditional probability and Baye's theorem.