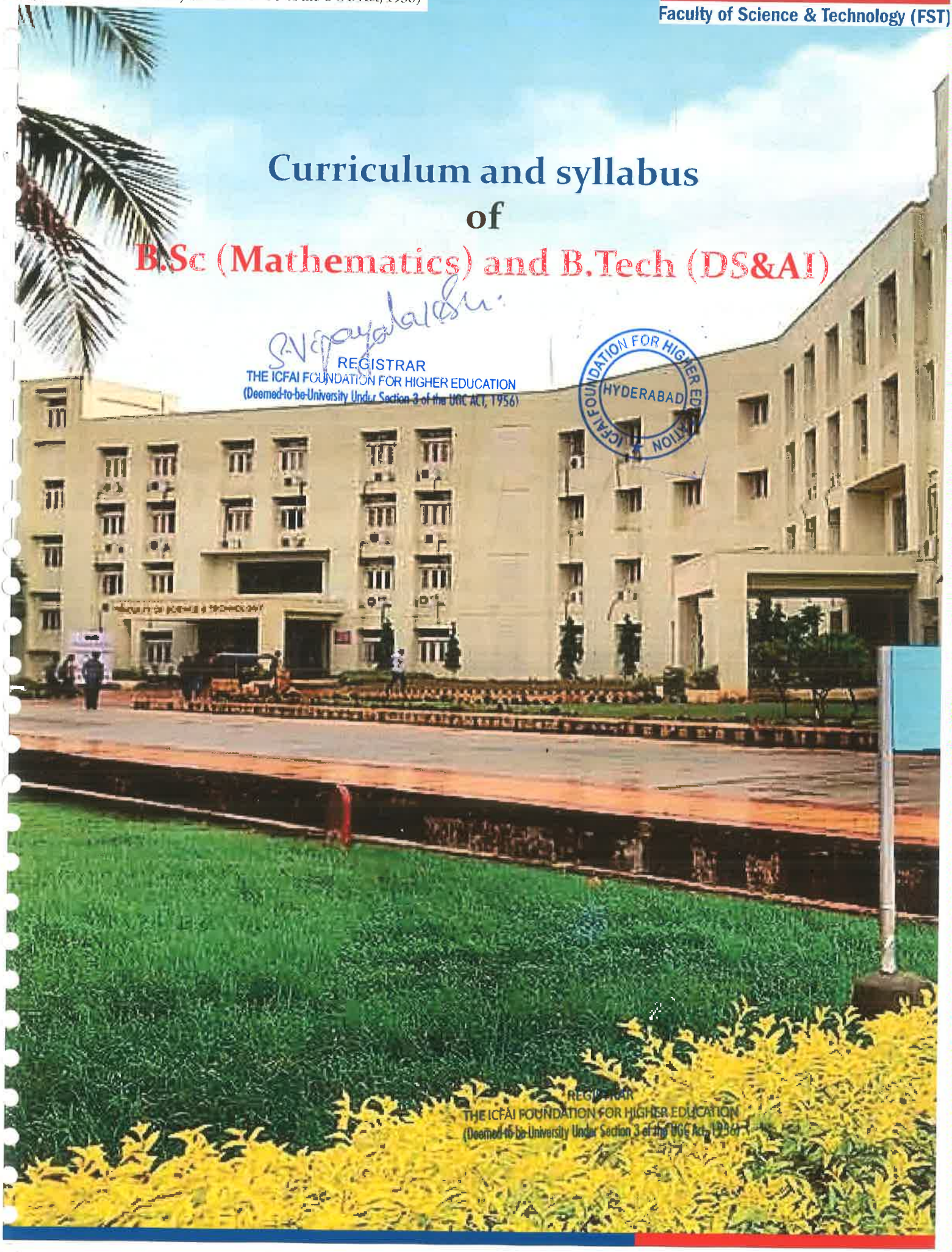
ICFAI Foundation for Higher Education
(Deemed-to-be University under Section 3 of the UGC Act, 1956)

IcfaiTech
Faculty of Science & Technology (FST)

Curriculum and syllabus
of
B.Sc (Mathematics) and B.Tech (DS&AI)



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REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University Under Section 3 of the UGC Act, 1956)

ICFAI FOUNDATION FOR HIGHER EDUCATION
HYDERABAD

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1. INTRODUCTION

1.1 The ICFAI Foundation for Higher Education

The ICFAI Foundation for Higher Education (IFHE) is declared as a Deemed-to-be University, under Section 3 of the UGC Act, 1956. It has evolved a comprehensive student-centric learning approach consisting of several stages, designed to add significant values to the learner's understanding in an integrated manner, covering relevant knowledge, practical skills and positive attitudes. IFHE comprises of:

- Faculty of Management (IBS Hyderabad),
- Faculty of Science and Technology (IcfaiTech), and
- Faculty of Law (FoL).

Vision and Mission of IFHE

The vision of IFHE is to be a top ranking University of choice for students, staff and corporates, recognized for excellence in Higher Education and Research especially relevant to social needs.

The mission of the Deemed University is to offer world class, innovative, career-oriented professional postgraduate and undergraduate programs through inclusive technology- aided pedagogies to equip students with the requisite professional and life skills as well as social sensitivity and high sense of ethics. The University will strive to create an intellectually stimulating environment for Research, particularly in areas bearing on the socio-economic and cultural development of the state and the nation.

1.2 Faculty of Science and Technology (IcfaiTech)

Faculty of Science and Technology (IcfaiTech), Hyderabad is a constituent of the ICFAI Foundation for Higher Education. It has been established to promote quality education in the field of Science andTechnology. IcfaiTech strives to acquire a reputation as a highly purposive, innovative institution setting the pace for workable reforms in professional education suitable and most relevant for the Indian cultural milieu.

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VISION

The IcfaiTech campus shall become a leading institute for scientific research as well as innovative teaching and learning, keeping pace with evolving knowledge domains. It shall emerge as an attractive destination for the excellent students and the faculties. IcfaiTech aspires to be highly ranked amongst the group of other peer institutes.

MISSION

The mission of the IcfaiTech is to provide high quality teaching and learning experience through our first degree and higher degree programs.

• Teaching Excellence: IcfaiTech periodically reviews and redesigns existing courses and introduces new courses and programs geared towards current research and industry. It explores new dimensions in teaching and learning and uses various platforms and methodologies.

• Research Excellence: The faculty members of the department carry out research in almost all the major areas. The department is now vigorously scaling up its research activity and giving more visibility to it. The volume of research publications in peer reviewed journals of repute and the research funding received by the department has been increasing steadily.

• Faculty Leadership in Administration: The faculty members of the department make significant contribution to administrative leadership and various institute activities and initiatives.

1.3 Educational Philosophy

The core philosophy of education at IcfaiTech is empowering students with the right knowledge and modern skill sets in order that they are ready to face the challenges of the competitive world. IcfaiTech strives to provide its students with the fine edge that is required in the making of a successful professional. The programs at IcfaiTech have been uniquely designed by including courses drawn from varied areas like humanities, arts, and management combined with science, engineering and industry-based internships. IcfaiTech ensures that students gain exposure and knowledge across different disciplines, develop inter-personal skills and leadership qualities that takes them beyond traditional thinking and practice. Today's era of globalization and integrated economies presents talented professionals huge opportunities

from across the world. The curriculum at IcfaiTech is truly global and modern in perspective and exposes its students to the latest practices and techniques. The curriculum offers a cafeteria approach allowing them to choose courses from across the disciplines. This exposure also helps them to develop interests in tune with the current inter-disciplinary nature of research. The educational philosophy practices at IcfaiTech allows it to integrate into its learning system, an innovative and emerging body of knowledge. The highlights of the academic program are summarized below:

• Cutting-edge course curriculum with contemporary and effective pedagogic methods that lay emphasis on application-oriented learning.

• Encouraging students to not only articulate Science and Technology needs but also provide appropriate solutions.

• Developing appreciation for synthesized multidisciplinary learning by way of workshops, internships and other group learning assignments.

1.4 Objectives of IcfaiTech

• To provide high quality, cutting-edge and career-oriented education programs in Science and Technology.

• To offer practice-oriented, contemporary and flexible programs developed through regular assessment and consultation with leading institutions, academicians, professionals and practitioners.

• To turn out highly motivated and successful Science and Technology graduates to meet the current and projected needs of the knowledge workforce.

1.5 Flexibilities

A few of the flexibilities available to the students are mentioned below. The principle of merit, preference of the students and the facilities available at the Institute generally guide the decisions regarding flexibilities. Transfer: Every year, various branches of engineering are ranked based on the preferences and demands of the admitted batch of students. After two semesters of study (end of the first year), students can seek transfer across branches. Requests from students seeking transfer from a less preferred branch to the most preferred branch of B.Tech would be considered if they maintain a CGPA of not less than 9.00, by the end of the first year of degree program. For a branch transfer to the second most preferred branch, a student should have a CGPA of not less than 7.00 by the end of the first year of degree

program. A branch transfer from a more preferred branch to a less preferred branch would be permitted without any restrictions on CGPA. Audit: Over the years of study at IcfaiTech, a student may develop interest in areas that go beyond the scope of his/her program of studies. IcfaiTech permits students to take such courses as audit courses. Certain courses like Foreign Languages, Music, etc. which are not the part of a degree program could be opted for on an audit basis, on payment of additional fees. Audit courses do not count for the CGPA calculation.

Other Flexibilities: The Academic Regulations also provide flexibilities like choice of electives, number of electives, repetition of courses, departure from normal pace, withdrawal from or substitution of course(s).

1.6 Admissios at IcfaiTech:

Admission Test for IcfaiTech (ATIT) is an All India Admission Test conducted by IcfaiTech, IFHE, Hyderabad for students seeking admission into the 4 year Integrated B.Tech. Programs and 3 year Integrated B.Sc Programs.

ATIT 2020 is an aptitude test conducted through online & offline tests constitute objective type questions in Mathematics, Physics, Chemistry, English and logical reasoning in multiple choice format. Question paper pattern is given below and syllabus given in website www.ifheindia.org/icfaitech.

Eligibility for admission into the B.Tech/BSc Program:

- Pass with 60% and above aggregate marks in Class XII ("or its equivalent") with Mathematics, Physics, Chemistry and English as subjects.

- Class XII (or icfaitech equivalent) students awaiting final examination results may also apply.

- Applicants should have completed 12 years of formal schooling in order to apply for the program.

- The applicant should fulfil the minimum age requirements as prescribed by the respective Board through which the applicant has appeared for the qualifying examination.

1.7 Programs at IcfaiTech

At IcfaiTech, the programs offered are divided into three tiers, namely the first degree programs, the higher degree programs and the doctoral programs falling into the first, second and the third tiers respectively. All the undergraduate, integrated programs fall under the first degree programs. The various masters programs fall under the category of the higher degree programs. The Ph.D. programs offered by various departments fall under the category of doctoral programs. The academic structures of each of these programs are discussed below.

First Degree Programs (First Tier)

There are three first degree programs being offered at IcfaiTech, the details of which are available in the prospectus/view book. Without going into the details of the regulatory processes, it is necessary to touch upon the subject to obtain a better understanding of these processes, which are controlled by these regulations in respect to operation.

There may be some restrictions from time to time in terms of flexibilities like transfer or dual degree concerning these degree programs. This will be notified in the prospectus/view book as per periodic decision of the Academic Council. All operational matters concerning this will be controlled by the PGC.

Program Courses

The various courses prescribed for a program of study may be categorized in terms of their academic affinity or their functional objectives. Depending on overall educational goals of programs, it is possible to have fixed named courses in a particular category, to have fixed number of electives; to have a range of named courses in a particular category and to have a number of electives within a range. Named courses are those indicated by course number and course title in the semester-wise- pattern prescribed for a program

For first degree students the named courses include all mandatory courses under the General Institutional Requirement and the Discipline Specific Core courses, known as Compulsory Discipline courses (CDCs), for the program(s). The Elective courses fall under three categories: Discipline Electives, Humanities Electives and Open Electives. Open Electives enable students to pursue courses that are neither part of the discipline requirement nor part of the humanities requirement. Normally any elective course will be treated as an Open Elective once the student's requirement under Discipline Electives and Humanities Electives have been accounted for. Open elective requirement of Dual degree students is met by counting the Discipline Electives of one degree as Open Electives of the other degree. A first degree student may also choose, where

permitted, up to a certain prescribed maximum of his/her elective courses from the offerings in the higher degree, subject to the approval by the DCA and the prerequisite requirements and clause 3.18 regarding over preparedness and under preparedness. Provided that, if such a student after graduation is admitted to a higher degree program his/her total requirement in the latter cannot ipso facto be reduced.

The prior preparation required of a student who intends to choose courses from a higher degree program of the Institute for the fulfillment of his/her elective requirement(s) are given in clause 3.15.

In a program all courses outside the elective categories are defined as named courses, in view of the fact that they have already been named in the semester-wise-patterns in the prospectus/view book or have been named by an appointed authority through subsequent operation on the basis of guidelines given in the prospectus/view book .The electives are, on the other hand, selected by the student himself/herself from outside the named courses in his/her program. The intended regions where he/she goes for the search will be designated as host regions. Certain specialized courses, Internship programs, Thesis etc., These courses are named courses for some specific programs and they are debarred to other students as electives in the same way as they are debarred to students who wish to take them on audit.

For each program the number of electives, under each of the categories, required to be taken by a student will be prescribed either through the prospectus/view book or through an appropriate committee. Over and above the prescribed number of electives, a student of an integrated first degree program will be allowed to take, on his/her own option, up to a maximum number of four electives. In extraordinary cases, the number may be increased by the DCA without violating limit. For the purpose of eligibility for degree(s),a student should get valid grades in at least the prescribed number of electives – under each of the categories, of his/her program(s). The student above a particular CGPA as prescribed by ACC will be allowed to register in maximum of one higher degree course per semester. This will be counted as open elective unless the course is listed in pool of discipline electives for his/her program.

Once a first degree student is declared to have fulfilled the requirements of graduation the student may be permitted to register for at most one additional semester with prior permission of his/her Coordinator(s) of Department and Chairperson-Academics. Any first degree student who is interested in pursuing open elective(s) above the graduation requirements and/or completing a minor program he/she is pursuing and if that necessitates additional stay, he/she should obtain permission from

Chairperson- Academics at least one semester before the start of the overstay period. The overstay period can be at most one semester during which the student must register for at least three new courses of at least 9 units. In case a student withdraws from one or more of his/her courses or otherwise is found not to be pursuing his/her courses in all earnestness Chairperson-Academics in concurrence with the student's department Coordinator is authorized to get him/her graduated and evacuate the student from the campus.

The structure contains a category of courses such as Internship Program (IP)/Thesis (TS), which attempts a synthesis of earlier courses and gives a glimpse of the application of these courses. They carry a large number of units and are to be pursued when student can ensure sufficient time and attention throughout the allotted period. In particular, IP components are to be pursued exclusively full time throughout the allotted period. There is no provision for taking other courses along with an IP component. In case of a Thesis a student may choose between 12 units worth of thesis work or 20 units worth of thesis work with the concurrence of his/her supervisor. A student pursuing a 20 unit thesis must pursue it exclusively full time throughout the allotted period and there is no provision for taking other courses along with it. A student pursuing a 12 unit thesis may concurrently pursue at most 3 courses (totaling at most 9 units) and will not be allowed to pursue any other course/component.

The Higher Degree Programs (Second Tier)

At higher degree level, structure of the program is classified into courses, like, Research Methods, CDCs, electives, IP and thesis. Registration for the IP can be done only after all other required courses have been completed.

In the case of thesis, while normal registration can be done only after completion of all other courses, in extraordinary cases, the DCA may allow registration in Dissertation, spread over various semesters, along with other courses. A student of higher degree program can register up to a maximum of one elective more than those prescribed in a semester. This additional elective can be from the pool of electives of the concerned degree or named/electives courses from other disciplines' with the permission of DCAs – namely the DCA of the student's Department and the DCA of the Department offering the course that the student wants to pursue. The grade obtained in such additional electives will also be counted towards the CGPA. Each course in the Core Requirement or in the List of Electives must be a graduate level (5th or 6th level) course or an advanced under-graduate course (4th level) with the restriction that a student may use at the most

two 4th level courses to meet the requirements in above.

Ph. D Program (Third Tier)

The Ph.D. program is designed for the student to achieve a broad competence before research begins. He/she is required to clear certain course work, if not already cleared, and pass the Qualifying Examination to satisfy the institute that his/her spectrum of knowledge is such as to enable him to undertake the demands of interdisciplinary research. Working knowledge of a modern European language, wherever specified, Teaching Practice, Independent Study, Research Methodology and specified units of Thesis course and Seminar are significant components of the Ph.D. program. The pursuit of research through the Thesis-Seminar course will continue and terminate in a thesis which meets the standards and requirements of the committee of scholars.

1.8 The Academic Year

At IcfaiTech, the academic year is divided into two semesters (First Semester and the Second Semester) and a term called Summer Term. Each semester is of 18 weeks duration and summer term of 8 weeks duration. There are eight semesters during the four year B.Tech program. After completing the first four semesters, the students undertake an Internship Program (IP-1) for two months. During the final year, students go for five and half month's duration Internship Program-II (IP-II) in either of the two semesters and the adjoining summer term. Instead of the Internship Programs, a student can opt for Thesis/Seminar in the final year.

Structure of B.Tech Program

The program of studies leading to the award of a B.Tech degree consists of the prescribed courses sequentially distributed over the required number of semesters known as Semesterwise pattern.

The program is planned in such a way that in the normal course, a student will complete the program in 8 semesters.

Categorization of Courses :

The courses are categorized as

- Basic Sciences Courses
- Analysis Oriented Courses
- Engineering Science Courses
- Humanities Courses
- Technical Art Course

Discipline Courses

Discipline Courses of the Specific branch of B.Tech Program consists of Compulsory Discipline Course (CDC) and Discipline Courses other than Compulsory (DCOC).The Compulsory Discipline Courses (CDC), twelve in number for each branch are to be completed by every student of the branch taking 2 CDCs in the second semester of the second year, and 10 CDCs in the two semesters of the third year of the Program.

Discipline Courses in the category of DCOC, may be taken as electives. A student must take up a minimum of 6 electives to earn the required credits for the completion of the program. Additionally, a student can take up to 4 optional electives. This is however not mandatory. Students can also opt for DCOCs from other branches as electives, provided he/ she completes all the prerequisites for the same.

Credits calculation

Each course in the program structure is associated with an LPU (three digits) which describes the nature of the course.The first digit denotes the number of lecture hours per week, the second digit denotes the number of practical hours per week and the third denotes the credits or units given to the course for calculation of CGPA. Wherever, a single number appears, it indicates the total number of units only; its break-up may be announced through the time table or the Course Handout.

The effort that has to be put in by a student for a course is quantified in terms of 'units'. One unit in a theory course denotes three hours per week of study. This includes one lecture hour and two hours spent towards self-study. One unit in a laboratory-based course denotes two hours per week of laboratory work and one hour of self-study.

For example, a three unit theory course requires students to work on that course for about 9 hours per week. 3 Hrs of formal contact hours/ week + 6 Hrs of self-study outside classroom/ week = 9 Hrs per week.

The eligibility for a degree is determined on the basis of number of units completed. The minimum stipulated number of units for various degree programs are given below

Integrated First Degree (First tier)

B. Tech.	172
B. Sc.	133
B. Sc. – B. Tech Degree	209
B.Tech – B.Tech Degree	243

Higher Degree (Second tier)

M. Tech	90
Ph.D. (Thesis)	40

PROGRAM EDUCATIONAL OBJECTIVES, PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Program Educational Objectives (PEOs):

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

Program Outcomes (POs):

Program outcomes describe what students are expected to know and would be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program.

Program Specific Outcomes (PSOs):

Program Specific Outcomes are statements that describe what the graduates of a specific engineering program should be able to do.

STATEMENTS OF PEOs, POs AND PSOs

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1-PROFESSIONAL DEVELOPMENT

To develop in the students the ability to acquire knowledge of Mathematics,Science & Engineering and apply it professionally within realistic constraintssuch as economic, environmental, social, political, ethical, health and safety,manufacturability and sustainability with due ethical responsibility.

PEO2-CORE PROFICIENCY

To provide ability to identify, formulate, comprehend, analyze, design and solve engineering problems with hands on experience in varioustechnologiesusing modern tools necessary for engineering practice to satisfy the needs ofsociety and the industry.

PEO3- TECHNICAL ACCOMPLISHMENTS

PO1	**Engineering knowledge**	An ability to apply knowledge of mathematics (including probability, statistics and discrete mathematics), science, and engineering for solving Engineering problems and modeling

To equip the students with the ability to design, simulate, experiment, analyze,optimize and interpret in their core applications through multi disciplinaryconcepts and contemporary learning to build them into industry readygraduates.

PEO4- PROFESSIONALISM

To provide training, exposure and awareness on importance of soft skills forbetter career and holistic personality development as well as professionalattitude towards ethical issues, team work, responsiblility, accountability,multidisciplinary approach and capability to relate engineering issues tobroader social context.

PEO5- LEARNING ENVIRONMENT

To provide students with an academic environment and make them aware of excellence, develop the urge of discovery, creativity, inventiveness, leadership, written ethical codes and guidelines and the life-long learning to become a successful professional in Electronics and Communication Engineering.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1	Model computational problems by applying mathematical concepts and design solutions using suitable data structures and algorithmic techniques
PSO2	Design and develop solutions by following standard software engineering principles and implement by using suitable programming languages and platforms
PSO3	Develop system solutions involving both hardware and software modules

PO2	**Problem analysis**	An ability to design, simulate and conduct experiments, as well as to analyze and interpret data including hardware and software components
PO3	**Design / development of solutions**	An ability to design a complex system or process to meet desired specifications and needs
PO4	**Conduct investigations of complex problems**	An ability to identify, formulate, comprehend, analyze, design synthesis of the information to solve complex engineering problems and provide valid conclusions.
PO5	**Modern tool usage**	An ability to use the techniques, skills and modern engineering tools necessary for engineering practice
PO6	**The engineer and society**	An understanding of professional, health, safety, legal, cultural and social responsibilities
PO7	**Environment and sustainability**	The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and demonstrate the knowledge need for sustainable development.
PO8	**Ethics**	Apply ethical principles, responsibility and norms of the engineering practice
PO9	**Individual and team work**	An ability to function on multi-disciplinary teams.
PO10	**Communication**	An ability to communicate and present effectively
PO11	**Project management and finance**	An ability to use the modern engineering tools, techniques, skills and management principles to do work as a member and leader in a team, to manage projects in multi-disciplinary environments
PO12	**Life-long learning**	A recognition of the need for, and an ability to engage in, to resolve contemporary issues and acquire lifelong learning

PROGRAM OUTCOMES (POs):

B.Sc (Mathematics) and B.Tech (DS&AI) Dual Degree Program Structure

Year	Course Code	Semester-I	L	P	U	Course Code	Semester-II	L	P	U
I	IMDCHEM 111	Chemistry	3	0	3	IMDES121	Thermodynamics	3	0	3
	IMDEGL112	English Language Skills	3	0	3	IMDAO122	Probability and Statistics	3	0	3
	IMDMATH113	Linear Algebra	3	0	3	IMDMATH123	Higher Calculus	3	0	3
	IMDPHY114	Physics I	3	0	3	IMDPHY124	Physics II	3	0	3
	IMDTA115	Engineering Graphics	2	4	4	IMDTA125	Scientific Measurements	0	4	2
	IMDTA116	Computer Programming I	3	0	3	IMDTA126	Workshop Practice	2	4	4
	IMDEVS117	Environmental Science	2	0	2	IMDTA127	Computer Programming II	3	0	3
	Total No of Credits				**21**	**Total No of Credits**				**21**
II	**Semester-III**					**Semester-IV**				
	IMDES211	Electrical Sciences I	3	0	3	IMDES221	Electrical Sciences II	3	0	3
	IMDES212	Digital Electronics	2	2	3	IMDTA222	Engineering Measurements	1	8	4
	IMDES213	Engineering Mechanics	3	0	3	IMDTA223	Professional Communication	3	0	3
	IMDECON214	Principles of Economics	3	0	3	IMDMGTS224	Principles of Management	3	0	3
	IMDMATH215	Complex Variables	3	0	3	IMDAO225	Optimization Techniques	3	0	3
	IMDMATH216	Differential Equations & Fourier Series	3	0	3	IMDES226	Structure & Properties of Materials	3	0	3
	IMDMATH217	Stochastic Process	3	0	3	IMDPHY221	Partial Differential Equations & Systems of ODEs	3	0	3
	Total No of Credits				**21**	**Total No of Credits**				**22**
Summer Term Internship Program IP 221										**5**
III	**Semester-V**					**Semester-VI**				
	MATH311	Real Analysis	3	0	3	AO311	Numerical Methods	3	0	3
	MATH312	Algebra	3	0	3	AO312	Control systems	3	0	3
	MATH313	Graph Theory	3	0	3	–	Humanities Elective	3	0	3
	MATH314	Combinatorial Mathematics	3	0	3		Elective	3	0	3
	MATH316	Statistical Methods	3	2	4	MATH315	Cryptography	3	0	3
	MATH317	Differential Geometry	3	0	3	DS221	Data Structures	2	2	3
	DS211	Discrete Structures for Computer Science	3	0	3					
	Total No of Credits				**22**	**Total No of Credits**				**21**
IV	**Semester-VII**					**Semester-VIII**				
	DS311	Artificial Intelligence	3	0	3	DS321	Machine Learning	3	2	4
	CS312	Operating Systems	3	2	4	DS322	Expert Systems	3	0	3
	DS313	Introduction to Data Science	3	0	3	CS323	Computer Networks	3	0	3
	DS314	Data Warehousing and Mining	3	0	3	DS324	Neural Networks & Fuzzy Logic	3	0	3
	–	Elective (1)	3	0	3	–	Elective (1)	3	0	3
	–	Humanities Elective	3	0	3	–	Special Project	0	0	3
	Total No of Credits				**19**	**Total No of Credits**				**19**
V	**Semester-IX**					**Semester-X**				
	IP401 / TS401	Internship Program-II / Thesis			20		Electives (5) / Humanities Elective (1)			18
		Electives (5) / Humanities Elective (1)			18	IP401 / TS401	Internship Program-II / Thesis			20
	Total No of Credits				**20/18**	**Total No of Credits**				**18/20**
Total No of Credits										**204**

Table : Compulsory Discipline Courses for the BSc Mathematics

Mathematics				
Course Code	Course Title	L	P	U
MATH211	Stochastic Processes	3	0	3
MATH221	Partial Differential Equations & Systems of ODEs	3	0	3
MATH311	Real Analysis	3	0	3
MATH312	Algebra	3	0	3
MATH313	Graph Theory	3	0	3
MATH314	Combinatorial Mathematics	3	0	3
MATH315	Cryptography	3	0	3
MATH316	Statistical Methods	3	2	4
MATH317	Differential Geometry	3	0	3

Table : Discipline Core Courses for the B.Tech. Programs

Data Science and Artificial Intelligence (DS & AI)				
Course Code	Course Title	L	P	U
DS211	Discrete Structures for Computer Science	3	0	3
DS221	Data Structures	2	2	3

Table : Compulsory Discipline Courses for the B.Tech Programs

Data Science and Artificial Intelligence (DA & AI)				
Course Code	Course Title	L	P	U
DS311	Artificial Intelligence	3	0	3
CS312	Operating Systems	3	2	4
DS313	Introduction to Data Science	3	0	3
DS314	Data Warehousing and Mining	3	0	3
DS321	Machine Learning	3	2	4
DS322	Expert Systems	3	0	3
CS323	Computer Networks	3	0	3
DS324	Neural Networks & Fuzzy Logic	3	0	3

Table: List of electives for B.Tech. (Data Science and Artificial Intelligence)

1) Data Science Specialization

Course Code	Course Title	L	P	U
DS401	Predictive Analytics	3	0	3
DS402	System for Data Analytics	3	0	3
DS403	Data Visualization	3	0	3
DS404	Big Data Systems	3	0	3
DS405	Real Time Analytics	3	0	3

2) Artificial Intelligence Specialization

Course Code	Course Title	L	P	U
DS406	Natural Language Processing	3	0	3
DS407	Soft Computing	3	0	3
DS408	Human Computer Interaction	3	0	3
DS409	Computer Vision	3	0	3

3) Cloud Computing Specialization

Course Code	Course Title	L	P	U
DS410	Distributed Cloud Computing	3	0	3
DS411	Internet of Things	3	0	3
DS412	Security & Privacy in Cloud Computing	3	0	3
DS413	Cloud Administration	3	0	3

4) Blockchain Specialization

Course Code	Course Title	L	P	U
DS414	Fundamentals of Blockchain Technology.	3	0	3
DS415	Ethereum & Solidity Programming Essentials	3	0	3
DS416	Blockchain with Artificial Intelligence	3	0	3
DS417	Blockchain with IoT	3	0	3

5. Electives for B.Sc. (Mathematics)

Course Code	Course Title	L	P	U
MATH323	Metric Spaces	3	0	3
MATH324	Rings and Fields	3	0	3
MATH325	Topology	3	0	3
MATH326	Advanced Probability Theory	3	0	3
MATH327	Continuum Mechanics	3	0	3
MATH328	Advanced Combinatorics	3	0	3

6. List of Humanities Electives

Course Code	Course Title	L	P	U
HS311	Dynamics of Social Change	3	0	3
HS312	Introduction to Psychology	3	0	3
HS313	Heritage of India	3	0	3
HS314	Modern Political Science	3	0	3
HS315	Public Administration	3	0	3
HS316	Professional Ethics	3	0	3

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3. B.Tech Program Course Description

Semester-wise Institute Courses

Course Code	Course Title	L	P	U	Course Description
IMDCHEM111	Chemistry	3	0	3	Coordination Chemistry: Effective atomic number, Nomenclature of coordination compounds, Shapes of d-orbitals, Valence Bond Theory, Magnetism, Crystal Field Theory of Octahedral Complexes, Tetragonal distortions of Octahedral Complexes (Jahn-Teller Distortions), Square Planar and Tetrahedral Complexes, Thermodynamics-First Law: Work and Heat, Internal Energy and Enthalpy, Thermo chemistry: Enthalpy changes accompanying physical change and chemical change e.g. Thermodynamics -Second Law: Entropy and 2nd Law, The Gibb's Free Energy, Phase equilibria: Pure substances The thermodynamics of phase transition, Phase diagrams, Phase diagrams of typical materials Principles of chemical equilibria: The reaction Gibb's energy, Reactions at equilibrium, The response of equilibria to the conditions Consequences of equilibrium: Proton transfer equilibria, Salts in water, Solubility equilibria, Common ion effect Electrochemistry: The migration of ions, Electrochemical cells. The cell potential. Application of standard potentials, The rates of reactions: Empirical chemical kinetics, Reaction rates, Temperature dependence of reaction rates.
IMDEGL112	English Language Skills	3	0	3	Familiarizing students with basic English sound system to enhance their power of articulation. It provides intensive practice and extensive exposure to listening, speaking, reading and writing Skills. It would enhance not only their comprehensive knowledge of vocabulary but also strengthens their all four skills. The design and content of the course are aimed at making students gain language proficiency and also improve their communication skills
IMDMATH113	Linear Algebra	3	0	3	Matrices, Elementary row operations, Row and column equivalence, Row Reduced Echelon Matrices, Invertible Matrices, Gauss Jordan method to find the inverse, Solving system of linear equations (homogeneous and non-homogeneous), Vector spaces, subspaces, Bases and Dimension, and Computations of Subspaces, Linear Transformations, The Algebra of linear Transformations, Isomorphism between Matrices and Linear Transformations, Representation of Linear Transformations by Matrices, Eigen values, Eigen vectors, Diagonalization, Quadratic forms, Canonical forms.
IMDPHY114	Physics I	3	0	3	Momentum and impulse; two and many particle system; Rotational kinematics and dynamics; work and energy; conservation principles; oscillations and wave motion;

Course Code	Course Title	L	P	U	Course Description
					interference, diffraction and polarization.
IMDTA115	Engineering Graphics	2	4	4	Angle of projections; free hand sketching; orthographic views; pictorial views; auxiliary views; lines and planes; intersection and development; AutoCAD command and simple drawings using AutoCAD.
IMDTA116	Computer Programming I	3	0	3	Basics of Problem solving, Solve with an example, Introduction to python, Data Types, Python Program Flow Control, Python Sequences, Python Functions, Python Modules, Python Packages, Python Object Oriented Programming, Exception Handling, My First Cloud Program - Powered by AWS (Cloud Inventor) :Overview of computer and internet, Introduction and basics of cyber security, General idea of data analysis, Basics of programming and algorithms, Overview of computing, Introduction to cloud computing, Overview of cloud models, General idea of cloud computing, Problem solving – Case Study
IMDEVS117	Environmental Science	2	0	2	Meaning of Environment, Types and components of environment, nature and scope of the subject, Need for environment studies, goals of environmental education, environmental education programs. Man-environment relationship, biogeochemical cycles. Concept of ecology, subdivisions and developmental phases of ecology; concept of the ecosystem, Structural and functional aspects of ecosystems; Productivity concept of ecosystem, food chains & food webs in ecosystems. Ecological energetic, ecological interactions. Population ecology, Population dynamics Soil, Land use patterns, Waste lands, Desertification, Water resources, Air resources, Energy resources, Waste management, Waste water management, Biomedical waste management, Environmental policies and laws
IMDES121	Thermodynamics	3	0	3	Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of non reacting mixtures.
IMDAO122	Probability & Statistics	3	0	3	Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectations; mean and variance; binomial; Poisson and distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distributions.

Course Code	Course Title	L	P	U	Course Description
IMDMATH123	Higher Calculus	3	0	3	Polar coordinates: Definition, graphing and conics , Cylindrical and spherical coordinates, Jacobian, Limits, Continuity and Differentiability of vector functions, Velocity & unit Tangent vector, Normal vectors, Curvature, Torsion and the Bi normal, Tangential & normal components of velocity and acceleration, Functions of several variables, Limits and continuity in higher dimensions, Partial derivatives, differentials, linearization, Taylors formula for two variables, Chain rule for derivative, Directions derivatives, Gradient and Tangent planes, Maxima, Minima with application Convergence of sequences and series , Maclaurin, s Series, Taylors series, Vector calculus inRn, Vector analysis, Theorem of Green Gauss and Stokes
IMDPHY124	Physics II	3	0	3	Electrical fied; magnetic field; electric current; electromagnetic induction; Max well's equation; Electromagnetic waves; wave particle duality; uncertainty principle and Bohr model of atom.
IMDTA125	Scientific Measurements	0	4	2	A laboratory course that covers the lab components associated with six core science courses in the integrated first degree structure. While the exact component and assignments may vary from time to time. The assignments would invariably be illustrative of the theory covered in this portion as well as aim to emphasize the aspects of measurement as a theme in experimental science. This course is a compulsory requirement for all students who have to compulsorily do the six core science courses.
IMDTA126	Workshop Practice	2	4	4	Basics of manufacturing processes, Technical and economical considerations of manufacturing, Significance of material properties with respect to selection of manufacturing processes, Fitting & Carpentry, Metal forming processes, Sheet-metal working, Mechanical joining processes, Smithy tools and making various parts, Casting processes, laboratory exercises involving machining, fitting & carpentry, joining, CNC, house wiring, foundry and smithy etc.
IMDTA127	Computer Programming II	3	0	3	Java Programming Fundamentals, features of Object oriented programming, primitive data types and operators, various program control Statements, Classes, Objects and Methods, more data types and operators, Strings and other Operators, A closer look at methods and Classes, learn and implement Inheritance, Interfaces and Packages, Exception Handling, File I/O, Multithreading, database connectivity, Exploring My Cloud Powered by AWS : Essentials in Cloud Computing, Fundamentals of Big Data and Analytics, Introduction to Database Management System, Basics of Web Technologies, Basics of Storage and Networking, Cloud Computing Fundamentals and Services, AWS Analytics and Database Services, AWS Developer and Management Tools, AWS Storage Services, AWS Networking and

Course Code	Course Title	L	P	U	Course Description
					Content Delivery Services.
IMDES211	Electrical Sciences I	3	0	3	Introduction; basic circuit elements; sources (dependent and independent); Kirchoff's current and voltage law, source representation and conversion; Network theorems, response of RL,RC and RLC circuits; sinusoidal steady state analysis of circuits; three phase circuits, transformers; basics of rotating machines; DC machines; induction machine
IMDES212	Digital Electronics	2	2	3	Number systems and machine representation, Boolean algebra, minimization techniques, combinational and synchronous sequential circuits, logic minimization, programmable logic devices, state table and state diagrams, digital integrated circuits, asynchronous circuits, arithmetic operations and algorithms. The course will also consist of laboratory practice
IMDES213	Engineering Mechanics	3	0	3	Introduction, System of Forces; Laws of Mechanics; Types of Supports and their reactions; Equilibrium of rigid bodies; Force resolution and Resultant force; Friction; Moments and couples; Varignon's Theorem; Center of Gravity; Moment of Inertia, product of inertia, Mass moment of inertia; Dynamics of particles- displacement, velocity and acceleration, D' Alembert's principle; Rectilinear motion; Impulse momentum principle; Impact of elastic bodies; Curvilinear motion; Work-energy principal.
IMDECON214	Principles of Economics	3	0	3	Nature and Scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behavior and of the firm; linear economic models; market structures; social accounting and basic elements of economic planning
IMDMATH215	Complex Variables	3	0	3	Regions in the Complex plane, Functions of Complex Variable, limits. Mappings, Theorems on limits, Continuity, Derivatives, Cauchy-Riemann equations, Analytic Functions, harmonic functions, Exponential logarithmic functions, complex exponents, Trigonometric, Hyperbolic functions and their inverses, Contour integrals, Anti derivatives, Cauchy theorem, Cauchy Integral Formula, Morera's theorem, Liouville's Theorem, Maximum Modulus Principle, Convergence of sequences of series, Taylor's and Laurent series, Residues poles and zeros of analytic functions, Applications of residues, Conformal mapping, Fourier Transforms and Z Transforms.
IMDMATH216	Differential Equations & Fourier Series	3	0	3	First order differential equations, Reduction of order, Second order equations with applications bending of beams and electrical circuits, The homogeneous equation with constant coefficients and the Method of Undetermined Coefficients, Variation of parameters, Higher order linear equations, Power series solutions and ordinary points, Frobenius Method &Regular singular points, Gauss' hyper-geometric equation, Legendre polynomials & Bessel functions. Laplace Transform & Inverse Laplace

Course Code	Course Title	L	P	U	Course Description
					Transform, Convolution of Laplace Transform & application to differential equations, Fourier series and convergence, Cosine and Sine series, Sturm-Liouville problem, one dimensional Heat and Wave equations and Laplace equations in rectangular form.
IMDES221	Electrical Sciences II	3	0	3	Semiconductor physics, doped semiconductors, junction diode, ideal diode, non-ideal diode models, Zener diode and their applications, effects of capacitance, PNP transistor, NPN transistor, cut off and saturation, application to digital logic circuits, Junction Field effect transistors, MOSFETs, MOSFET Logic gates, Complementary MOSFETs, BJT Amplifiers, FET amplifiers biasing and small signal analysis ,Frequency response, power amplifiers, IC amplifiers, Operational amplifiers
IMDTA222	Engineering Measurements	1	8	4	Measurement of basic electrical and non-electrical quantities; system performance measurements; analysis of experimental data. The course shall aim to train the student in the skill of operation of instruments in the electrical and electronics, chemical, civil and mechanical engineering applications. Precise lab exercises will be prescribed from time to time.
IMDTA223	Professional Communication	3	0	3	Basics of Communication; Verbal and Non-verbal Communication; Barriers to Communication; Business Correspondence; E-mail Communication; Memo-Reports; Notice, Agenda and Minutes of Meetings; Effective Writing; Report: Its Features: Types of Reports; Formal Reports; Gathering Information; Organization of the Material; Uses of Visual Aids; Writing Abstract and Summaries; Writing Definitions; Reading and Listening Skills; Note-making; Précis Writing; Audio Visual Aids; Oral Presentation; Editing; Mechanics of Writing.
IMDMGTS 224	Principles of Management	3	0	3	Fundamental concepts of management-planning-organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.
IMDAO225	Optimization Techniques	3	0	3	Optimization of functions of one and more variables with and without constraints, Kuhn-Tucker conditions, Gradient Methods, Linear Programming, Simplex based and integer programming methods, Duality Theory, Transportation and assignment problems, Dynamic programming, Branch and bound methods, Models of linear production systems
IMDES226	Structure & Properties of Materials	3	0	3	Study of the basic properties of materials in relation to their molecular structure; emphasis on the structure of metallic, polymeric and ceramic materials in relation to

Course Code	Course Title	L	P	U	Course Description
					their mechanical, electrical, electronic and chemical properties, methods of imparting desirable properties to materials by inducing changes in molecular structure; property requirements and material selection, criteria for widely ranging service conditions.
IMDAO311	Numerical Methods	3	0	3	Solution of non-linear algebraic equations; interpolation and approximation; numerical differentiation and quadrature; solution of ordinary differential equations; system of linear equations; matrix inversion; Eigen-value and Eigenvector problems.
IMDAO312	Control Systems	3	0	3	Mathematical models of physical systems, feedback characteristics of control systems, control system components, time response analysis, stability, frequency response, state-space analysis
IMDHS311	Dynamics of Social Change	3	0	3	Nature of Society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change ideological, economic, technological and political demographics; agencies of social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion
IMDHS312	Introduction to Psychology	3	0	3	The development of psychology as a science individual and the environment; nature; kinds and determinants of perceptions; response mechanism and kinds of responses, motivations, modifications of behaviour through learning, memory and transfer of training; thought process, problem solving and creative thinking; nature and evaluation techniques of intelligence and personality.
IMDHS313	Heritage of India	3	0	3	Foundations of India; India and its ancient culture; life of the people; systems of Indian philosophy; art and archeology; languages and literature; impact of world civilization; Western influence.
IMDHS314	Modern Political Science	3	0	3	Nature and scope of political science; emergence and basis of the state; rights and duties; forms of government; democracy, fascism, capitalism, socialism, anarchism, communism, Maoism, radicalism and Gandhism.
IMDHS315	Public Administration	3	0	3	Definition, nature and scope of public administration; the chief executive; leadership qualities of an administrator; principles of organization; organization of Ministries of Home and Finance; personnel administration-bureaucracy; recruitment, promotion, conduct and discipline, employer employee relations; administration at work-planning, policy formulation, decision making, supervision, coordination; integrity in administration; public corporations in India; financial administration in India; local administration in India.

Course Code	Course Title	L	P	U	Course Description
IMDHS316	Professional Ethics	3	0	3	Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.
DS491 CE491 CS491 EC491 EE491 ME491 MEC491	Special Projects	0	0	3	This is an unstructured open ended where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time bound which is of basic or peripheral concern of student's discipline. Each student must submit a project report as a culmination of his endeavor and investigation. The instructor-in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. This course will aim to evaluate the student actual ability to use the fundamentals of knowledge and to meet the new unknown situations as demonstrated by the student's interaction with the instructors and instructor-in-charge. The instructor-in-charge may assign specific hours of formal brain storming sessions.
IP 221	Internship Program I	0	0	5	This course is run during the summer term at various industries and is of about 8 week duration.
IP 401	Internship Program II	0	0	20	This course is run during one of the two semesters in the final year and is a part of adjoining summer vacation. The duration of this program is about five and half months. Students will be working at industries on the live projects under the supervision of the FST faculty.
TS 401	Thesis & seminar	--	--	--	TS 401 is a required course for all the students with thesis option.
TIP 491/TIP 491	**Technology Innovation Project**	0	0	3	A unique opportunity for the students in the form of a course that facilitate the combination of academics with the industry by involving an in-depth innovation, investigation under the supervision of mentor from Industry and a faculty member for performing the real-life projects with the support from various organizations. Students working in groups will be required to perform research, customer and problem discovery, ideation, concept creation and validation, and technical implementation for a real-world challenge. The specific time-bound based on the students registered for the course will be graded based on the performance feedback from both the industry and the Faculty supervisor. The student will be able to improve the skills and knowledge for improving written and oral communication with indicative content which includes innovation methodology, customer & problem discovery, problem validation, innovation experiments with innovative presentations.

B.Sc. Program (Mathematics)

Course Description

Course Code	Course Title	L	P	U	Course Description
MATH221	Stochastic Processes	3	0	3	Introduction of Stochastic process, specification of stochastic process, Stationary process, martingales. Markov chain, Transition probability, Classification of states and chains, Determination of higher transition probability, Stability of Markov chain, Reducible chains, Markov chain with discrete and continuous space.
MATH222	Partial Differential Equations & Systems of ODEs	3	0	3	Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients(Two Equations in two unknown functions). Simultaneous linear first order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables. Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions. Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients, Separation of variables, Non-linear equation of the second order.
MATH311	Real Analysis	3	0	3	Review of Algebraic and Order Properties of R, Neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima. The Completeness Property of R, The Archimedean Property, Density of Rational and Irrational numbers in R, Intervals. Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotonic Sequences, Monotonic Convergence theorem (weierstrass completeness theorem). Cantor's completeness theorem. Subsequences, Divergence Criteria, Monotonic Sub-sequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criteria. Infinite series, convergence and divergence of infinite series, Cauchy Criteria, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n-th root test, Integral test, Alternating series, Leibnitz test, Absolute and Conditional convergence.

Course Code	Course Title	L	P	U	Course Description
MATH312	Algebra	3	0	3	Binary algebras, Cyclic monoids, submonoids, Groups, Morphisms, direct products, Examples of Groups, postulates, subgroups, Abelian groups, Groups acting on sets, Permutations, Lagrange's theorem, Normal subgroups. (Rings and Ideals) Introduction, Integral domains and fields, Fields of quotients, Subrings, Morphism of rings, Direct sums, ideal and quotient rings, Divisibility, Euclidean domains, Unique factorization theorem, Prime and maximal ideals, Gaussian elimination. (Polynomial Rings and polynomial codes :) The Rings R[x], polynomial rings over fields, Polynomial codes, Advantageous properties, Shift registers, Unique factorization theorem for polynomials, Complete roots of unity, polynomial functions, Formal derivative. (Finite Fields :) Extension of fields, simple extensions, Computation in R[x]/m[x], Existence theorem, Finite fields. Lattices: Lattices and Posets,
MATH313	Graph Theory	3	0	3	Graphs: Basic concepts and graph terminology, representing graphs and graph isomorphism. Distance in a graph, Cut-vertices and Cut-edges, Connectivity, Euler and Hamiltonian paths.
MATH314	Combinatorial Mathematics	3	0	3	Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers Principle of Inclusion and Exclusion, Derangements, Inversion formulae Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions. Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.
MATH315	Cryptography	3	0	3	Elementary number theory: Prime numbers, Fermat's and Euler's theorems, Testing for primality, Chinese remainder theorem, discrete logarithms. Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form GF(p), Polynomial Arithmetic, Finite fields of the form GF(2). Data Encryption Techniques: Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems. Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.
MATH316	Statistical Methods	3	2	4	Random variables: probability distributions; Sampling distributions; Test of hypotheses; test for goodness of fit; analysis of variance; non-parametric tests; correlation and

Course Code	Course Title	L	P	U	Course Description
					regression analysis.
MATH317	Differential Geometry	3	0	3	Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves. Developables: Developable associated with space curves and curveson surfaces, Minimal surfaces. Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Eulers theorem. Rodrigues formula, Conjugate and Asymptotic lines.
MATH323	Metric Spaces	3	0	3	Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantors theorem. Subspaces, dense sets, separable spaces. Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem. Connectedness, connected subsets of R.
MATH324	Rings and Fields	3	0	3	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains. Algebraic extension of fields: Irreducible polynomials and Einstein criterion, Adjunction of roots, Algebraic extension. Algebraically closed fields, Normal separable extensions: splitting fields, normal extensions. Normal separable extension: Multiple roots, Finite fields, Separable extensions. Galois Theory: Automorphism groups and fixed field s, Fundamental theorem of Galois theory. Application of Galois theory to classical problems: Roots of unity and Cyclotomic polynomials, Cyclic extensions.
MATH325	Topology	3	0	3	Countable and uncountable set, Infinite sets and the Axiom of choice, Well-ordered sets. Topological spaces, Basis and sub basis for a topology, The order, product and subspace topology, closed sets and limit points. Continues function and homeomorphism, Metric topology, Connected spaces, connected subspaces of the real line, Components and local connectedness. Compact spaces, Basic properties of compactness, Compactness and finite intersection property, Compact subspaces of the real line,

Course Code	Course Title	L	P	U	Course Description
					Compactness in metric spaces, Limit point compactness, Sequential compactness and their equivalence in metric spaces, Local compactness and one point compactification. First and second countable spaces, Lindel of space, Separable spaces, separable axioms, Hausdorff, Regular and normal spaces. The Urysohn lemma, completely regular spaces, The Urysohnmetrization theorem, Imbedding theorem, Tietn extension Theorem, Tychonoff theorem, Stone-Cechcampactification.
MATH327	Continuum Mechanics	3	0	3	Vector spaces, index notation, second order tensors: skew symmetric, orthogonal and symmetric tensors, invariants of second-order, directional derivative, Frechet derivative, gradient, divergence, curl, and integral theorems. Lagrangian and Eulerian description, deformation gradient, strain tensor, stretchtensors, area and volume transformation, material and spatial derivative, rate of deformation and spin tensors, Reynolds' transport theorem, vorticity and circulation. Connservation of mass, conservation of linear momentum, the Cauchy's hypothesis, Cauchy stress tensor, conservation of angular momentum, first law of thermodynamics, second law of thermodynamics, governing equations in reference configuration and also for control volume, principle of frame-indifference. necessity of constitutive relations, principle of material frame - indifference, material symmetry, thermoelastic solids, hyperelasticity, linear elasticity, thermomechanics of fluids, classical heat-conducting fluids, incompressible fluids.

B.Tech Data Science and Artificial Intelligence Program (DS & AI)

Course Description

Course Code	Course Title	L	P	U	Course Description
DS211	Discrete Structures for Computer Science	3	0	3	Introduction to discrete mathematical structures; Formal logic and predicate calculus; Sets, relations and functions; Proof techniques; Graphs and trees; Primes, factorization, greatest common divisor, residues and application to cryptology; Boolean algebra; Permutations, combinations and partitions; Recurrence relations, and generating functions; Introduction to error-correcting codes; Formal languages and grammars, finite state machines.
DS221	Data Structures	2	2	3	Introduction to Software Design Principles- Modularity, Abstract Data Types. Data Structures And Algorithms. Analysis Of Algorithms. Linear Data Structures – Stacks, Arrays, Lists, Queues And Linked List. Representations- Pre-Fix, In-Fix and Post-Fix Expressions. Recursion. Set Operations. Hashing and Hash Functions. Binary and Other Trees. Traversal Algorithms. Huffman Codes. Search Trees. Priority Queues. Heaps and Balanced Trees. Sorting Techniques. Graphs and Digraphs. Algorithmic Design Techniques. Data Structures for External Storage. Multi-Way Search and B-Trees.
DS311	Artificial Intelligence	3	0	3	Introduction to the problems and techniques of A.I. along with the application of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.
CS312	Operating System	3	2	4	Introduction to Operating Systems. Various Approaches to Design of Operating Systems. Overview of Hardware Support for Operating Systems. Process Management. Process Synchronization and Mutual Exclusion. Inter-Process Communication. Process Scheduling. CPU Scheduling Approaches. Memory Management- Paging, Segmentation, Virtual Memory, Page Replacement Algorithms. File Systems- Design and Implementation of File Systems. Input/Output Systems. Device Controllers and Device Drivers. Security And Protection. Case Studies on Design and Implementation of Operating System Modules.
DS313	Introduction to Data Science	3	0	3	Introduction to DBMS, ER Modeling, Functional Dependencies, Normalization, DDLs, DMLs, Views, OLTP, Database Integrity, Concurrency. Introduction, Statistical Inference, Exploratory Data Analysis and the Data Science Process, Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process - Case Study, Linear Regression - k-Nearest Neighbors (k-NN) - k-means, Feature Generation and Feature Selection, Recommendation Systems, Principal Component Analysis, Mining Social-Network Graphs, Neighborhood properties in graphs Data Visualization, Data Science and Ethical Issues.

Course Code	Course Title	L	P	U	Course Description
DS314	Data Warehousing and Mining	3	0	3	Basic Concepts, Database Architectures for Parallel Processing – Parallel DBMS Vendors – Multidimensional Data Model – Data Warehouse Schemas for Decision Support, Concept Hierarchies -Characteristics of OLAP Systems – Typical OLAP Operations, OLAP and OLTP. Knowledge Discovery Process – Data Mining Techniques, Mining Methods- Pattern Evaluation Method – Pattern Mining in Multilevel, Multi Dimensional Space – Constraint Based Frequent Pattern Mining, Datasets – Introduction, Introduction to WEKA.
DS321	Machine Learning	3	2	4	Introduction, Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation, Linear regression, Decision trees, overfitting, Instance based learning, Feature reduction, Collaborative filtering based recommendation, Probability and Bayes learning, Logistic Regression, Support Vector Machine, Neural network, introduction to deep neural network, Computational learning theory, PAC learning model, Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model.
DS322	Expert Systems	3	0	3	The nature of Expert Systems. Types of applications of Expert Systems; relationship of Expert Systems to Artificial Intelligence and to Knowledge-Based Systems, Distinguishing features of Expert Systems. Benefits of using an Expert System. Choosing an application, Theoretical Foundations Basic forms of inference: abduction; deduction; induction, The representation and manipulation of knowledge in a computer. Rule-based representations (with backward and forward reasoning); logic-based representations (with resolution refutation); semantic and partitioned nets (query handling), Handling of uncertainties, Truth Maintenance Systems, Expert System Architectures, An analysis of some classic expert systems, Limitations of first generation expert systems, Deep expert systems
CS323	Computer Networks	3	0	3	Introduction to network, OSI Reference model, TCP/IP Reference Model, Physical layer, Datalink Layer, Network layer, Transport Layer, Session Layer, Presentation Layer, Application Layer.
DS324	Neural Networks & Fuzzy Logic	3	0	3	Introduction: Overview of Artificial Neural Networks, Basic definitions of neuron, Comparison study of human neuron and artificial neuron, learning, types of learning, ANN, Recurrent NN, Perceptron, Single layer and Multi-Layer Perceptron, Multilayer Feedforward Neural networks with Sigmoidal activation functions, Back propagations algorithm, Representational abilities of feedforward networks, Case Study, Backpropagation in Practice, Analysis of pattern Association Networks, Analysis of Pattern Classification Networks, Fuzzy set theory, Difuzzification etc.

Course Code	Course Title	L	P	U	Course Description
DS401	Predictive Analytics	3	0	3	Predictive Analytics Methods, Ability to apply specific statistical and regression analysis methods applicable to predictive analytics to identify new trends and patterns, uncover relationships, create forecasts, predict likelihoods, and test predictive hypotheses, Predictive Analytics Tools: Develop familiarity with popular tools and software used in industry for predictive analytics, especially R, R Studio and R Markdown, The Predictive Analytics Cycle
DS402	System for Data Analytics	3	0	3	Fundamentals of data engineering- data engineering vs data science, data processing concepts – partitioning, replication, grouping and sorting, data locality, Flynn's taxonomy, Task vs data parallelism, databases, parallel vs distributed databases, architecture- performance, distributed computing architecture, processing frameworks,- batch, map-reduce, stream processing, parallel processing, real time processing, cloud fundamentals – virtualization, batch-transactional-continuous workloads, execution model and examples- AWS, Azure etc…
DS403	Data Visualization	3	0	3	Value of Visualization, Data and Image Models, Visualization Design, Exploratory Data Analysis, Multidimensional Data, Graphical Perception, Visualization Software, Interaction, Animation, Color, Using Space Effectively.
DS404	Big Data Systems	3	0	3	Introduction to storage, Deriving design space of storage, NoSQL advances using the design space, The periodic table of data structure, Learned cost model, data structure design continuums, fast statistics through synthesis, Neural network synthesis.
DS405	Real Time Analytics	3	0	3	Motivation and challenges of real-time, distributed, fault tolerant data processing, distributed messaging architecture (Apache Kafta), Real time data processing platform: storm, storm basic programming skills, linking spouts, and connecting to the live Twitter API tp [process real lite tweets, Multilanguage capability of stirm (with Python script), case study: Networking fault prediction. This course also helps a student to analyze and understand big data using visuals. Topic include, design principles, Perception, color, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.
DS406	Natural Language Processing	3	0	3	Language modeling with N-gram, Spelling correction, Neural networks and neural language models, Parts-of-speech tagging, Syntactic parsing, Language semantics, Computational semantics.

Course Code	Course Title	L	P	U	Course Description
DS407	Soft Computing	3	0	3	Introduction: Soft computing, Fuzzy logic, Fuzzy membership functions, Operations on Fuzzy sets, Fuzzy relations, Fuzzy proposition, Fuzzy implications, Fuzzy inferences, Defuzzification Techniques-Defuzzification Techniques-II, Fuzzy logic controller-I, Fuzzy logic controller-II, Solving optimization problems ,Concept of GA,GA Operators: Encoding, GA Operators: Selection-I, GA Operators: Selection-II,GA Operators: Crossover-I,GA Operators: Crossover-II,GA Operators: Mutation, Introduction to EC-I, Introduction to EC-II,MOEA Approaches: Non-Pareto, MOEA Approaches: Pareto-I, MOEA Approaches: Pareto-II, ANN Architecture.
DS408	Human Computer Interaction	3	0	3	Introduction, Interactive system design, Model-based Design and evaluation, Guidelines in HCI, Empirical research methods in HCI, Task modeling and analysis, Dialog Design, Cognitive architecture, Design -Case Studies.
DS409	Computer Vision	3	0	3	Introduction to computer vision, fundamentals of image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, image classification, scene understanding, and deep learning with neural networks. Finding known models in images, depth recovery from stereo, camera calibration, image stabilization, automated alignment, tracking, boundary detection, and recognition.
DS410	Distributed Cloud Computing	3	0	3	Basic concepts of Cloud Computing, Virtual Machines and Virtualization, Cloud Computing services and issues, Service Oriented Architecture, Cloud Programming and S/W environment, File systems, security and cloud applications.
DS411	Internet of Things	3	0	3	Introduction to Internet of Things Introduction-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, IoT Communication APIs , IoT Enabling Technologies- Wireless Sensor Networks , Cloud Computing, Big Data Analytics, Communication Protocols, Embedded Systems, Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Case Studies: Renewable Energy Systems, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics, Agriculture-Smart Irrigation,.
DS412	Security and Privacy in Cloud Computing	3	0	3	Design security architectures that assure secure isolation of physical and logical infrastructures including compute, network and storage, comprehensive data protection at all layers, end-to-end identity. Complexity of risk assessment, Emergence of new business models and implications for consumer privacy, Regulatory compliance, Privacy by design, Using PETs to implement privacy by design, Description of data processing flows, Using PETs, International Telecommunication Union (ITU), International Organization for Standardization (ISO), Organization for the Advancement of Structured Information Standards (OASIS).

Course Code	Course Title	L	P	U	Course Description
DS413	Cloud Administration	3	0	3	Cloud Resource Administration and Provisioning, Scalable and Elastic Administration, Cloud Interoperability & Portability, Strategic Policy Design for Cloud Usage and Compliance, Business Continuity Strategies and Disaster Recovery for Cloud, Cloud Security Fundamentals, Federated Controls and Strategies for Multiple Cloud and Non-cloud Administration, Performance Measures, Monitoring and Optimization in Production, Cloud Resource Administration and Provisioning.
DS414	Fundamentals of Block chain Technology.	3	0	3	Blockchain Concepts, Blockchain application example, Blockchain stack, From web 2.0 to next generation decentralized web, Domain specific Blockchain application, Blockchain benefits and challenges, Blockchain application templates, Blockchain applications components, design methodology of Blockchain applications. Setting up Ethereum developments tools, Smart Contracts, Decentralized Applications (Dapps), Case Studies, Mining, Whisper, Swarm, Solidity Essentials, case studies and Advanced topics.
DS415	Ethereum and Solidity Programming Essentials	3	0	3	Introduction, History of Ethereum, setting up Ethereum developments tools, Smart Contracts, Decentralized Applications (Dapps), Case Studies, Mining, Whisper, Swarm, hyper-ledger, hyper-ledger fabrics, case studies and Advanced topics, solidity fundamentals, data type, functions etc..
DS416	Block chain with Artificial Intelligence	3	0	3	Introduces of two high-impact contemporary emerging technologies for the future of AI and Block chain. Distributed Ledgers and Deep Learning Algorithms, and its implications for the future of artificial intelligence, Deep learning Chain: Future of artificial intelligence for smart networks with intelligence "baked in" the form of Blockchain Distributed Ledgers for confirming authenticity and transferring value, and Deep Learning Algorithms for predictive identification
DS417	Block chain with IoT	3	0	3	Introduction to Blockchain and IoT, Trust building, Cost reduction, Accelerated data exchanges, Scaled security, Decentralise IoT Network, In an IoT network, the blockchain can keep an immutable record of the history of smart devices. This feature enables the autonomous functioning of smart devices without the need for centralized authority. As a result, the blockchain opens the door to a series of IoT scenarios that were remarkably difficult, or even impossible to implement without it.

4. Institute Core Courses Handouts

Course No: **IMDCHEM111**	Course Title: **Chemistry**	L	P	U
		3	0	3

Course Learning Objectives

- To integrate the principles of Inorganic, Physical and Industrial chemistry with the relevant domains of core engineering courses offered at B.Tech level.
- To provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.
- Provides a comprehensive survey of underlying principles that govern the properties and behavior of chemical systems.
- The student will understand the interdisciplinary nature of chemistry and to integrate knowledge of mathematics, physics and other disciplines to a wide variety of chemical problems.

Course Contents

UNIT-I

Werner's work, recent studies on complexes, Effective atomic number, Nomenclature of coordination compounds, Shapes of d-orbitals, Valence Bond Theory, Crystal Field Theory of Octahedral Complexes, Magnetism, Thermodynamic aspects of crystal field splitting, Tetragonal distortions of Octahedral Complexes (Jahn-Teller Distortions), Square Planar and Tetrahedral Complexes.

UNIT-II

Work and Heat, Internal Energy and Enthalpy, Enthalpy changes accompanying physical change and chemical change, Entropy and 2nd Law, Absolute Entropies and 3rd Law, The Gibb's Energy, The thermodynamics of transition, Phase diagrams, and Phase diagrams of typical materials, The reaction Gibb's energy, Variation of reaction Gibbs energy with composition, Reactions at equilibrium, The standard reaction Gibbs energy, Equilibrium composition, Equilibrium constant in terms of concentration, The response of equilibria to the conditions, Proton transfer equilibria, Salts in water, Solubility equilibria.

UNIT-III

The migration of ions, Half reactions and electrodes, Reactions at electrodes, varieties of cells, The cell reactions, Cell potential, Cells at equilibrium, standard potentials, The variation of potential with pH, Determination of pH, Electrochemical series, Determination of thermodynamic functions.

UNIT-IV

Empirical chemical kinetics, Reaction rates, Temperature dependence of reaction rates, Reaction schemes and reaction mechanisms.

UNIT-V

Basic industrial processes like distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, Emulgator, Scaling up operations in chemical industry, Introduction to clean technology, Introduction to synthesis, properties and application of nano-materials

Text Books:

1. Lee J. D., "*Concise Inorganic Chemistry*", 5th Edition, Blackwell Science, Oxford University Press, New Delhi, 1996.
2. Atkins Peter and De Paula Julio, "*The Elements of Physical Chemistry*", 6th Edition, Oxford University Press, New Delhi, 2015.
3. Felder R.M., Rousseau R.W. "*Elementary Principles of Chemical Processes*", Wiley Publishers, New Delhi, 2006.
4. Dieter Vollath, "*An introduction to synthesis, properties and application of nano-materials*", 2nd Edition, Willey, New York, 2013.

Reference Books:

1. Levine Ira N., "*Physical Chemistry*", 5th Edition, Tata McGraw-Hill, 2002.

2. Mahan Bruce M. and Mayers Rollie J., "*University Chemistry*", 4th Edition, Addison, Wesley Longman, 1998.

3. Huheey James E, Keiter Ellen A and Keiter Richard L., "*Inorganic Chemistry*", 4th Edition, Harper Collins College Publishers, 1993.

4. Stocchi E, "*Industrial Chemistry*" Vol-I, Ellis Horwood Ltd. UK.2006.

Course Outcomes

Upon successful completion of the course student will be able to:

- Understand the chemical behaviour of matter and materials using fundamental knowledge of their nature (i.e. electrons and intermolecular forces)
- Correlate the concepts of thermodynamics learnt with the study of engineering devices covered in Mechanical Engineering.
- Use fundamental chemical principles to make predictions about reactivity and general properties of materials of the built environment.
- Predict potential complications from combining various chemicals or metals in an engineering setting.
- Apply concepts learnt to the basic requirements of Civil Engineering, particularly focusing to the built environment
- Collect, represent and interpret experimental results accurately and concisely using technical narrative, graphs, and tables.

Course No: IMDELS112	Course Title: **English Language Skills**	L	P	U
		2	4	4

Course Learning Objectives

- Tofamiliarizing learners with aspects of pronunciation to attain intelligibility and grammatical accuracy in spoken and written English.
- To provides intensive practice and extensive exposure to the four basic skills; listening, speaking, reading and writing

Course Contents

UNIT-I

English Sound System: distinction between letters and sounds, classification of English sounds, syllable structure, confusing sounds for practice, words and sentences for practicing vowel contrasts.

Accent Patterns: accentual patterns of single words, accentual patterns of compound words, accent change according to function, sentence accent.

Effective speech: elision of sounds or syllables, addition of sounds or syllables, transposition sounds, pronunciation based on semantics, inflectional suffixes and some common word endings, general suggestions for pronunciation, Pronunciation of consecutive consonants.

Listening skills: hearing and listening, phonetic features of listening, purpose of listening, barrier to listening, guidelines for improving listening.

Art of conversation: small talk, body language, principles of a good conversationalist.

Debate: process of organization, purpose, rebuttal, participating in a debate, preparation for the debate.

Group Discussion: conversation, debate and GD, kinds of groups, importance and features of GD (oral communication skill, leadership skills, intensive listening skills, nonverbal communication clues), strategies of a group interaction, barriers to an effective GD, suggestions for self-improvement.

UNIT-II

Uses of dictionary: the meaning, spelling and pronunciation of a word, antonyms and synonyms, grammar, abbreviations and dictionary symbols, use of thesaurus.

Punctuation: end punctuation marks, internal punctuation marks, direct quotation punctuation marks, word punctuation, spacing with punctuation, too much punctuation.

Prepositions and phrasal verbs: prepositions and phrasal verbs prepositions, Idiomatic combinations, phrasal verbs, Vocabulary extension: context clues, word analysis, semantic change, word-formation methods, antonyms, synonyms, one word substitutions.

Effective use of words: word order, words: its meaning, avoid clichés

Common errors in English: errors in using nouns, errors in using pronouns, errors in using prepositions, errors in using verbs, errors in using gerund/infinitive, use an infinitive not a gerund, errors in using adjectives, errors in using adverbs, errors in using conjunction, errors in using punctuation, common errors due to commonly confused words

UNIT-III

Effective use of sentences: unity and emphasis on sentences, coordination and subordination. Paragraph writing: unity, coherence and development of the paragraph, types of paragraphs, paragraph development.

Essay writing: features of an essay, thesis statement, organization of the material, modes of developing essays, Revise and proofread essay, practice essay.

UNIT-IV

Reading Skill: mechanics of reading, types of reading, reading speed.

UNIT- V

Business correspondence: structure and layout of business letters, enquiry letter and important points, complaint and adjustment letters, complaint letter, important points, sales letter.

Resume writing: elements of resume, preparing a resume, writing a job application letter Presentation Skills: Tips for making presentations.

Text Books:

1. Koneru. A. (2011). English Language Skills. McGraw Hill

Reference Books:

1. Langan, J. (2010). College writing skills. McGraw-Hill, Eighth Edition.
2. Langan, J., & Jenkins, L. (2010). Ten steps to advancing college reading skills. Townsend Press.
3. Swan, M. (2016). Practical English Usage 4th edition.

Course Outcomes

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

- Develop listening skills to distinguish between letters and sound to use them effectively in speech during standard communication or debates and group discussions.
- Use dictionary and grammar effectively to overcome errors in reading and writing.
- Frame sentences and effectively use while writing paragraphs, essays, business letters and resumes etc.

Course No: **IMDMATH113**	Course Title: **Linear Algebra**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To solve systems of linear equations
- To compute standard forms of given matrices
- To compute eigenvalues and eigenvectors of 3x3 real matrices
- To compute quadratic forms and diagonalize matrices.
- To introduce complex matrices and obtain analogues of real matrix theorems

Course Contents

UNIT-I Matrices, Matrix addition, Vectors and Scalar Multiplication, Matrix Multiplication, Rank of a matrix Symmetric, Skew-symmetric matrices Row Operation, Row Equivalence, Row Reduced Echelon Matrices

UNIT-II Linear systems of Equations, Gauss Elimination, Determinant method: Cramer's Rule Solutions of Linear systems, Existence and Uniqueness, Inverse, Gauss-Jordan Method

UNIT-III The matrix eigenvalue problem, Determining eigenvalues and eigenvectors, applications

UNIT-IV Vector spaces, Linear Independence, Inner product spaces, subspaces Linear Transformations, Algebra of linear Transformations, Isomorphism between Matrices and Linear Transformations

UNIT- V Similarity of Matrices, Diagonalization, Quadratic Forms, Canonical forms Complex Matrices and Forms Hermitian, Skew-Hermitian, Unitary matrices and Orthogonal matrices

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig ,10th Edition, John Wiley & Sons, 2012.

2. An Introduction to Linear Algebra, V. Krishnamurthy, V. P. Mainra, J. L. Arora, East West Press,2002

Reference Books:

1. Linear Algebra and its Applications, Gilbert Strang,
2. 4th Edition, Thomson Brooks, 2006

Course Outcomes

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

- Systematically solve sets of linear equations of small size
- Analyse eigenvalue/eigenvector problems and compute the same
- Apply the concept of rank for a variety of problems
- Perform diagonalization and related operations on quadratic forms

Course No: IMDPHY114	Course Title: **Physics-I**	L	P	U
		3	0	3

Course Learning Objectives

Develop an understanding of the basic principles of Mechanics and wave optics and the application of the principles with emphasis on problem solving skills.

Course Content:

UNIT I

Conservation of Momentum: Collisions, Impulse-Momentum Theorem, Conservation of Momentum, Two-body collisions, Complex Motions, Many-particle systems, Center of Mass and Conservation of momentum

UNIT II

Rotational motion: Rotational Kinematics, Relation between linear and angular variables, Torque and Rotational inertia, rolling without slipping, Angular momentum for system of particles, Conservation of angular momentum

UNIT III

Conservation of Energy: Work, Energy and Power, Work-Energy theorem, Conservative forces, Potential energy, Conservation of mech. Energy, Work done by ext. force, Frictional force, Conservation of total energy

UNIT IV

Oscillators and Waves: Simple Harmonic Oscillator, Free, Damped and Forced Oscillations, Types of waves, Traveling waves, Interference of waves, Standing waves etc

UNIT V

Optics: Double-Slit interference, Interference due to thin films, Single Slit diffraction Intensity calculation, Multiple slits, Diffraction gratings, Dispersion and Resolving power

Text Books:

1. Robert Resnick, David Halliday and Kenneth S. Krane "Physics", Vol. I and II, 5th Edition John Wiley Inc, Singapore, 2002.

Reference Books:

1. Robert Resnick, David Halliday and Jearl Walker "*Fundamentals of Physics*", 6th Edition, John Wiley Inc, Singapore, 2001.
2. Cutnell and Johnson, "*Physics*", 5th Edition, John Wiley, Asia, 2001.

Course Outcomes

- Apply conservation of linear momentum to two/many body systems in lab and centre of mass frame of reference.
- Apply conservation of angular momentum to two/many body systems in lab and centre of mass frame of reference.
- Apply the conservation of energy principle and find the work done by a body under the influence of conservative/non-conservative forces.
- Understand the types of oscillations/waves and the fundamental equations governing them.
- Understand the physics of the most important phenomena in wave optics, namely, interference, diffraction.

Course No: **IMDTA115**	Course Title: **Engineering Graphics**	L	P	U
		2	4	4

Course Learning Objectives

- To enhance the visualization and imagination abilities
- To promote creative thinking for solving engineering problems.
- To take data and transform it into drawings.
- To learn basic Auto CAD skills
- To learn basic Engineering formats

Course Contents

UNIT-I

Drawing conventions & Practices, Dimensioning, Geometrical terms, bisecting a line, angle, arc. Regular polygons, curves.

Introduction to CAD, limits, toolbars, starting new drawing, saving new drawing, etc. Simple commands like line, circle, polygon, etc and formatting commands, 2D exercises

UNIT-II

First and third angle projections, Multi view drawing from pictorial views. Projections of points, Projection of lines, true lengths, true inclinations, shortest distances between lines.

UNIT-III

Projections of planes, Primary and Secondary auxiliary views, true shapes. Projections of solids inclined to both the planes.

UNIT-IV

Construction of Sectional views of truncated solids, Development of surfaces - Parallel Line method, Radial Line Method, Intersection of surfaces

UNIT- V

Construction of isometric views from orthographic projections, Missing Views- identifying missing Views.

Text Books

1. Engineering Drawing with an Introduction to AutoCAD, D.A.Jolhe, TMH, 5th edition, 2010
2. Fundamentals of Engineering Drawing, Warren J. Luzzader & Duff J. M., PHI, 11th edition., 2015

Reference Books

1. Engineering Drawing, K.Venugopal, New Age International (P)., 2006
2. Engineering Drawing, N.D.Bhatt, V.M.Panchal , Charotar Publishing, 53rd edition, 2014
3. Engineering Graphics with Auto CAD 2002", James D. Bethune, PHI, 2002

Course Outcomes

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

- To specify units, limits of drawing. It also includes creating and editing 2 D computer geometry, and constructing lines, arcs, chamfers and fillets.
- Draw parallel and perpendicular lines, and to construct circles, arcs, tangencies and curves.
- Apply standard vertical, horizontal, radius, diameter, and other dimensions to an engineering drawing.
- Generate Engineering Drawings using drafting tools
- Visualize geometrical solids in 3D space through exercises in Orthographic Projections
- Draw auxiliary views and isometric views
- Develop the surfaces of geometrical solids

Course No: IMDTA116	Course Title: **Computer Programming I**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce the basic concepts of UNIX operating systems.
- To understand the fundamentals of Problem Solving.
- To learn how to design and program Python applications.
- To learn how to design object-oriented programs with Python classes.
- To learn how to use exception handling in Python applications for error handling.

Course Contents

UNIT-I

Introduction to UNIX: Multi-programming, Time sharing, personal computer, and UNIX operating system, etc. **General Purpose Utilities & File System:** cal, date, and echo, etc directory related commands: pwd, cd, mkdir, rmdir, file related commands.**Simple and Advanced Filters:** head, tail, paste, sort, uniq, grep and sed, etc, **Basics of Problem solving: Building** blocks of algorithms (statements, state, control flow, functions), notation.

UNIT-II

Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), Example: find minimum in a list, insert a card in a list of sorted cards, and Towers of Hanoi etc. **Introduction to python:** History of Python, Need of Python Programming, Applications Basics of Python Programming, Data Types: Declaring and using Numeric data types.

UNIT-III

Data Types string data type and string operations, fining list and list slicing, Tuple, string, list and dictionaries **Python Program Flow Control:** if, else and else if, for loop, while loops continue, and break **Python Sequences:** String in build methods, List and dictionary manipulation, Programming using string, list and dictionary

UNIT-IV

Python Functions: Organizing python codes using functions **Python Modules:** Organizing python projects into modules, importing own module as well as external modules **Python Packages:** Lambda function, Programming using functions, modules and external packages

UNIT-V

Python Object Oriented Programming: Class, object and instances Constructor, class attributes and destructors, Real time use of class in live projects Inheritance, overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, **Exception Handling:** Avoiding code break using exception handling, Safe guarding file operation is using exception handling, Handling and helping developer with error code.**AWS Educate:** Introduction to Cloud Computing, Overview of Cloud Models, Cloud Inventor Certification.

Text Books:

1. Learning Python, Mark Lutz, Orielly, 5 Edition, 2013.

Reference Books:

1. How to Think Like a Computer Scientist: Learning with Python 3, Peter Wentworth, Jeffrey Elkner, Allen B. Downey and Chris Meyers, 3rd Edition, 2019.
2. Fundamentals of Python: First Programs, Kenneth A. Lambert, Cengage, 1st Edition, 2011.
3. Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem- Solving Focus, Wiley India Edition, 2013.
4. UNIX Concepts and Applications, Sumitabha Das, TMH, 4th edition, 2006.

Course Outcomes

After successful completion of the course student will be able to

- To execute shell commands in Linux.
- Understand, analyze and solve problems using algorithmic approach.
- Write Python programs using conditional statements, loops and functions.
- Use Python data structures -- lists, tuples, dictionaries.
- Do input/output with files in Python.
- Understand the Importance of cloud computing and its applications.

Course No: IMDEVS117	Course Title: **Environmental Science**	L	P	U
		2	0	2

Course Learning Objectives

- To understand the fundamentals of environment
- To understand the science of interrelationship between the living organisms and their environment
- To understand the relationship between the population and the environment.
- To have an understanding about the land resources, water resources, air recourses and their pollution, control methods
- To have an understanding about the waste management.
- To know about the environmental policies and laws.

Course Contents

UNIT-I

Meaning of Environment, Types and components of environment, nature and scope of the subject, Need for environment studies, goals of environmental education, environmental education programs, Man-environment relationship, biogeochemical cycles.

UNIT-II

Concept of ecology, Subdivisions and developmental phases of ecology, Concept of the ecosystem, Structural and functional aspects of ecosystem, Productivity concept of ecosystem, food chains and food webs in ecosystems, Ecological energitics, ecological interactions, Population ecology, Population characteristics, Population dynamics, population regulation.

UNIT-III

Nature and importance of soil, Formation of soil, soil properties, Nutrients in soil soil erosion, contamination of soil, Land use, Waste lands, Desertification.Introduction, properties of water, hydrological cycle, Water resources, waste water of India-its future, Water pollution, Pollution of ground water.

UNIT-IV

Origin of the atmosphere, composition of the air, structure of the atmosphere, Air pollution, Effects of air pollution on human health, flora and fauna, Global effects of air pollution.

UNIT-V

Energy, sources of energy, conventional and non conventional sources of energy, Waste water management, biomedical waste management, Air pollution control, Environmental policies and laws.

Text Books:

(1) A Text Book of Environment, Agarwal, K.M., Sikdar, P.K and Deb.S.C Mac Millan India Ltd., 2002.

Reference Books:

(1) A Text Book on Environmental Science, V. Subramanian, Third reprint, Narosa Publishing House, 2005.

(2) Environment, Raven, Peter H., and Linda R. Berg. 3rd ed., Fort Worth: Harcourt College Publishers, 2001.

Course Outcomes

After successful completion of the course student will be able to

- Understand the natural environment and its relationships with human activities.
- Characterize and analyze human impacts on the environment.
- Integrate facts, concepts, and methods from multiple disciplines and apply to environmental issues.
- Acquire practical skills; devise methodologies for scientific problem-solving, including familiarity with laboratory and field instrumentation.
- Understand and implement scientific research strategies, including collection, management, evaluation and interpretation of environmental data.
- Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Course No: IMDES121	Course Title: **Thermodynamics**	L	P	U
		3	0	3

Course Learning Objectives

- To study the properties of pure substances and their use in widely used devices such as steam power plant, fuel cells, refrigerator, Turbine and Pumps.
- To know how to use the thermodynamic tables to identify the phase of a given state of matter and estimate the quality of saturated liquid vapor mixture
- To understand the concept of heat and work and estimate the same at the boundary of real time systems
- To know the application of first law for closed systems and the interpretation of thermodynamic properties such as Internal Energy and Enthalpy and determine their change during a process; To know the application of first law for control volume systems and to understand the transient process
- To know the application of second law of thermodynamics and to know the thermodynamic temperature scale; To understand the concept of entropy and entropy change in solid, liquid and liquids and gases
- To delimit the application of second law for control volume systems and to understand the concept of efficiency of engines

Course Contents

UNIT-I

Introduction to some devices like steam power plant, fuel cells etc.; Thermodynamic system, properties and state, processes and cycles, force, energy, pressure, specific volume, Zeroth law and numerical problems; Phase equilibrium, independent property, compressibility factor; Study of steam tables and solving numerical problems.

UNIT-II

The concept of heat and work: Definition of work, understanding of piston work; Understanding of heat concept, modes of heat transfer and numerical problems on it; Definition of first law, first law for a change of state, internal energy and enthalpy; Specific heat, internal energy and enthalpy of an ideal gas, first law as a rate equation and numerical problems

UNIT-III

Application of first law for control volume systems: Conservation of mass in control volume, first law for a control volume, SSSF process and examples on it viz. Heat exchangers, Nozzles and diffusers, Throttle, Compressor & Pump, Steam Power Plant and Refrigerator; Transient process: Study of USUF process, numerical problems on it

UNIT-IV

Application of second law of thermodynamics: Heat engines and refrigerators, the Clausius and the Kelvin plank statement, reversible and irreversible processes, study of Carnot cycle and efficiency of a cycle; Thermodynamic and ideal gas temperature scale, numerical problems on it

UNIT-V

The concept of entropy: Clausius inequality, study of entropy as a property, thermodynamic property relations, entropy change of reversible and irreversible processes, entropy generation and principle of increase of entropy; Entropy change in solid, liquid and gases, polytropic process, entropy as rate equation, numerical problems; Second law for control volume, study of entropy for both reversible and irreversible processes, principle of increase of entropy; Understanding efficiency and related numerical problems

Text Books:

1. Fundamentals of Thermodynamics ISV, Sonntag R E & Claus B John Wiley, 7th Edition, 2009.

Reference Books:

1. Thermodynamics, P.K.Nag, Tata Mc Graw Hill Publishing Company limited, New Delhi, 3rd Edition, 2004.
2. Fundamentals of Engineering Thermodynamics, Michael J Moran and Howard N Shapiro, John Wiley, 5th Edition, 2004.
3. Thermodynamics- An Engineering Approach, Yunus A. Cengel and Michael A Boles, Tata Mc Graw Hill Publishing Company limited, New Delhi, 5th Edition, 2006.

Course Outcomes

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

- *Identify* and explain the basic concepts of thermodynamics like system, properties and their quantification
- *Calculate* thermodynamic properties using steam tables and *analyze* the processes on T-v diagrams to solve advanced engineering problems
- *Explain* the concept of thermodynamic work. *Calculate* and *compare* work for systems executing different thermodynamic processes or different thermodynamic cycles
- *State* and *apply* the first law of thermodynamics for closed and open systems undergoing different thermodynamic processes. *Evaluate* the performance of steam power plants, refrigeration plants and their components
- *Evaluate* the feasibility of a thermodynamic cycle using the second law of thermodynamics for typical engineering problems
- *Quantify* the second law of thermodynamics for a cycle by establishing the inequality of Clausius. *Apply* the inequality of Clausius and *establish* the property, entropy of a system. *Apply* principle of increase of entropy to *evaluate* the feasibility of a thermodynamic process

Course No: IMDAO122	Course Title: **Probability & Statistics**	L	P	U
		3	0	3

Course Learning Objectives

- This course introduces the concept of probability and enables the student to become familiar with probabilistic concepts,
- A selected study of discrete & continuous distributions and their characteristics

Course Contents:

UNIT-I

Sample Spaces and Events, Counting, Probability, The Axioms of Probability, Some elementary Theorems, Conditional Probability, Bayes' Theorem

UNIT-II

Random Variables, The Binomial Distribution, The Hypergeometric Distribution, The Mean and the Variance of a Probability Distribution, Chebyshev's Theorem, The Poisson Distribution, Poisson Processes, The Geometric and Negative Binomial Distribution, The Multinomial Distribution.

UNIT-III

Continuous Random Variables, Normal Distribution, Normal Approximation to the Binomial Distribution, Other Probability Densities, the Uniform Distribution, Log-Normal Distribution, Gamma Distribution, Beta Distribution, TheWeibull Distribution.

UNIT-IV

Joint Distributions—Discrete and Continuous, Moment Generating Functions.

UNIT- V

Populations and Samples, The Sampling Distribution of the Mean (σ known), The Sampling Distribution of the Mean (σ unknown), The Sampling Distribution of the Variance, representations of the Normal Theory Distributions.

Text Books:

1. Miller & Freund's Probability & Statistics for Engineers: Johnson Richard A., Eastern. Economy Edition, PHI, 7th Edition, 2006

Reference Books:

1. Mathematical Statistics: Freund, J.E.: Prentice Hall, 6th Edition,2002
2. Applied Statistics and Probability for Engineers: Douglas C. Montgomery, & George C. Runger, John Wiley & Sons, Inc., 3rd Edition, 2004

Course Outcomes

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

- Calculate probabilities and other relevant quantities by selecting suitable probability distributions.
- Work with certain multivariate distributions and derive marginal and conditional probability distributions.

Course No: **IMDMATH123**	Course Title: **Higher Calculus**	L	P	U
		3	0	3

Course Learning Objectives

- Use calculus to study the paths, velocities, and accelerations of moving bodies
- To study the applications of derivative motion in space
- To understand the frame of mutually orthogonal unit vectors
- To study the functions of more than one independent variable, the way to graph them
- To understand the idea of directional derivatives and the equations of tangent planes and normal lines
- To find extreme values of functions of several variable
- To find the volume of three dimensional shapes using triple integrals
- To calculate the work done by variable forces alone paths in space and rates at which fluids flow along curves and cross boundaries
- To describe the relationship between the way an incompressible fluid flows across the boundary of a plane region and the way it moves inside the region
- To understand Infinite summations

Course Contents:

UNIT-I
Limits, Continuity and Differentiability of vector functions, Velocity & Unit tangent vector, Normal vectors, Curvature, Torsion and the binormal, Tangential & normal components of velocity and acceleration.

UNIT-II
Functions of several variables, Limits and continuity in higher dimensions, Partial derivatives, differentials, linearization, Taylors formula for two variables, Chain rule for derivative, Directions derivatives, Gradient and Tangent planes, Maxima,Minima with application, Polar coordinates: Definition, graphing and conics.

UNIT-III
Double integrals in rectangular coordinates, Double integrals in polar coordinates, Cylindrical and spherical coordinates, Triple integrals in rectangular, cylindrical and spherical coordinates (moments, masses and centroids), Substitution in multiple integrals, Jacobian.

UNIT-IV
Lines integrals, potential & Conservatives fields, Green's, Gauss, and Stokes theorems, Surface area and surface integrals.

UNIT-V
Infinites series, convergence & divergence, Integral, Comparison & Ratio Tests, Alternating series and absolute Convergence.

Text Books:

Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2012.

Reference Books:

1. Thomas G.B. and Finney R. L., Calculus and Analytic Geometry, Pearson Education, 11th ed., 2008.
2. Salas S. L., Einar Hille and Garret J. Etgen, Calculus (One and Several variables), John Wiley, 8th Edition, 1999.

Course Outcomes

After successful completion of the course student will be able to

- Students will learn important tools of calculus in higher dimensions.
- Engineering applications will help the student appreciate the role of the course in B.Tech
- Geogebra software exposure for mathematical problem solving
- Students will become familiar with 2- and 3-dimensional coordinate systems.
- Students will also learn how to represent motion of objects in 3D using vector functions, how to represent velocity and acceleration using vector projections into tangential and centripetal coordinates of acceleration, and how to characterize curves in space by computing arc length and curvature.
- For functions of 3D surfaces, students will be able to characterize aspects of surfaces and volumes using partial derivatives and the gradient vector.
- Partial derivatives will also be used to describe approximating tangent planes to points on surfaces, and how to compute derivatives of multi-dimensional function compositions can be performed using a multidimensional version of the chain rule.
- Evaluating Double and Triple Integrals.

Course No: IMDPHY124	Course Title: **Physics-II**	L	P	U
		3	0	3

Course Learning Objectives

Develop an understanding of the basic principles of electromagnetism and the application of the principles with emphasis on problem solving skills.

Course Content:

UNIT I

Coulomb's law, continuous charge distributions. Electric field of point charges, continuous charge distributions, field lines, point charge and dipole in an electric field. Flux of a vector field, flux of electric field, Gauss' law, its applications, Gauss' law and conductors.

UNIT II

Electric potential, potential due to point charges and continuous charge distribution, calculating field from potential, potential from field, equipotential surfaces, potential of a charged conductor. Types of materials, conductor in an electric field, Ohm's law, Ohmic materials. Capacitance, calculation of capacitance, capacitors in series and parallel, energy storage in an electric field, capacitor with dielectric

UNIT III

Magnetic interactions, magnetic poles, force on a moving charge, circulating charges, force on a current carrying wire, Hall effect, torque on a current loop. Magnetic field due to moving charge, due to current, parallel currents, field of a solenoid, Ampere's law.

UNIT IV

Faraday's law, Lenz' law, motional emf, induced electric fields. Magnetic dipole and force on a magnetic dipole in a non-uniform field, Magnetization, Gauss' law for magnetism. Inductance, calculating the inductance, energy storage in magnetic field

UNIT V

Equations of electromagnetism, Maxwell's equations, induced magnetic fields and Displacement currents. Concept of photons, Thermal radiation, photoelectric effect. Matter waves, de Broglie's hypothesis, experimental verification by Davison and Germer experiment, uncertainty principle.

Text Books:

1. Physics, Robert Resnick, David Halliday and Kenneth S. Krane Vol. 2, John Wiley, 5th ed., 2002.

Reference Books:

1. Fundamentals of Physics, Robert Resnick, David Halliday and Jearl Walker, John Wiley, 6th ed., 2001.
2. Physics, Cutnell and Johnson, John Wiley, 5th ed., 2001.
3. Introduction to Electrodynamics, David J Griffiths, PHI, 3rd ed., 2002.

Course Outcomes

Upon successful completion of the course student will be able to:

- Understand the main concepts of electromagnetic theory
- Develop the mathematical framework to explore electricity and magnetism
- Apply the mathematical framework quantitatively for solving relevant problems
- Appreciate qualitatively how they play a role in many aspects of daily life.

Course No: **IMDTA125**	Course Title: **Scientific Measurements**	**L**	**P**	**U**
		0	**4**	**2**

- **List of Physics experiments:**

No.s	Experiments	Duration
1.	Vernier calipers and Screw gauge	1:40 H
2	Graphical Analysis	1:40 H
3.	Error analysis and Graph drawing	1:40 H
4.	Compound pendulum	1:40 H
5.	Parallelogram law of forces and Lami's Theorem	1:40 H
6.	Dispersive power of the material of the a prism	1:40 H
7.	Fly Wheel	1:40 H
8.	Diffraction Grating	1:40 H
9.	Magnetic Field along the Axis of Current Carrying Coil – Stewart and Gees Method	1:40 H
10	Hall Effect	1:40 H

- **List of Chemistry experiments:**

No.s	Name of the Experiment	Duration
1.	Estimation of iron (Fe^{+2}) by Dichrometery	1:40 H
2.	Estimation of copper by Iodometry	1:40 H
3.	pH curve of an Acid Base titration	1:40 H
4.	Dissociation constant of a weak electrolyte by conductometry	1:40 H
5.	Colorimetric estimation of Iron	1:40 H
6.	Estimation of strength of oxalic acid using potassium permanganate as an intermediate solution	1:40 H
7.	Synthesis of Nickel(II)-Dimethylglyoxime complex	1:40 H
8.	Determination of rate constant and activation energy of the given ester catalysed by an acid	1:40 H

Course No: IMDTA126	Course Title: **Workshop Practice**	L	P	U
		2	4	4

Course Learning Objectives

1. To learn how the physical artifacts we use are manufactured and gain technical knowledge and skills.
2. The practical knowledge is supplemented by the lectures to provide the knowledge and genesis of various manufacturing processes.
3. To check the dimensional tolerances of machined components and acquire knowledge of handling basic machine tools for different applications.
4. To develop skills required for machining components by advanced manufacturing methods like CNC programming.
5. To analyse the difference between conventional and non-conventional manufacturing processes.

Course Contents

UNIT-I

Basics of Manufacturing: Basics, ethics and safety in workshop, Material properties, fracture, selection, mechanical properties, common engineering materials, Metrology, quality, Inspection measuring and gauging, Limits & fits, Examples.

UNIT-II

Metal Cutting Basics: Metal cutting, Machine tools, Cutting tools, Tool material, Types of tools, Tool geometry, Chips, Cutting fluid, Tool life, Lathe machine tool, Turning and other operations,Operating conditions, MRR, Examples.

UNIT-III

Machine Shop Activities: Introduction to other Machines, tools, operating conditions, Shaping & planing machines, Milling machine, types of milling operations, Operating conditions, Milling operations, MRR, Abrasive machine, abrasives, Grinding, Grinding wheel, Grinding machines, fine finishing operations.

UNIT-IV

Sheet metal working: Production of parts by forming processes, Metal forming processes, rolling, extrusion, forging, Punches and dies, Sheet metal operations.

UNIT- V

Mechanical joining processes: Production of parts by casting processes, Mechanical joining, Welding (arc, gas), Soldering, Brazing, Fasteners, Examples, Application of Computers in Manufacturing, CNC programming for machining components using co-ordinate system, Automation, Comparison between conventional machines and NC machines.

Text Books:

1. B S Nagendra Parashar and R K Mittal, Elements of Manufacturing Process, Prentice Hall of India, 2011, 10th reprint.

Reference Books:

1. Campbell J.S., Principles of Manufacturing Materials and Processes, Tata Mc-Graw-Hill, New Delhi, 1999 print.
2. Serope Kalpakjain, Steven Schmidt, Manufacturing Engineering and Technology, Pearson, 7th Edition, 2014.

Course Outcomes

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

- The course will provide an overview of the techniques and applications of basic manufacturing processes used for producing finished articles from raw materials.
- The course is practice-orientated and requires that basic skills in handling of tools, machines and machine tools used in different manufacturing processes are acquired through the hands-on experience.
- Much of the knowledge in the course is conceptual and this knowledge will be useful in whatever discipline the students are going to specialize.

Course No: IMDTA127	Course Title: **Computer Programming II**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce object-oriented programming (OOP) using the Java programming language.
- To learn how to use the Java SDK environment to create, debug and run simple Java programs.
- To introduce Arrays, Abstract Classes, Exception Handling, File I/O and Multithreading.
- To provide hands-on experience in developing Java applications using database connections.

Course Contents

UNIT-I

Introduction to Java: Java Development Kit, Keywords, Identifiers, Class libraries, Key Attributes of OOP, Primitive Data types, Literals, Variables, Scope and lifetime of variables, Operators, Type casting, Operator precedence, Expressions. If Statement, Loops, Nested loops. **Class Fundamentals**: Objects, Reference Variables and Assignment, Methods, Constructors, Parameterized Constructors, new operator, Garbage collection, finalizers, and this keyword.

UNIT-II

Arrays: Multidimensional arrays, Alternative Array declaration syntax, using length member, Constructing Strings, Operating on Strings, Array of Strings, Using a string to control switch statement, Command line arguments, Conditional operator. Controlling access to class members, passing objects to methods, Returning Objects, Method Overloading, Overloading Constructor, Recursion, static keyword, Nested and inner classes, vararags

UNIT-III

Inheritance: Basics, Member access, Constructor and Inheritance, using super keyword, multi-level hierarchy, method overriding, abstract classes, creating and implementing an interface, multiple interfaces. **Package:** Packages and member access, Importing packages, static import

UNIT-IV

Exception: Exception Hierarchy, Multiple catch clauses, catching sub class exception, nested try blocks, throwing an exception, finally, throws, Java's Built in Exceptions. Introduction to I/O, Byte stream and Character stream, Reading and writing files using byte stream, Multithreading: Fundamentals, Life Cycle, Thread class, Runnable Interface, Multiple Threads, Thread priorities, Synchronization.

UNIT-V

Database Connectivity: Overview of RDBMS, Call Level Interface (CLI), JDBC, JDBC Architecture, types of JDBC Drivers, JDBC Connection using Statement, Prepared Statemen and Callable Statement, Scrollable and Updatable Result Set, Inserting & Fetching from BLOB Columns, Managing Transactions in JDBC. **Exploring My Cloud Powered by AWS:** Virtualization, Types of Virtualization, Cloud Containers, Client server computing, Big Data, Data Analytics, Data Visualization, DBMS, Relational and Non-Relational DBMS, Data Warehouse Basics, HTML basics to design a Web Page, QoS Factors, File System, Load Balancing, and Domain Name System.

Text Books:

1. Java Fundamentals A Comprehensive Introduction, Herbert Schildt, Dale Skrien. Tata McGraw Hill, 1st Edition, 2013.

Reference Books:

2. Java The Complete Reference, Herbert Schildt, 7th Ed. TataMcGrawHill (2007)
3. Programming with Java A Primer, E. Balaguruswamy,3rd Ed,TataMcGrawHill 2007
4. Object Oriented Programming with Java: Essentials and Applications, Rajkumar Buyya, Thamarai Selvi Somasundaram, Xingchen Chu, 1st Ed. TataMcGrawHill 2010
5. Java How to Program, Paul Dietel and Hervey Dietel, 9th Edition

Course Outcomes

After successful completion of the course student will be able to

1. Understand object-oriented programming concepts and basics of java programming
2. Solve real world problems using OOP techniques
3. Understand the use of abstract classes, packages and interfaces.
4. Expand their knowledge of AWS cloud computing models, services and tools through narrative-based scenarios and short interactive tasks.

Course No: IMDES211	Course Title: **Electrical Sciences I**	L	P	U
		3	0	3

Course Learning Objectives

- To equip the students with a basic understanding of Electrical circuits and machines for specific types of applications.

Course Contents

UNIT-I

DC Circuits, Kirchhoff's Laws, Mesh & Nodal analysis, D.C transients- First order & second order circuits- The natural and complete Response

UNIT-II

Thevenins & Nortons theorem, Linearity, Superposition, Maximum power transfer theorems, Star- Delta transformation and Concept of Duality

UNIT-III

AC Circuits: Current, voltage, power, - circuit elements R, L and C, phasor diagram, impedance, real and reactive power in single phase circuits, Steady state analysis of AC circuits using Phasor Method, Resonance in series and parallel circuits

UNIT-IV

Transformers- Introduction, Ideal transformer with and without core losses, Transformer circuit model, Determination of parameters and voltage regulation & efficiency.

UNIT- V

Induction motor, circuit model & Rotating magnetic field, Torque-Slip characteristics, Synchronous machines and and applications.

Text Books:

1. Hughes revised by Mckenzie Smith with John Hilcy and Keith Brown, *'Electrical and Electronics Technology', 8th Edition, Pearson, 2012*

Reference Books:

1. D. P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw Hill, 2009, Third edition
2. Leonard Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press 2nd edition 2005
3. W.H.Hayt, J.E. Kemmerly, *Engineering circuit analysis*, McGraw Hill Company, 6th Edition, 2000.

Course Outcomes

- The students shall develop an intuitive understanding of the circuit analysis, basic concepts of electrical machines and be able to apply them in practical situation.

Course No: **IMDES212**	Course Title: **Digital Electronics**	L	P	U
		2	2	3

Course Learning Objectives

- To obtain the knowledge of basic tools for the design of digital circuits.
- To understand the methods, procedures suitable for a variety of digital computers and related applications.

Course Content

UNIT-I

Review of number systems-representation-conversions, Boolean algebra- theorems, sum of product and product of sum simplification, canonical forms-minterm and maxterm.

UNIT-II

Simplification of Boolean expressions-Karnaugh map, completely and incompletely specified functions, Quine Mc Cluskey method, Implementation of Boolean expressions using universal gates.

UNIT-III

Combinational logic circuits- adders, subtractors, BCD adder, ripple carry look ahead adders, parity generator, decoders, encoders, multiplexers, demultiplexers, Realization of Boolean expressions- using decoders-using multiplexers. Memories – ROM- organization, expansion. PROMs. Types of RAMs – Basic structure, organization, Static and dynamic RAMs, PLDs, PLAs, PALs, Dual Data RAM (DDR), FPGA

UNIT-IV

Sequential circuits – latches, flip flops, edge triggering, asynchronous inputs. Shift registers, Universal shift register, applications. Binary counters – Synchronous and asynchronous up/down counters, mod-N counter, Counters for random sequence.

UNIT-V

Synchronous circuit analysis and design: structure and operation, analysis-transition equations, state tables and state diagrams, Modelling- Moore machine and Mealy machines, Serial binary adder, sequence detector, state table reduction, state assignment. Hazard; Overview and comparison of logic families.

Text Books

1. M Morris Mano, *Digital Design*, 5th edition, Pearson Education ,New Delhi,2013.

Reference Books

1. Charles H. Roth, Jr, Fundamentals *of Logic Design*, 5th Edition, CENGAGE Learning, India, 2004.
2. ZVI Kohavi and Niraj K Jha, *Switching and Finite Automata Theory*, 3rd Edition, Cambridge University Press, New Delhi, 2011.

Course Outcomes

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

- Realize complex logic functions utilizing programmable logic.
- Apply the digital design principles in real time applications.

Course No: IMDES213	Course Title: **Engineerng Mechanics**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce the basic principles of engineering mechanics.
- To introduce concepts of equilibrium of bodies at rest and in dynamics, the motion of bodies and the forces that cause them.
- To emphasize analysis and application to practical engineering problems.
- To promote thinking and problem solving capacity of students.

Course Content

UNIT I

Concurrent forces on a plane – composition, Resolution and equilibrium of concurrent coplanar forces, Methods of moment, Friction, Parallel forces in a plane – General case of parallel forces,

UNIT II

Center of parallel forces and center of gravity- centroids of composite plane figure and curves, Moments of inertia - Plane figure with respect to an axis in its plane and perpendicular to the plane – parallel axis theorem

UNIT III

General case of forces in a plane – composition and, equilibrium of forces in a plane –plane trusses – method of joints and method of sections, Principle of virtual work equilibrium of ideal systems

UNIT IV

Rectilinear Translation – Kinematics – Principles of Dynamics - D' Alembert's Principle- Momentum and impulse- work and energy- impact

UNIT V

Curvilinear translation – Kinematics – equation of motion – projectile – D' Alembert's Principle for curvilinear motion – Kinetics of Rotation of rigid body

Text Books

1. S Timoshenko & D.H Young , "*Engineering Mechanics*"McGraw Hill, 4th Edition

Reference Books

1. Fundamental of Engineering Mechanics: S. Rajesekharan& G. SankaraSubramanium ; Vikas Publishing House Pvt. Ltd., (2nd Edition)
2. Engineering Mechanics : K.L Kumar; Tata McGraw Hill, 4th Edition
3. A K Tayal, Engineering Mechanics, Umesh Publication, Delhi, 14th Edition.

Course Outcomes

Upon successful completion of this subject students should be able to:

- Apply the concepts of equilibrium to system of forces on rigid bodies.
- Simplify and clarify mechanics problems using free body diagrams.
- Analyze equilibrium of rigid bodies with frictional forces.
- Determine force couples, centre of gravity and moment of inertia of rigid bodies.
- Determine simple dynamic variables and solve simple dynamic problems involving kinematics, energy and momentum.
- Analyze simple statically determinate structures such as beams, pin jointed trusses and pin jointed frames subjected to various loading and supporting conditions.

Course No: **IMDECON214**	Course Title: **Principles of Economics**	L	P	U
		3	0	3

Course Learning Objectives

The course aims to provide to the students an insight into the scientific & analytical methods, techniques and tools of economics, a precise and comprehensive coverage of fundamental concepts in economics; and give suitable examples to expose him/her to possibilities of applications of these concepts in business and economic policy.

Course Content

- Introduction to Economics
- Application of Supply & Demand & Elasticity
- Demand and Consumer Behaviour
- Production & Business Organization
- Analysis of Costs
- Input Pricing by marginal productivity
- Perfectly Competitive Markets
- Imperfect Competition and its polar case of monopoly
- Oligopoly and Monopolistic Competition
- Externalities, Public Goods & Imperfect Information
- Macroeconomic concerns and its components
- GDP, Growth, Unemployment & Inflation
- Multiplier, Fiscal Policy at work
- Monetary Policy at Work and Money Supply.
- Open Economy

Text Books

1. Principles of Economics, Case E. Karl & Fair C., Pearson Education, 6th Edition, 2002.

Reference Books

1. Economics, Samuelson & Nordhus, TMH, 16th Edition, 1998.
2. Principles of Economics, Lipsey, RG & K.A. Chrystal, Oxford University Press, 9th Edition, 1999

Course No: **IMDMATHC215**	Course Title: **Complex Variables**	L	P	U
		3	0	3

Course Learning Objectives

- Identify and construct complex-differentiable functions.
- Use the general Cauchy integral theorem and formula.
- Use conformal mapping.
- Express functions as infinite series or products.

Course Content:

UNIT I: Regions in the Complex plane, Functions of Complex Variable, limits.Mappings, Theorems on limits, Continuity.

UNIT II: Derivatives, Analytic Functions, Cauchy-Riemann equations, harmonic functions, Exponential, logarithmic functions, complex exponents, Complex Trigonometric, Hyperbolic functions and their inverses.

UNIT III: Contour integrals, Anti derivatives, Cauchy theorem, Cauchy Integral Formula,

UNIT IV: Morera's theorem, Liouville's Theorem, Maximum Modulus Principle, Convergence of sequences of series, Taylor's and Laurent series,

UNIT V: Residues poles and zeros of analytic functions, Applications of residues, Conformal mapping, Fourier Transforms and Z Transforms.

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, Latest Indian Edition

Reference Books:

1. Complex Variables and Applications, J.W. Brown, R.V. Churchill, Mc Graw-Hill, 7th ed, 2003.

2. Complex analysis for Mathematics & Engineering, , John H Mathews & Russel W Howell, Jones & Barlett Publishers, 2001

3. NPTEL Videos http://nptel.ac.in/courses/111103070/

Course Outcomes

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

- Define continuity and differentiability for complex functions,
- Prove the Cauchy-Riemann equations and apply them to complex functions in order to determine whether a given continuous function is complex differentiable,
- Compute the radius of convergence for complex power series,
- Define the complex exponential function, trigonometric and hyperbolic functions and use their basic properties,
- Evaluate integrals along a path - directly from the definition and also via the Fundamental Theorem of Contour Integration and Cauchy's Theorem,
- Compute the Taylor and Laurent expansions of simple functions, determining the nature of the singularities and calculating residues,
- Prove the Cauchy Residue Theorem and use it to evaluate integrals.

Course No: IMDMATH216	Course Title: **Differential Equations and Fourier Series**	L	P	U
		3	0	3

Course Learning Objectives

- To solve first and second order Ordinary Differential Equations by standard methods
- To gain exposure to Engineering applications of Ordinary Differential Equations.
- Introduction to Laplace Transforms for future Engineering courses
- Basics of Fourier series required for Engineering
- Solving important Partial Differential Equations (Simple cases of Wave & Heat equations).

Course Contents

UNIT-I First order differential equations, Reduction of order, second order equations with applications bending of beams and electrical circuits.

UNIT-II Second order homogeneous equations with constant coefficients and the Method of Undetermined Coefficients, Variation of parameters, higher order linear equations.

UNIT-III Power series solutions and ordinary points, Frobenius Method & Regular singular points, Gauss' hyper-geometric equation, Legendre polynomials & Bessel functions.

UNIT-IV Laplace Transform & Inverse Laplace Transform, Convolution of Laplace Transform & application to differential equations,

UNIT- V Fourier series and convergence, Cosine and Sine series, Sturm-Liouville problem, one dimensional Heat and Wave equations and Laplace equations in rectangular form.

Text Books:

Advanced Engineering Mathematics, Erwin Kreyszig 10th Edition, John Wiley & Sons, 2012.

Reference Books:

1 George F.Simmons and Steven. G. Krantz, Differential Equations: Theory, Technique and Practice Tata Mc-Graw Hill, 2007.

2 Elementary Differential Equations, W.E.Boyce and R.C.Diprima, 7th Edition, John Wiley, 2001.

Course Outcomes

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

- Solve standard ODEs of First and Second Order
- Compute Laplace and Inverse Laplace Transforms for functions in Engineering
- Expand functions in Fourier/Sine/Cosine series
- Obtain series solutions for standard PDEs in two variables

Course No: IMDES221	Course Title: **Electrical Science II**	L	P	U
		3	0	3

Course Learning Objectives

- Characterize semiconductors, diodes, transistors and FETs
- To study behavior of Diod and its applications
- To study characteristics of electronic devices to understand their behavior.
- To design simple analog circuits using BJTs, FETs and Diodes.
- To design and evaluate audio, Power and Feedbak amplifiers.

Course Contents

UNIT-I

Semiconductors: intrinsic and doped; p-n junction. Junction Diode & its characteristics.Defferent types of modeling of Diodes. Ideal Diode and Practical diodes. Zener Diode & its characteristics. Applications of Zener Diode. Application of Practical Diodes: Clamper and Peak to Peak Detector.

UNIT-II

Introduction to transistors, PNP Transistor, NPN transistors and their characteristics & operation.

Types of biasing the transistors.CE & CB Configuaration. Different catergories of operation: active region, Cutoff and Saturation. Application to Digital Logic Circuits. Introduction to JFETs, their operation & characteristics. MOSFETs & its characteristic (Depletion and Enhancement MOSFET). Introduction MOSFET logic gates and characteristics. Introduction CMOS logic gates and characteristics.

UNIT-III

Introduction to JFETs, their operation & characteristics. MOSFETs & its characteristic (Depletion and Enhancement MOSFET). Introduction MOSFET logic gates and characteristics. Introduction CMOS logic gates and characteristics.

UNIT-IV

Biasing the BJT and Amplifier, Small Signal AC Models, Additional Amplifier Principles. FET Amplifier with common source, fixed biasing and self-bias. Biasing Enhancement MOSFETs. Small Signal AC Models, MOSFET feedback amplifiers. Effect of bypass capacitors, FET amplifiers. Class A Power Amplifier, Power terminology, Class B power amplifier maximum output power.

UNIT- V

Ideal Op-amp characteristic, equivalent circuit & Block diagram, Parameters of practical Op-amp, CMRR, skew rate, offset voltage and current Series parallel FB amplifier, non-ideal op-amp.

Text Books:

1. Leonard Bobrow, *Fundamentals of Electrical Engineering*, Oxford University Press, Asian Edition Adapted by Navneet Gupta.

Reference Books:

1. Alan R. Hambley, *Electrical Engineering: Principles and Applications*, Publisher, 6nd Edition 2013.
2. W.H.Hayt, J.E. Kemmerly, *Engineering circuit analysis*, McGraw Hill Company, 8th Edition, 2013.
3. Vincent Del Toro, *Electrical Engineering Fundamentals*, Phi Learning, 2nd Edition.

Course Outcomes

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

- Study and analyze the behavior of PN junction diodes.
- Characterize the current flow of a bipolar transistor in CB and CE configurations
- Bias the transistors and FETs for amplifier applications.
- Realize simple amplifier circuits using BJT and FET.

Course No: IMDTA 222	Course Title: Engineering Measurements	L	P	U
		1	6	4

Course Learning Objectives

- To give introduction to the experimental methods and measurement techniques.
- To train the students in the operation of various instruments and equipments and the measurement of various parameters in electronics and mechanical engineering.

UNIT -I:

Generalized Measurement System, Calibration, Standards, Dimensions and Units, Impedence Matching, Experiment Planning, Causes and Types of errors, Error Analysis, Uncertainty Analysis, Evaluation of uncertainties, Method of Least Squares, The Correlation Coefficient, Multiple regression, Standard deviation of mean, Graphical Analysis and Curve fitting, Choice of Graph Formats, General considerations in Data Analysis

UNIT-II:

Basic analog meters, Basic digital meters, Basic input circuits, The Electronic Voltmeter, Digital voltmeters, The Oscilloscope, Variable resistance, LVDT, Capacitive Transducers Photo electric effects, Hall effect Transducers, Digital Displacement Transducers, Comparison of analog &digital instruments

UNIT-III:

Area measurements, Graphical measurement , Planimeter, Graphical and Numerical Methods for Area measurement, Mechanical pressure-measurement devices, Dead weight tester, Bourdon tube, Diaphragm & Bellow Gages, Bridgman Gage, Low-Pressure Measurement, McLeod Gage, Ionization Gage,Alphatron.

UNIT-IV

Flow measurements, Positive-Displacement methods, Flow obstruction methods, Sonic nozzle, Drag effects, Hot-wire and Hot-film Anemometers, Magnetic flowmetersFlow –visualization methods, Laser Doppler Anemometer, Smoke methods, Pressure probes, Impact pressure in supersonic flow.

UNIT-V

Temperature measurements, Temperature scales, Ideal-gas thermometer, Temperature measurements by mechanical effects, by electrical effects, by radiation, heat transfer effect, transient response of thermal systems, thermocouple compensation, Temperature measurements in high flow speed flow.

Concepts of Radiation, types, Detection of Radiation, GM counter, Ionization chambers, Photographic detection , Scintillation Counter, Neutron detection

Text Books

J.P.Holman,Experimental Methods for Engineers, TMH , 7th Edition, 2007

Reference Book

E.O. Doebelin ,Measurement Systems: Application & Design, 6th Edition, 2011

Course Outcomes

Upon successful completion of the course student will be able to:

- Measure calibration errors in instruments
- Measure Area of a given curve
- Choose the graph format for any given curve: Can draw Semi-Log Graph.
- Operate and understanding the operation of pressure, flow, temperature, strain & stress measuring instruments

Course No: IMDTA223	Course Title: **Professional Communication**	L	P	U
		3	0	3

Course Learning Objectives

The course aims at acquiring the students

- to understand various aspects of business communication.
- to gain knowledge regarding the various ways of assembling information,
- to write clearly and concisely and to present information in an effective manner
- to train them for oral presentation.

Course Contents

UNIT-I

Basics of Communication process, Features of Techincal communication, differences between general purpose communication and technical communication, Verbal and non verbal communication and their differences, understanding and overcoming barriers of communication.

UNIT-II

Definition and characteristic features of a technical report, Classification of reports, Strucutre and Layout of report, Various elements of a report and features of each of the elements, Various ways of collection of data, principles of preparing a questionnaires, Practicing questionnaire preparation, Organization of materials, Preparation of the outline, Formatting techniques.

UNIT-III

Elements of effective writing, Mechanics of writing, Writing styles and use of suitable words and phrases for technical writing according to the context, Revision practices, Principle steps of writing a précis, making notes, abstract and executive summary.

UNIT-IV

Oral presentation features, Use of illustrations, tables and visual aids in presentation and technical writing, Non –verbal aspects in oral presentations, Reading skills for different purposes.

UNIT- V

Distinctive features of memo reports and letter reports, Preparing Notice, Minutes of meeting Brochures,Instructions manual and User's Manual, Understand the difference between Preparing Notice, Minutes of meeting Brochures,Instructions manual and User's Manual, Business Letter formats, layouts and its significance.

Text Books:

1. Koneru. A. (2008).*Professional Communication.* McGraw Hill

Reference Books:

1. Omfort, Jeremy et al (1984). *Business Report in English.* Cambridge University Press
2. Gerson & Gerson (2000). *Technical Writing Process and Product.* Pearson Education.

Course Outcomes

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

- Understand the aspects of verbal and non verbal communication in its significane in professional and personal communication
- Utilize their knowledge of report writing and write appropriate technical reports.
- Make oral presentations
- Distinguish between various busniness communicational formats and use them appropriately.

Course No: IMDMGTS224	Course Title: **Principles of Management**	L	P	U
		3	0	3

Course Learning Objectives

The course aims at acquainting the students with various aspects of modern management. During the past two decades a revolution has taken place in the area of management. The new era is one in which entrepreneurship; innovation & technology are seen as the backbone of management. The emphasis is on the modern management essentials, drawing up from the earlier principles & practices, so as to enable the students to be familiar with the basic concepts of management when they enter the professional world.

Course Content

- Introduction to Management: Science, Theory & Practice
- Management & Society: Social Responsibility and Ethics
- Essentials of Planning
- Setting Objectives
- Strategies, Policies & Planning Premises
- Decision- Making
- The Nature of Organizing
- Organizational Structure: Departmentation
- Line/ Staff Authority, Empowerment, & Decentralization
- Managing Change through Manager and Organization Development
- Human Resources Management and selection
- Performance Appraisal & Career Strategy
- Motivation
- Leadership
- Communication
- The System & Process of Controlling
- Control Techniques
- Marketing Management
- Production & Operations Management
- Information Technology
- International Management

Text Books

1. "Essentials of Management", Koontz H. and Weihrich H., 7th edition, Mcgraw Hill Int. ed., 2007.

Reference Books

1. "Management, Principles and Practices for Tomorrow's Leaders", Gary Dessler, 3rd edition, Prentice Hall, 1998.
2. Engineering Management, Fraidoon Mazda, 1st edition, Addison-Wesley, 1999

Course No: **IMDAO225**	Course Title: **Optimization Techniques**	L	P	U
		3	0	3

Course Learning Objectives:

- Introduction to optimization techniques using both linear and non-linear programming.
- Students will learn to frame minima maxima problems in the framework of optimization problems.

Course Content:

UNIT-I:

Introduction to Linear Programming, Assumptions of Linear Programming, the Simplex Method in Tabular Form, the Revised Simplex Method, Duality Theory, Primal-Dual Relationships

UNIT-II:
The Transportation Problem, Methods of solutions to transportation problem, The Assignment Problem, Hungarian Metod

UNIT-III:
Dynamic Programming, Characteristics of Dynamic Programming Problems, Deterministic Dynamic Programming

UNIT-IV
Integer Programming, Formulation, the Branch-and-Bound Technique, a Branch-and-Bound Algorithm for Mixed Integer Programming

UNIT-V:
Nonlinear Programming , Graphical Illustration of Nonlinear Programming Problems , Types of Nonlinear Programming Problems , One-Variable Unconstrained Optimization , Multivariable Unconstrained Optimization , The Karush-Kuhn-Tucker (KKT) Conditions for Constrained Optimization.

Text Books:

1. F.S.Hillier, G.J. Lieberman, Introduction to Operations Research, 9e, TMH, 2012

Reference Books:

1. H.A. Taha, Operations Research- An Introduction, 7e, PHI,

2. Ravindran, Phillips, Solberg, Operations Research: Principles and Practice, 2e John Wiley & Sons, 2007

Course Outcomes:

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

- Cast minima/maxima problems into optimization framework.
- Learn efficient computational procedures to solve optimization problems.

Course No: IMDES226	Course Title: **Structure and Properties of Materials**	L	P	U
		3	0	3

Course Learning Objectives

- The course is interdisciplinary in nature, predominantly covering the fields of physics, chemistry, mechanical and metallurgical engineering
- The course is offered to students of all branches of engineering, and provides an excellent understanding of the structure of materials at the atomic and microscopic level
- The main objective is to show how the type of bonding and crystal structure affects properties of metallic, ceramic, electronic and polymeric materials
- The course aims at to establish correlation between processing/Structure/Performance of materials of importance and shed light on interesting materials and their applications

Course Contents

UNIT-I

General understanding of materials science, Bonding forces and their types: Atomic bonding in solids. Crystal structures and systems: Unit cells, crystallographic directions and planes, Crystalline and non crystalline materials, Single crystals and polycrystalline Materials, Metallic structures, Ceramic and polymer crystal structure, Density computations, Linear and planar densities, Polymorphism and allotropy, Imperfections in solids: Impurities in solids, specification of composition, Defects and dislocations, point defects, Linear defects, Interfacial and bulk defects.

UNIT-II

Diffusion in solids: Diffusion mechanisms, steady and non-steady state diffusions, Factors that affect diffusion, Diffusion in Ionic and polymeric materials. Dislocations and strengthening mechanism in metals: Dislocation characteristics, Slip systems, slip in single crystals, plastic deformation of polycrystalline solids, strengthening mechanisms and strain hardening. Mechanical Properties of solids: Concepts of stress and strain, Elastic and Plastic deformation, Hardness

UNIT-III

Structure and properties of ceramics: Mechanical test behavior of ceramics, Types and application of ceramics, Applications and processing of ceramics, Fabrication and processing of glasses: Glasses - Glass forming – properties, heat treatment of glasses and glass ceramics. Polymer structures: Molecular size, shape & structure of polymers, Important Characteristics of polymeric materials, Mechanical behavior, Crystallization and processing of polymers

UNIT-IV

Phases, microstructures, phase equilibrium: Phase diagrams, unary, binary and binary Eutectic phase diagrams, Lever Rule. Iron carbon systems: Fe-Fe_3C phase diagram, development of micro-structure in Fe-C alloys. Kinetics of phase transformations: Avarami rate equation, Correlation of properties to microstructures, Isothermal transformation diagrams - continuous cooling diagrams, Mechanical behavior of Fe-C alloys, tempered martensite

UNIT-V

Thermal properties of materials; Electronic properties: Energy band in semiconductors etc., Piezoelectricity and Ferro electric materials, applications. Magnetic properties: Super conductivity, superconducting materials and applications, Nanotechnology: Carbon Nano Tubes and their applications.

Text Books:

1. Callister's Materials Science & Engineering Adopted by R. Balasubramaniam, Wiley India Pvt. Ltd., 9th Edition, Reprint 2016.

Reference Books:

1. Engineering Materials: Properties and Selection, K.G. Budinski and M. K. Budinski, Prentice Hall of India, 9th Edition, 2008.

2. The Science and Engineering of Materials, Donald R. Askeland and Pradeep P. Phule, 4th Edition, Thomson book Company, 2003.

3. Principles of Materials Science and Engineering, William F. Smith, Mc Graw-Hill 3rd Edition 1996.

Course Outcomes

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

- Identify bonding in different material types; describe the lattice structure of materials; describe the lattice parameters for 7 crystal systems; specify the Miller indices for the planes in a unit cell of metals, ceramics and polymers. Define isotropy and anisotropy w.r.t. material properties; describe various types of defects and dislocations and interpret atomic structure within the vicinity of grain and twin boundaries.
- Describe the atomic mechanisms of diffusion in metallic, ionic and polymeric materials; distinguish between steady state and non-steady state diffusions; Explain the factors that affect the rate of diffusion; define slip systems and its relation to mechanical properties; Define stress, strain, state Hook's law, Poisson's ratio; Discuss various mechanical properties like strength, toughness, resilience and hardness

- Describe the process used to produce glass-ceramics; describe structure, composition of different types of ionic, covalent ceramics viz. cements, refractories, clay products, abrasives. Compute the flexural strength of ceramics by transverse bending test; Interpret the effect of porosity on strength of ceramics; explain the procedure of thermal tampering of glass; Describe polymer structure, classification based on shape, size, chemistry and molecular configuration; Thermosetting and thermoplastic polymers; Interpret mechanical properties of elastomers

- Describe phase, composition in binary phase diagram of alloys; explain the phase diagram of Fe-C systems and estimate the composition of individual phases Explain the kinetics of phase transformation; describe the microstructure of micro-constituents of iron alloy and cite mechanical characteristics of each; Isothermal cooling and C-C-T diagrams.

- Describe the electronic band structure; electrical conductivity of metals, semiconductors, electronic mobility; Describe the phenomenon of ferroelectricity and piezoelectricity; Describe the phenomenon of superconductivity; Define heat capacity and specific heat, thermal conductivity and thermal stress; Determine the linear coefficient of thermal expansion; explain the phenomenon of thermal expansion from an atomic perspective; Explain the structure, property and applications of nano materials.

Course No: **IMDAO312**	Course Title: **Control System**	L	P	U
		3	0	3

Course Learning Objectives

- To equip the students with the fundamental concepts in control systems.

Course Content

UNIT-I

Modelling of physical systems: Differential equations of physical systems, mechanical systems and electrical analogies, Electrical systems - Electromechanical systems – Mechanical systems – Thermal systems. Concept of Transfer Function, Block diagrams and reduction methods, Construction of Signal flow graphs; Mason's Gain formula and its applications

UNIT-II

Feedback systems and effect of feedback on sensitivity and system dynamics, Effect of feedback on control systems with disturbance signals. Time domain analysis: Test signals and time domain response of first order system, Response of second order system; time domain specifications, Steady state errors and error constants for various types of systems

UNIT-III

Stability of control systems and effect of root locations, Routh-Hurwitz stability criterion. Concept of root locus and magnitude and angle criteria, Root locus construction rules, Effect of pole-zero additions on the root loci.

UNIT- IV

Frequency domain analysis: Bode plot - Polar plot - Nyquist plot - phase-margin - gain margin - Nyquist stability criterion.

UNIT- V

Controller design: Design of P, PI, PID, lag, lead, lead-lag compensator design.

Text Books

1. Katsuhiko Ogata, '*Modern Control Engineering*', 5th Edition, Pearson Education Publishers, New Delhi, 2010.
2. Nagrath I.J. and Gopal M, '*Control Systems Engineering*', 5th Edition, New Age International Publications, New Delhi, 2010.
3. Benjamin C.Kuo and Farid Golnaraghi, '*Automatic Control Systems*', 8th Edition John Wiley & Sons Publications, New Delhi, 2002.

Reference Books

1. Richard C. Dorf and Robert H. Bishop. '*Modern Control Systems*', 12th Edition Pearson Prentice Hall Publications, New Delhi, 2010.
2. Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, '*Feedback Control of Dynamic Systems*', 6th Edition. Pearson Education India Publications, New Delhi, 2008.

Course Outcomes

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

- Understand the concepts of closed loop control systems.
- Analyze the stability of closed loop systems.
- Apply the control techniques to any electrical systems.
- Design the classical controllers such as P, PI, etc., for electrical systems.

Course No: IMDAO 311	Course Title: **NUMERICAL METHODS**	L	P	U
		1	6	4

Course Learning Objectives: Enables one to devise algorithms for the numerical solutions of mathematical problems. Applications to problems from Engineering are included for each method.

Course Content:

UNIT 1:

Computer Arithmetic and Errors, Interval halving /Bisection , Linear interpolation methods, Newton's method, Muller's method, Fixed point iteration: x = g(x) method, Multiple roots.

UNIT II:

The Gaussian Elimination and Gauss - Jordan methods, LU-decomposition approach, Norms, Condition numbers and errors in solutions, Iterative methods-Gauss-Seidel and Jacobi methods

Unit-III:

Interpolation; Newton and Lagrangian polynomials, divided differences, Derivatives from difference tables, Higher order derivatives, Newton - Cotes integration formulas, The trapezoidal rule - a composite.

UNIT IV:

Simpson's rules , Gaussian integration, The Taylor Series method, Euler and Modified Euler's method, Runge- Kutta methods, Multistep methods, Milne's method, The Adams-Moulton method, System of equations and higher order equations

UNIT V:

Solution through set of equations, Derivative boundary conditions, Eigen - value problems(Power Method)

Text Books

1. Steven Chapra, Raymond Canale., *Numerical Methods for Engineers*, Tata McGraw Hill, New Delhi, 5th Edition, 2007.

Reference Books

1. Francis Scheid , *Numerical Analysis*, Schaum's Outline, Tata McGraw Hill, New Delhi, 2009.

2. S.S.Sastry , *Numerical Methods* , PHI, New Delhi, 2010.

3. Erwin Kreyszig, *Advanced Engineering Mathematics*, 9th Edition, John Wiley & Sons, Inc, Singapore, 2006.

Learning Outcomes Upon successful completion of the course the student will be able to

- To solve nonlinear equations by standard methods.
- To solve Linear equations by Gauss-Seidel and other methods.
- To perform Matrix inversion by Gauss-Jordan method.
- To do Numerical differentiation and integration by standard methods.
- To solve ODEs numerically by standard methods.
- To apply software packages to solve above problems.

Course No	Course Title	L	P	U
IP221	Internship Program I	0	0	5

Scope & Objective of the Course:

This course is run during the Summer Term only at various industries and is of about 8 weeks. This course aims to provide an exposure of the world of professional work to the students.

Textbook(s): Not Applicable
Reference book(s): Not Applicable
Lecture-wise plan: Not Applicable

Evaluation Scheme:

Evaluation Component	Weightage (%)	Duration
Quiz-I	5	2nd week
Group Discussion-I	7	3rd week
Seminar-I	10	6th week
Project Report-I	10	7th week
Observation-I	6	7th week
Diary-I	2	Daily
Mid-Term Grading	40	16th week
Quiz-II	5	9th week
Group Discussion-II	8	12th week
Seminar-II	15	15th week
Project Report-II	20	16th week
Observation-II	9	16th week
Diary-II	3	Daily
Final Grading	100	

Course No	Course Title	L	P	U
IP401	Internship Program II	0	0	20

Scope & Objective of the Course:

The IP II Program is planned to bridge the gap between the professional world and the academic world and is implemented during the final year of graduation in either of the semesters. This Program constitutes working on real life situations, necessary for subsequent problem-solving efforts in the professional world.

Textbook(s): Not Applicable
Reference book(s): Not Applicable
Lecture-wise plan: Not Applicable

Evaluation Scheme:

Evaluation Component	Weightage (%)	Duration
Quiz-I	4	2nd week
Group Discussion-I	5	3rd week
Seminar-I	6	6th week
Project Report-I	5	7th week
Observation-I	3	7th week
Diary-I	3	Daily
Quiz-II	4	9th week
Group Discussion-II	5	12th week
Seminar-II	6	15th week
Project Report-II	5	16th week
Observation-II	3	16th week
Diary-II	3	Daily
Mid-Term Grading	52	16th week
Quiz-III	4	17th week
Group Discussion-III	5	20th week
Seminar-III	12	Last week of IP II
Project Report-III	20	22nd week
Observation-III	4	End of IP II
Diary-III	3	Daily
Final Grading	100	

Course No	Course Title	L	P	U
TS401	Thesis & Seminar	0	0	20

Objective of the course:
This course TS 401 is a must for all students with Thesis option for the eligibility of degree. This course involves research work in an active area to satisfy the creative urge in a student and may involve advanced study learning and experimentation. This work may form the basis for dissertation of a higher degree. Also this requires fulltime work from the student for a complete semester and must co-terminate with thesis report.

Textbook(s) No prescribed text book. Literature Survey to be done with peer reviewed journals.
Reference book(s) - do -
Mid -Semester Grading and Final Grading
TS 401 courses are only awarded non-letter grades Excellent/Good/Fair/ Poor based on the performance of the student as per the evaluation scheme Mid term Grading is to be done announced to the student. All grades are to be submitted to the IC in the format provided to the Supervisors.
Operation Procedure
1. Student has to devote full semester for TS 401 course.
2. Student has to report to Supervisor regularly.
3. Particular of Thesis is to be submitted to IC within two weeks of registration
4. Seminars and Thesis evaluation has to carried out in the presence of two member Committee comprising of experts in the relevant area constituted by the Supervisor.
5. Final Thesis to be submitted has to be in formal hard bound cover bearing the Institute emblem.

Course No	Course Title	L	P	U
CE 491/CS 491 EC 491/EE 491 ME 491	Special Project	0	0	3

- **Scope & objective of the course:**

This is an unstructured open ended where under the overall supervision of a faculty-in-charge, batches of students will be attached to different faculty members. Each batch will work on a specific time bound which is of basic or peripheral concern of student's discipline. Each student must submit a project report as a culmination of his endeavor and investigation. Faculty-in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. This course will aim to evaluate the student actual ability to use the fundamentals of knowledge and to meet the new unknown situations as demonstrated by the student's interaction with the faculty member and faculty-in-charge. The faculty-in-charge may assign specific hours of formal brain storming sessions.

4. Evaluation Scheme:

Component	Duration (hr/min)	Weightage (%)	Remarks
Literature Survey	2nd week	7	
Project outline	3rd week	5	**To be submitted to I/C by the faculty**
Diary -I	**Continuous**	4	
Observation-I	**Continuous**	4	
MidTerm Project	7th week	15	
Report	7th week		
Mid-Semester	8th week	10	
Seminar/Viva	8th week		
Mid-Term Grading	8th week	45	**To be submitted to I/C by the faculty**
Diary-II	**Continuous**	5	
Observation-II	**Continuous**	5	**A copy to be submitted to I/C by the faculty**
Final Project Report	14th week	25	
Final Seminar	15th week	20	
Final Grading	15th week	100	**To be submitted to I/C by the faculty**

Textbook(s) & Reference book(s)

Based on literature survey to be done with peer reviewed journals.

General guidelines:

a) This being a three unit course, a student is expected to work for at least 9 hours per week including the formal contact hours with the instructor.

b) Each student should meet the faculty at least once a week in addition to the formal contact hours at mutually agreed time to apprise the faculty of the progress in the project.

c) Student is supposed to maintain a diary and record the daily progress of the work done. The diary would be periodically checked by the faculty.

d) All the evaluation components are compulsory. If a student misses any component of evaluation, he is likely to get 'NC'.

e) The Mid-term evaluation is to be strict to avoid any laxity on the part of the student.

f) Student should make two copies of the final report in the prescribed format, one his personal copy and the other for submission to the Institute. The faculty may ask for an additional copy if so desired.

g) The final seminar is to be planned only after the submission of the project report.

h) The final seminar is open to all the students and the faculty. The faculty member should involve the local experts in the evaluation of final seminar.

i) If the progress in the project work is not satisfactory, the faculty may advise the student to withdraw from the course in time and the same may be communicated to the instructor-in-charge.

j) The student should submit the withdrawal request to the Convener, Academic Registration Committee. The last day for withdrawal is the same as that for all other courses.

k) If more than one student is working on the same project, the distribution of work among the students is to be made clear to the students and the Instructor-in-charge. The evaluation should be based on individual performances only.

l) The details of components of evaluation should be submitted in the prescribed format only.

m) The student is expected to attend a **conference** on the area of project opted or present a **technical paper** in any of the journal.

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Course No	Course Title	L	P	U
TIP 491	Technology Innovation Project	0	0	3

Scope & Objective of the course:

A unique opportunity for the students in the form of a course that facilitate the combination of academics with the industry by involving an in-depth innovation, investigation under the supervision of mentor from Industry and a faculty member for performing the real-life projects with the support from various organizations. Students working in groups will be required to perform research, customer and problem discovery, ideation, concept creation and validation, and technical implementation for a real-world challenge. The specific time-bound based on the students registered for the course will be graded based on the performance feedback from both the industry and the Faculty supervisor. The student will be able to improve the skills and knowledge for improving written and oral communication with indicative content which includes innovation methodology, customer & problem discovery, problem validation, innovation experiments with innovative presentations.

Evaluation:
Student evaluation is based on Literature survey, seminar series conducted, and observations of the supervisor and Thesis report.

Component	Weightage (%)	Date	Remarks
Literature Survey and Project outline	20	3rd week	Supervisor to submit copy to IC
Mid-term Project Report	10	7th week	Supervisor to submit to IC after evaluation
Mid-term Seminar	20	8th Week	Mid-semester grading to be submitted to IC by Supervisor
End-Sem Project Report	25	14th week	Supervisor to submit to IC after evaluation
End-Sem Seminar	25	15th Week	

Textbook T1	There are no specifically prescribed or recommended texts for this subject as student must do literature survey from journals of his field of research.
Reference book(s) R1	Related to Project work

General Guidelines:

a) This being a three-unit course, a student is expected to work for at least 12- 14 hours per week including the formal contact hours with the instructor.

b) Each student should meet the faculty and mentor from Industry at least twice a week in addition to the formal contact hours at mutually agreed time to apprise the faculty of the progress in the project.

c) Student is supposed to maintain a diary and record the daily progress of the work done. The diary would be periodically checked by the faculty.

d) All the evaluation components are compulsory. If a student misses any component of evaluation, he is likely to get "NC".

e) The Mid-term evaluation is to be strict to avoid any laxity on the part of the student.

f) Student should make two copies of the final report in the prescribed format, one his personal copy and the other for submission to eh Institute. The faculty may ask for an additional copy if so desired.

g) The final seminar is to be planned only after the submission of the project report.

h) The final seminar is open to all the student and the faculty. The faculty member should involve the local experts in the evaluation of final seminar.

i) If the progress in the project work is not satisfactory, the faculty may advise the student to withdraw from the course in time and the same may be communicated to the instructor-in-charge.

j) The student should submit the withdrawal request to the Convener, Academic Registration Committee. The last day for withdrawal is the same as that for all other courses.

k) If more than one student is working on the same project, the distribution of work among the students is to be made clear to the students and the Instructor-in-charge. The evaluation should be based on individual performances only.

l) The details of components of evaluation should be submitted in the prescribed format only.

m) The student is expected to attend a conference on the area of project opted or present a **technical paper** in any of the journal.

Learning Outcomes:

After successful completion of the course student will be able to

1. Work independently as part of an interdisciplinary team to complete a technical innovation project
2. Collect and critically analyse a range of data about the project allotted by creating innovation hypotheses from the data
3. Validate innovation hypotheses
4. Conceptualize, design, and implement an innovative and technology-based solution to the identified problem Present technical solutions to various stakeholders in both written and oral forms

B.Sc. Program (Mathematics)

Course Handouts

Course No: MATH211	Course Title: **Stochastic Processes**	L	P	U
		3	0	3

Course Learning Objectives:

- The course will consider Markov processes in discrete and continuous time.
- Elucidate the power of stochastic processes and their range of applications.

Course Contents

UNIT-I

Introduction to Stochastic processes. Specification of stochastic process, Stationary process, martingales

UNIT-II

Markov chain, Transition probability, Classification of states and chains. Determination of higher transition probability, Stability of Markov chain. Reducible chains, Markov chain with discrete and continuous space.

UNIT-III

Poisson process with related distribution, Generalization of Poisson process,
Birth and death process, Erlang process,

UNIT-IV

Brownian motion, Wiener process, Kolmogorov equations, First passage time distribution of Weiner process

UNIT- V

Renewal process, Renewal process in continuous time, Renewal equations,
Wald's equation, Renewal theorem, delayed and equilibrium renewal process.

Text Books:

Stochastic Process by J. Medhi, New Age International Publication (2nd edition}

Reference Books:

1. Stochastic Process by Shedon M. Ross, Wiley & sons, (2nd edition)
2. Probability, Random Variables and Stochastic Processes, 4th Edn.
A.Papoulis and S. U. Pillai, TMH Publication.

Course Outcomes

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

- Demonstrate essential stochastic modelling tools such as Markov chains, Poisson process, formulate & solve problems which involve setting up stochastic models.

Course No: MATH221	Course Title: **Partial Differential Equations & Systems of ODEs**	L	P	U
		3	0	3

Course Learning Objectives

- Evaluate first order differential equations including separable, homogeneous, exact, and linear.
- Show existence and uniqueness of solutions.
- Solve second order and higher order linear differential equations.
- Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits.
- Solve differential equations using variation of parameters
- Solve linear systems of ordinary differential equations
- Introduce students to partial differential equations.
- Introduce students to how to solve linear Partial Differential with different methods.
- To derive heat and wave equations in 2D and 3D.

Course Contents

UNIT-I

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.

UNIT-II

Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients (Two Equations in two unknown functions). Simultaneous linear first order equations in three variables, methods of solution.

UNIT-III

Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

UNIT-IV

Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions.

UNIT- V

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients, Separation of variables, Non-linear equation of the second order.

Text Books:

1. J.Sinha Roy and S. Padhy, A Course on Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi, Ludhiana, 2012.

Reference Books:

1. Differential Equations: Theory, Technique and Practice, George F.Simmons and Steven. G. Krantz, Tata Mc-Graw Hill, 2007.
2. An Elementary Course in Partial Differential Equations, T Amaranath, Narosa Publishing House, 2013.
3. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
4. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi
5. An Introduction to Ordinary Differential Equations, Earl A. Coddington, PHI, 2002.

Course Outcomes

Upon successful completion of the course, students will be able to:

- The student will be able to solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- The student will be able to find the complete solution of a nonhomogeneous differential equation as a linear combination of the complementary function and a particular solution.
- The student will be introduced to the complete solution of a nonhomogeneous differential equation with constant coefficients by the method of undetermined coefficients.
- The student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.
- Solve linear partial differential equations of both first and second order
- Apply partial derivative equation techniques to predict the behaviour of certain phenomena.
- Apply to specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialisation.
- Identify real phenomena as models of partial derivative equations.

Course No: MATH311	Course Title: **Real Analysis**	L	P	U
		3	0	3

Course Learning Objectives: This course is intended to expose student to the basic ideas of Real Analysis. In particular,

- To learn about Real Numbers and the Axiom of Completeness, Sequences and Limits of Sequences, Infinite Series, Sequences of Functions and Uniform Convergence, Power Series and Taylor Series
- The course is all about mathematical proofs. One has to study examples definitions and theorems. Learn certain proof techniques.

Course Contents

UNIT-I

Review of Algebraic and Order Properties of R, Neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R.

UNIT-II

Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima. The Completeness Property of R, The Archimedean Property, Density of Rational and Irrational numbers in R, Intervals.

UNIT-III

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotonic Sequences, Monotonic Convergence theorem (weierstrass completeness theorem).

UNIT-IV

Cantor's completeness theorem. Subsequences, Divergence Criteria, Monotonic Sub-sequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criteria

UNIT- V

Infinite series, convergence and divergence of infinite series, Cauchy Criteria, Tests for convergence:. Comparison test, Limit Comparison test, Ratio Test, Cauchy's n-th root test, Integral test, Alternating series, Leibnitz test, Absolute and Conditional convergence

Text Books:

1 Methods Of Real Analysis,Richard R. Goldberg, John Willey & Sons,1976.

Reference Books:

1 Introduction to Real Analysis, Fourth Edition, Robert G. Bartle, Donald R. Sherbert, John Wiley & Sons, 2011.

Course Outcomes

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

- Define the real numbers, least upper bounds, and the triangle inequality.
- Define functions between sets; equivalent sets; finite, countable and uncountable sets. Recognize convergent, divergent, bounded, Cauchy and monotone sequences.
- Calculate the limit superior, limit inferior, and the limit of a sequence.
- Recognize alternating, convergent, conditionally and absolutely convergent series.
- Apply the ratio, root, limit and limit comparison tests.

Course No: MATH312	Course Title: **Algebra**	L	P	U
		3	0	3

Course Learning Objectives:

This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of fundamental concepts of algebra which include groups, subgroups, permutations, cosets and the theorem of Lagrange, homomorphism, isomorphism, rings, fields, integral domains and relate these concepts to the number systems, calculus and linear algebra.to study the division algorithm, factor theorem, remainder theorem and unique factorization theorem as they apply to polynomials over a field. Abstract algebra gives a good mathematical maturity and enables to build mathematical thinking and skill.

Course Contents

UNIT-I

Binary algebras, Cyclic monoids, submonoids, Groups, Morphisms, direct products, Examples of Groups, postulates, subgroups, Abelian groups,Groups acting on sets, Permutations, Lagrange's theorem, Normal subgroups.

UNIT-II

Introduction, Integral domains and fields, Fields of quotients, Subrings, Morphism of rings, Direct sums, ideal and quotient rings, Divisibility, Euclidean domains, Unique factorization theorem, Prime and maximal ideals, Gaussian elimination

UNIT-III

The Rings R[x], polynomial rings over fields, Polynomial codes, Advantageous properties, Shift registers.

UNIT-IV

Unique factorization theorem for polynomials, Complete roots of unity, polynomial functions, and Formal derivative.

UNIT- V

Extension of fields, simple extensions, Computation in R[x]/m[x], Existence theorem, Finite fields. Lattices: Lattices and Posets.

Text Books:

Moderen Applied Algebra, Garrett Birkhoff and Thomas C Bartee, CBS Publishers& Distributors, Delhi, 1987.

Reference Books:

Algebra, Hungerford, Thomas W., Graduate Texts in Mathematics, Springer, 1974.

Course Outcomes

Upon successful completion of the course, students will be able to:

- Understand the concepts of groups, group homomorphism and isomorphism and related notions.
- Be familiar with common examples of groups of both finite and infinite order.
- Be able to construct and work with related objects: subgroups, Cartesian products, quotient groups.
- Understand what it means for a group to act on a set.
- Use the axioms that define a ring, and know the basic properties of rings arising from these axioms
- Know how to add and multiply polynomials over arbitrary fields, and be able to use this to define polynomial rings.
- Be familiar with various methods of proof, including direct proof, constructive proof, proof by contradiction, induction.
- Develop skills in creative and critical thinking, problem solving, logical writing and clear communication of mathematical ideas

Course No: MATH313	Course Title: **Graph Theory**	L	P	U
		3	0	3

Course Learning Objectives

- To understand and apply the fundamental concepts in graph theory
- To apply graph theory based tools in solving practical problems
- To improve the proof writing skills

Course Contents

UNIT-I

Graphs: Basic concepts and graph terminology,

UNIT-II

Representing graphs and graph isomorphism.

UNIT-III

Distance in a graph, Cut-vertices and Cut-edges, Minimum spanning tree.

UNIT-IV

Connectivity, Euler and Hamiltonian paths.

UNIT- V

Planar graphs: Combinational and Geometric Duals, Kuratowski"s graphs, Detection of planarity, thickness and crossing.

Text Books:

1. F.Harary Graph Theory Narosa (Indian Edition) 2002

Reference Books:

1. Narsingh Deo Graph Theory with Applications Prentice Hall India 1986
2. Bollobás, B. Modern Graph Theory (Graduate Texts in Mathematics). New York, NY: SpringerVerlag, 1998. ISBN: 0387984917.

Course Outcomes

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

- Explain the basic concepts of graph theory.
- apply the basic concepts of mathematical logic.
- Describe and solve some real time problems using concepts of graph theory.

Course No: MATH314	Course Title: **Combinatorial Mathematics**	L	P	U
		3	0	3

Course Learning Objectives

- To acquire standard principles and functions for counting problems
- To use the fundamental facts on Set Partitions and Inclusion-Exclusion
- To familiarize the machinery of Generating Functions
- To develop ways of solving Recurrence Relations
- To initiate the study of Integer Partitions

Course Contents

UNIT-I

Basic counting principles, Permutations and Combinations (with and without repetitions).

UNIT-II

Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers. Principle of Inclusion and Exclusion, Derangements, Inversion formulae.

UNIT-III

Generating functions: Algebra of formal power series, Generating function models, calculating generating functions, Exponential generating functions.

UNIT-IV

Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations.

UNIT- V

Solutions by generating functions. Integer partitions, Systems of distinct representatives.

Text Books:

1. V.Krishnamurthy Combinatorics:Theory and Applications Ellis Horwood Ltd,Chichester,UK 1986

Reference Books:

1 Richard A. Brualdi, Introductory Combinatorics 5th ed Pearson Publishers 2010

2 Marshall Hall, Combinatorial Theory 2nd ed John Wiley 1998

Course Outcomes

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

- To formulate and solve basic combinatorial problems
- To apply techniques like Formal Power Series and Generating Functions when the problems require more than common sense
- To appreciate the scope of Combinatorial Theory involving other parts of mathematics like Number Theory.

Course No: MATH315	Course Title: **Cryptography**	L	P	U
		3	0	3

Course Learning Objectives

- To understand the fundamentals of Cryptography
- To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.
- To understand the various key distribution and management schemes.
- To understand how to deploy encryption techniques to secure data in transit across data networks
- To design security applications in the field of Information technology

Course Contents

UNIT-I

Elementary number theory: Prime numbers, Fermat's and Euler's theorems.

UNIT-II

Testing for primality, Chinese remainder theorem, discrete logarithms.

UNIT-III

Finite fields: Review of groups, rings and fields; Modular Arithmetic, Euclidean Algorithms, Finite fields of the form GF(p), Polynomial Arithmetic, Finite fields of the form GF(2).

UNIT-IV

Data Encryption Techniques: Algorithms for block and stream ciphers, private key encryption – DES, AES, RC4; Algorithms for public key encryption – RSA, DH Key exchange, KERBEROS, elliptic curve cryptosystems.

UNIT- V

Message authentication and hash functions, Digital Signatures and authentication protocols, Public key infrastructure, Cryptanalysis of block and stream ciphers.

TEXT BOOKS:

1. William Stallings: Cryptography and Network Security, Pearson 6th edition. 2013
2. Christof Paar, Jan Pelzl, Understanding Cryptography, Springer Verlag, 2010.

REFERENCES:

1. C. Pfleeger and S.L. Pfleeger, Security in Computing, 3rd Ed., Prentice-Hall of India, 2007.
2. Neal Koblitz, A Course in Number Theory and Cryptography, Second Edition, Springer International Edition, 2010.
3. 3. M.Y. Rhee, Network Security, John Wiley and Sons, NY, 2002

Course Outcomes

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

- Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
- Identify the security issues in the network and resolve it.
- Evaluate security mechanisms using rigorous approaches, including theoretical

Course No: MATH316	Course Title: **Statistical Methods**	L	P	U
		3	2	4

Course Learning Objectives

- Using probability as a tool for addressing random variation and statistical relationships.
- Sampling methodology and principles
- Inference and various cases of it
- Exposure to standard nonparametric tests
- Methods of Regression Analysis

Course Contents

UNIT-I

Random variables:- Two Discrete Random Variables-Joint Probability Distributions-Marginal Probability Distributions - Conditional Probability Distributions – Independence. Two Continuous Random Variables - Joint Probability Distributions- Marginal Probability Distributions-Conditional Probability Distributions- Independence

UNIT-II

Sampling distributions & Estimations:- Sampling Distributions-Sampling Distribution of Means -General Concepts of Point Estimation- Unbiased Estimators-Variance of a Point Estimator-standard error-Reporting a Point-Estimator- Mean Square Error of an Estimator-Methods of Point Estimation - Method of Moments-Method of Maximum Likelihood- -Confidence Interval on the Mean of a Normal Distribution, Variance Known- Development of the Confidence-Interval and Its Basic Properties- Choice of Sample Size-One-sided Confidence Bounds-Confidence Interval on the Mean of a Normal Distribution, Variance Unknown - The *t* Distribution-The *t* Confidence Intervalon.

UNIT-III

Test of hypotheses:- Statistical Inference for Two Samples-Introduction -Inference For a Difference in Means of Two Normal Distributions, Variances Known -Hypothesis Tests for a Difference in Means, Variances Known-Choice of Sample Size-Identifying Cause and Effect-Confidence Interval on a Difference in Means, Variances Known -Inference For a Difference in Means of Two Normal Distributions, Variances Unknown -Hypothesis Tests for a Difference in Means, Variances Unknown -Choice of Sample Size-Confidence Interval on a Difference in Means, Variances Unknown -Paired *t*-Test -Inference on the Variances of Two Normal Distributions-The *F* Distribution - Hypothesis Tests on the Ratio of Two Variances-Error and Choice of Sample Size-Confidence Interval on the Ratio of Two Variances-Inference on Two Population Proportions-Large-Sample Test for *H*0 : *p*1 _ *p*2 -Test for goodness of fit.

UNIT-IV

Designing Engineering Experiments :-The Completely Randomized Single-Factor Experiment-The Analysis of Variance - Multiple Comparisons Following ANOVA- Residual Analysis and Model Checking-Determining Sample Size – Nonparametric Statistics:-Introduction -Sign Test -Description of the Test - Sign Test for Paired Samples -comparison to the *t*-Test-Wilcoxon Signed-Rank Test -Description of the Test-Large-Sample Approximation-Paired Observations- Comparison to the *t*-Test-Wilcoxon Rank-Sum Test-Description of the Test-Large-Sample Approximation - Comparison to the *t*-Test - Nonparametric Methods in the Analysis of Variance- Kruskal-Wallis Test- Rank Transformation.

UNIT- V

Multiple Linear Regression:-Multiple Linear Regression Model-Introduction -Least Squares Estimation of the Parameters-Matrix Approach to Multiple Linear Regression - Properties of the Least Squares Estimators-Hypothesis Tests in Multiple Linear Regression-Test for Significance of Regression-Tests on Individual Regression Coefficients and Subsets of Coefficients-Confidence Intervals in Multiple Linear Regression-Confidence Intervals on Individual Regression Coefficients-Confidence Interval on the Mean Response-Prediction of New Observations- Model Adequacy Checking -Residual Analysis-Influential Observations-Aspects of Multiple Regression Modeling-Polynomial Regression Models- Categorical Regressors and Indicator Variables-Selection of Variables and Model Building-Multicollinearity.

Text Books:

Applied Statistics and Probability for Engineers Third Edition Douglas C. Montgomery, John Wiley & Sons, Inc.

Reference Books:

1. Probability & Statistics for Engineers & Scientists e i g h t h e d i t i on, Ronald E. Walpole Roanoke College, Raymond H. Myers Virginia Polytechnic Institute andState University, Pearson Education International
2. Introduction to the Practice of Statistics SIXTH EDITION, DAVID S. MOORE GEORGE P. McCABE, BRUCE A. CRAIG, Purdue University, W. H. Freeman and Company, New York.

Course Outcomes:

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

- The student will have the knowledge and understanding of how to apply probability concepts and theorems into real world problems.

Course No: MATH317	Course Title: **Differential Geometry**	L	P	U
		3	0	3

Course Learning Objectives

- To apply Vector Calculus to the description of space curves
- To use Evolutes and Involutes for deeper study of space curves
- To connect classes of curves with surfaces of Developable and Minimal types
- To introduce the Fundamental Forms to describe variation on surfaces
- To use Principal and Gauss curvatures to distinguish between surfaces

Course Contents

UNIT-I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae.

UNIT-II

Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curve.

UNIT-III

Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

UNIT-IV

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms.

UNIT- V

Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigues formula, Conjugate and Asymptotic lines

Text Books:

1. C.E.Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003

Reference Books:

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
2. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.

Course Outcomes

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

- Compute Serret-Frenet frames and understand their significance for curves in space
- Determine Evolutes and Involutes for various curves
- Compute Fundamental Forms and Curvatures for surfaces and appreciate their roles.

Course No: **MATH323**	Course Title: **Metric Spaces**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- Concept and examples of Metric spaces motivated by the real line
- Convergence and Completeness in Metric spaces
- Continuity in Metric spaces,criteria and characterization
- Fixed Point theorems introduced

Course Contents

UNIT-I

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences.

UNIT-II

Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantors theorem.

UNIT-III

Subspaces, dense sets, separable spaces. Continuous mappings, sequential criterion and other characterizations of continuity

UNIT-IV

Uniform continuity. Homeomorphism, Contraction mappings.

UNIT- V

Banach Fixed point Theorem. Connectedness, connected subsets of R.

Text Books:

R.R.Goldberg Methods of Real Analysis 2nd edition John Wiley 1976

Reference Books:

1 Tom Apostol Mathematical Analysis 2nd edition Narosa 1998

2. W Rudin Principles of Mathematical Analysis McGraw Hill2008

Course Outcomes

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

- Understand and apply Real Analysis beyond Advanced Calculus.

Course No: MATH324	Course Title: **Rings and Fields**	L	P	U
		3	0	3

Course Learning Objectives

Rings and Fields is a one semester course designed to:

Study fundamental concepts of algebra which include rings, fields, integral domains and relate these concepts to the number systems; to study the division algorithm, factor theorem, remainder theorem and unique factorization theorem as they apply to polynomials over a field and aims to introduce the basic concepts and techniques of Galois Theory.

Course Contents

UNIT-I

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x].

UNIT-II

Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains. Algebraic extension of fields: Irreducible polynomials and Einstein criterion, Adjunction of roots, Algebraic extension.

UNIT-III

Algebraically closed fields, Normal separable extensions: splitting fields, normal extensions. Normal separable extension: Multiple roots, Finite fields, Separable extensions.

UNIT-IV

Galois Theory: Automorphism groups and fixed field s, Fundamental theorem of Galois Theory.

UNIT- V

Application of Galois Theory to classical problems: Roots of unity and Cyclotomic polynomials, cyclic extensions

Text Books:

Modern Applied Algebra, Garrett Birkhoff and Thomas C Bartee, CBS Publishers& Distributors, Delhi, 1987.

Reference Books:

1Algebra, Hungerford, Thomas W.,Graduate Texts in Mathematics,Springer,1974.
2 Topics in Algebra, I.N.Herstein, Wiley India 2012

Course Outcomes

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

- show familiarity with the concepts of ring and field, and their main algebraic properties;
- use the axioms that define a ring, and know the basic properties of rings arising from these axioms
- know how to add and multiply polynomials over arbitrary fields, and be able to use this to define polynomial rings
- understand the meaning of the highest common factor of two polynomials, the proof of existence of the hcf, the meaning of 'coprime' in the context of polynomials over fields, and be able to apply the Euclidean Algorithm to compute the hcf of two polynomials f and g in Q[x], and find polynomials a, b such that hcf$(f, g) = af + bg$
- Understand the meaning of the least common multiple of two polynomials, the proof of its uniqueness, and be able to compute lcms in the polynomial ring Q[x].
- correctly use the terminology and underlying concepts of Galois theory in a problem-solving context;

Course No: MATH325	Course Title: **Topology**	L	P	U
		3	0	3

Course Learning Objectives

- Set theory as background for topological spaces
- Concept of topology and Connectedness as a topological property
- Compactness, its various forms
- Separation properties and types of topological spaces

Course Contents

UNIT-I

Countable and uncountable set, Infinite sets and the Axiom of choice, Well-ordered sets. Topological spaces, Basis and sub basis for a topology.

UNIT-II

The order, product and subspace topology, closed sets and limit points. Continuous functions and homeomorphism, Metric topology, Connected spaces, connected subspaces of the real line, Components and local connectedness.

UNIT-III

Compact spaces, Basic properties of compactness, Compactness and finite intersection property, Compact subspaces of the real line, Compactness in metric spaces, Limit point compactness, Sequential compactness and their equivalence in metric spaces, Local compactness and one point compactification.

UNIT-IV

First and second countable spaces, Lindel of space, Separable spaces, separable axioms, Hausdorff, Regular and normal spaces.

UNIT- V

The Urysohn lemma, completely regular spaces, The Urysohnmetrization theorem, Imbedding theorem, Tietze extension Theorem, Tychonoff theorem, Stone-Cechcampactification

Text Books:

J.R.Munkres Topology, Prentice Hall 2008

Reference Books:

1 J.L.Kelley General Topology Springer Verlag 1993

2. J.Dugundji Topology Allyn and Bacon 1978

Course Outcomes

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

- Apply topological concepts to various structures, like groups, vector spaces and algebras.
- Prepare for subjects requiring neighbourhood, continuity and other concepts not in the context of Euclidean space.

Course No: **MATH327**	Course Title: **Continuum Mechanics**	L	P	U
		3	0	3

Course Learning Objectives

- The purpose of the course is to expose the students to the basic elements of continuum mechanics in a sufficiently rigorous manner.
- After attending this course, the students should be able to appreciate a wide variety of advanced courses in solid and fluid mechanics.
- To introduce students to the general analytic machinery of tensor calculus, variational principles and conservation laws in order to formulate governing equations.
- To illustrate the principles of constitutive modelling
- To make students aware of some exact, approximate and numerical methods to solve the resulting equations.

Course Contents

UNIT-I

Vector spaces, index notation, second order tensors: skew symmetric, orthogonal and symmetric tensors, invariants of second-order, directional derivative, Frechet derivative, gradient, divergence, curl, and integral theorems.

UNIT-II

Lagrangian and Eulerian description, deformation gradient, strain tensor, stretchtensors, area andv olume transformation, material and spatial derivative, rate ofdeformation and spin tensors , Reynolds' transport theorem, vorticity and circulation.

UNIT-III

Connservation of mass, conservation of linear momentum, the Cauchy'shypothesis, Cauchy str ess tensor, conservation of angular momentum, first law of thermodynamics.

UNIT-IV

Second law of thermodynamics, governing equations in reference configuration and also for control volume, principle of frame-indifference.

UNIT- V

Necessity of constitutive relations, principle of material frameindifference, material symmetry, thermoelastic solids, hyperelasticity, linear elasticity, thermomechanics of fluids, classical heat-conducting fluids, incompressible fluids.

Text Books:

1. Jog, C.S., Continuum mechanics: Foundations and applications of mechanics, Volume I, Third edition, 2015, Cambridge University Press.
2. Chadwick, P., Continuum mechanics: Concise theory and problems, 1999, Dover Publications, Inc., New York.
3. Gurtin, M.E., An introduction to continuum mechanics, 1981, Academic press, Inc.

Reference Books:

Course Outcomes

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

- Use tensor algebra and calculus for calculations and derivations in general (curvilinear) coordinates.
- Derive the governing equations of continuum mechanics from Lagrangian and Eulerian viewpoints using the divergence and Reynolds transport theorems and use the same principles to extend the derivations to previously unseen situations.
- Determine whether particular vectors, tensors and derivatives are objective and explain the concept of objectivity.
- Use the Clausis-Duhem inequality to derive thermodynamically consistent constitutive laws and determine any implied constraints.
- Use the general theory to formulate and solve problems in linear and nonlinear elasticity and compressible and incompressible fluid mechanics.
- Solve idealised problems in continuum mechanics analytically in spherical, cylindrical and Cartesian coordinates.
- Be able to convert the physical description of a problem in continuum mechanics into the appropriate governing equations and boundary conditions and, conversely, provide a physical interpretation for the solutions.

Course No: **MATH328**	Course Title: **Advanced Combinatorics**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- Use of Group Theory for Counting Problems
- Coset techniques for representatives
- Polya theory of Enumeration

Course Contents

UNIT-I

Necklace Problem and Burnside's Lemma.

UNIT-II

Cycle index of a permutation group, Polya's theorems and their immediate applications.

UNIT-III

Binary operations on permutation groups.

UNIT-IV

Further Avatars of Polya's theorem.

UNIT- V

Double coset method for the construction of pattern representatives.

Text Books:

1. V.Krishnamurthy Combinatorics: Theory and Applications Ellis Horwood Ltd, Chichester, UK 1986

Reference Books:

1 Martin Aigner Combinatorial Theory Springer Verlag 1997

2 Marshall Hall Combinatorial Theory 2nd edition John Wiley 1998

Course Outcomes

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

- Apply Group Theory to advanced enumeration problems.

B.Tech Data Science and Artificial Intelligence Program (DS & AI)

Course Handouts

Course No: **DS211**	Course Title: **Discrete Structures for Computer Science**	L	P	U
		3	0	3

Course Learning Objectives

- To write an argument using logical notation and determine if the argument is or is not valid
- To write and evaluate a proof or outline the basic structure of and give examples of each proof technique
- To understand the basic principles of sets and operations in sets
- To understand the basics of Boolean Algebra and Lattices
- To design and analysealgorithms
- To study finite state machines
- To understand phrase structure grammars
- To introduce error-correcting codes
- To applyNumber Theory in cryptography.

Course Contents

UNIT-I

Statement of Addition Principle, Sequences, Strings, Characteristic Function, Matrices, Boolean matrix operations Mathematical Structures,Logic, Logical Operations, Quantifiers, Conditional Statements,

UNIT-II

Methods of proof, Mathematical Induction, permutation, combinations. Pigeonhole Principle, Recurrence relations, Generating functions, Relations and Directed Graphs, Paths in relations anddirected, Equivalence relation and partitions,

UNIT-III

Graphs, Euler paths and Circuits, Hamiltonian paths and Circuits, Colouring Graphs, Chromatic polynomial, Closure and transitive closure, Warshall's Algorithm

UNIT-IV

Partially Ordered sets, Lattices, Hasse diagram, Boolean algebra and Boolean Expressions, Trees and their representations, labeled trees, Undirected trees, spanning trees, Minimal Spanning Trees, Prim's and Kruskal's algorithms for minimal spanning tree in a connected graph

UNIT- V

Definition of group and semi group, Languages and finite state machines, Coding of Binary information and Error detection, Error Correction,Factorization of integers, Greatest common divisor, residues, Fermat's theorem and RSA

Text Books:

1. Kolman Bernard, Robert Busby, Sharon Ross andNadeemurRehman, Discrete Mathematical Structures, PHI, 5th Edition, 2006.

Reference Books:

1. Liu.C.L, and D.P.Mohapatra, Elements of Discrete Mathematics,a Computer Oriented Approach, Tata McGraw Hill, 4th edition, 2013.
2. Gary Haggard and John Schlipf, Discrete Mathematics for Computer Science, Thomson 2006.
3. Mott.J.L, Kandel.A, Baker.T.P, Discrete Mathematics for Computer Scientists and Mathematicians, PHI 2006.
4. Rosen.K.H, Discrete Mathematics and its Applications, TMH,2011

Course Outcomes:

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

- use logical notation to determine if an argument is valid
- write and evaluate a proof
- Use graph theory in optimal circuit design
- understand the basics of Boolean Algebra and Lattices
- design and analyse algorithms
- analyse phrase structure grammars for languages
- develop error-correcting codes
- apply Number Theory in cryptography for computer security

Course No: **DS221**	Course Title: **Data Structures**	L	P	U
		2	2	3

Course Learning Objectives

- To understand the basics of all data structures.
- To choose the appropriate data structure for specific application.
- To understand and analyze various searching and sorting algorithms.
- To solve the complex problem using hashing, trees and graph.

Course Contents

UNIT-I

Introduction to Data Structures, need and advantages of data structure. Array, Pointers: basics, pointer with function, array of pointers, pointer to array, applications, advantages and disadvantages of pointer. Linear data structures: Stack, Queue, Linked list. Stack: Fundamentals, stack implementation using array and linked list, infix to postfix conversion and vice versa, postfix expression evaluation, recursion, stack operations: Traversing, insertion, deletion, searching (linear search and binary search), sorting (insertion sort, selection sort, bubble sort, quick sort, merge sort)

.

UNIT-II

Queue: Fundamentals, queue implementation using array and linked list. Queue operations: traversing, insertion and deletion. Double ended queue: Basics, implementation, operations. Circular queue: Basics, implementation, operations. Application of queue.

UNIT-III

Linked list: Fundamentals, difference between array and linked list. Single linked list: basics, representation, operations: insertion, deletion, traversing. Double linked list: basics, representation, operations: insertion, deletion, traversing. Circular linked list: basics, representation, operations: insertion, deletion, traversing.

UNIT-IV

Tree: Fundamentals, representation. Binary tree: Basics, representation, complete binary tree, tree, traversal: Inorder, preorder, postorder traversal, searching, sorting (heap sort, radix sort). Binary search tree: Basic, Inorder, preorder, postorder traversal, searching, sorting (heap sort, radix sort). B+ tree: Basic, traversing, searching, sorting. Red-black tree: Basic, traversing, searching, sorting. AVL tree: traversing, searching, sorting. Threaded binary tree: Basic, traversing, searching, sorting.

UNIT- V

Graph: Basics, Representation: adjacency matrix. Cyclic graph: basics, Acyclic graph: Basics, Traversal: Depth first search, Breadth first search. Minimum spanning tree, shortest path (Dijkstra algorithm), Prim's algorithm. Hashing.

Text Books:

1. Fundamentals of Data structures in C, E. Horowitz, S. Sahni and Susan Anderson-Freed, Universities Press. , 2nd Edition, 2007.
2. Data Structures, S. Lipscutz, Schaum's Outlines, TMH.McGraw Hill Education; 1st edition, July 2017.

Reference Books:

1. Data structures: A Pseudo code Approach with C, R. F. Gilberg and B. A. Forouzan, Cengage Learning, 2nd edition, November 2007.

2. Data structures A Programming Approach with C, D. S. Kushwaha and A.K. Misra, PHI.Phi Learning pvt Ltd, 1st edition, February 10, 2011.

Course Outcomes

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

- Understand how to use data structure concepts for realistic problems.
- Ability to identify appropriate data structure for solving computing problems in respective language.
- Ability to solve problems independently and think critically.

Course No: **DS311**	Course Title: **Artificial Intelligence**	L	P	U
		3	0	3

Course Learning Objectives

- To explain basic concepts of machine learning and classical AI
- To compare advantages and disadvantages of some basic AI algorithms
- To choose appropriate algorithms for solving given AI problems in a memory- and time-efficient manner.
- To implement efficient AI algorithms in a suitable programming language.
- To analyze and critically discuss soft aspects of AI.

Course Contents

UNIT-I

Definitions of Artificial Intelligence, Different Perspectives, Historical background. Understanding those elements constituting problems and learn to solve it by various uninformed and informed (heuristics based) searching techniques.

UNIT-II

To understand those formal methods for representing the knowledge and the process of inference to derive new representations of the knowledge to deduce what to do

UNIT-III

To understand the notion of planning in AI and some techniques in the classical planning system

UNIT-IV

To understand the notion of uncertainty and some of probabilistic reasoning methods to deduce inferences under uncertainty

UNIT- V

To understand some of those mechanisms by which an AI system can improve it's behavior through its experience. Approaches to machine learning, AI-prospects, and dangers Ethical and Philosophical issues.

Text Books:

1. Artificial Intelligence A Modern Approach, by Stuart Russell and Peter Norvig, 3rd Edition, Pearson Education, 2010, ISBN 13:978-0-13-604259-4.

Reference Books:

1. Artificial Intelligence, structures and strategies for complex problem solving, by George F. Luger , 6th Edition, Pearson Education, 2008 ISBN-10:0321545893.
2. Artificial Intelligence Illuminated, by Ben Coppin, Jones and Bartlett, 2nd Edition, 2001, ISBN-13:978-0763732301

Course Outcomes

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

- give an overview of the field of artificial intelligence, its background, history, fundamental issues, challenges and main directions
- explain basic concepts, methods and theories for search - account for classical planning of proactive agents
- describe methods and theories for reactive agents, architectures based on subsumption, and potential fields
- explain concepts, methods and theories of embodied cognition and situatedness and theories of sensing
- explain basic concepts, methods and theories of artificial evolution, genetic algorithms, multiple autonomous agents and swarm intelligence

Course No: **CS312**	Course Title: **Operating Systems**	L	P	U
		3	2	4

Course Learning Objectives

- To provide a clear understanding of the concepts that underlies operating systems.
- To introduce the practical aspects that pertain to the most popular operating systems such as Unix/Linux and Windows,
- Explore instructional operating systems will be studied as well.

Course Content

UNIT- I

Introduction to Operating System: Operating Systems Objectives and functions, Computer System Architecture, OS operations, Different types of O.S: batch, multi-programmed, time-sharing, real-time, distributed, parallel. Operating System services, System Calls and Types of System Calls, Operating System Structure, Virtual Machines.

UNIT-II

Process Management :The Process ,Process States, Process Control Block(PCB), Process Scheduling, Operations on process ,Inter Process Communication(IPC), Examples of IPC on Unix Operating System Thread Management: Overview of Thread, Advantages of Multithreaded Programming ,Thread libraries on Unix Operating System CPU scheduling: Basic Concepts, Scheduling criteria ,Scheduling Algorithms and Thread Scheduling.

UNIT- III

Concurrency: Principles of Concurrency ,Mutual Exclusion ,Critical Section Problems, Peterson's Solution, Semaphores, Classic Problems of Synchronization ,Monitors Deadlocks: Deadlock, Deadlock Characterization ,Methods to Handle deadlocks, Deadlock prevention, Detection and Recovery Techniques Memory Management: Background, Swapping ,Memory Management Algorithms ,paging ,Structure of Page Table , Segmentation.

UNIT- IV

Virtual Memory Management: Introduction to Virtual Memory , Demand paging ,Page Replacement Algorithms ,Allocation of Frames and Thrashing , Case studies on Unix and Windows File System: File Concept, Access Methods ,Directory and Disk Structure ,File System Mounting ,File Sharing and File Protection Implementing File System: File System Structure, File System Implementation, Directory Implementation, Allocation Methods ,Free Space Management and Efficiency and Performance .

UNIT- V

Secondary Storage Structure: Mass-Storage Structure, Disk structure, Disk Scheduling ,Swap Space management , RAID Structures System Protection: Goals of Protection, Principles of Protection ,Domain of Protection, Access Matrix, Operation of Access Matrix, Revocation of Access rights ,Capability Based Protection System Security: The Security Problem, Program Threads , System and Network Threads, Cryptography, Firewalls to Protect Systems and Networks case study: The Linux System.

Text Books

1. Abraham Silberschatz, Peter B.Glavin, Greg Gagne, "Operating System Concepts", Wiley Publication, 8Th Edition,2011

Reference Books

1. D.M.Dhamdhere,"Operating System A concept based approach", Tata Mcgraw-Hill, 2nd Edition.
2. Andrew S Tanenbaum,"Operating System Design and Implementation", 3/E, Prentice Hall.
3. Achyut S Godbole,"Operating System", Tata Mcgraw Hill, 2nd Edition.
4. Maurice J. Bach,"The design of Unix Operating System", Prentice Hall.1986,1st edition
5. W .Richard Stevens "Advanced Programming in the Unix Environment", 2015, 3rd edition.

Course Outcomes

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

- Gain extensive knowledge on principles and difference between different types of modern operating systems, virtual machines and their structure of implementation.
- Understand process management, concurrent processes and threads
- Compare performance of processor scheduling algorithms.
- Able to understand the concepts of deadlock in operating systems and how they can be managed / avoided and implement them in multiprogramming system.
- Produce algorithmic solutions to process synchronization problems.
- Able to understand the types of I/O management; disk scheduling, protection and security problems faced by operating systems and how to minimize these problems

Course No: **DS313**	Course Title: **Introduction to Data Science**	L	P	U
		3	0	3

Course Learning Objectives

- To know how to select, calculate, and report the suitable descriptive & visual statistics for a research problem.
- To understand the probability, hypothesis testing, and sampling.
- To know the current future analysis using parametric and non-parametric test
- To familiar with the multiple regression and logistic regression and DBMS.

Course Contents

UNIT-I

Exploratory Data Analysis (EDA): Different types of data, Summary Analytics (Descriptive Statistics): Central Tendency, Dispersions, Five number, Distributions, Cross Tabulations. Visual, Analytics: Histogram, Box Plot, Correlation Plot, Scatter Plot, Line Chart, Bar Chart, Pie Chart, Bubble Chart, Decision Tree, Cluster Charts.

UNIT-II

Hypothesis Testing: Confidence Intervals, Hypothesis Testing: Constructing a hypothesis, Null Hypothesis & Alternative Hypothesis, Type I and Type II errors, Power Value, Parametric test: Z test, One Sample T-TEST, Paired T-TEST, Independent Sample T-TEST, ANOVA, MANOVA, Level of significance, Power of a test. Non parametric test: Chi Square Test, Fisher's Test, Mann-Whitney U test, Kruskal-Wallis Rank Test, Wilcoxon sign rank.

UNIT-III

Regression Analysis: SLR Regression: Coefficient of determination, Significance, tests for predictor variables, Residual analysis, Auto Correlation, Homoscedasticity, Multicollinearity, MAPR, VIF Analysis, Durbin Watson, AIC, BIC, Stepwise regression, Forward Regression, Backward Regression, Quadrant Regression, Transformed Regression and Dummy Regression, Multiple linear regression and Odd ratio.

UNIT-III

Classification: Logistic Regression, Discriminate Regression Analysis, Test of Associations, Chi-square strength of association, Maximum likelihood estimation, Confusion matrix (Model fit parameters), Support Vector Machines (SVM), Naive Bayes, Random Forests: Bagging & Boosting, CHAID Analysis, Decision trees, k-Nearest Neighbors, Neural Network.

UNIT -V:

Unsupervised Learning: Principle component analysis, Reliability Test, KMO tests, Eigen Value Interpretation, Rotation and Extraction steps, Conformity Factor Analysis, Exploratory Factor Analysis, K Means clustering, Agglomerative Clustering. Introduction to DBMS: ER Modeling, Functional Dependencies, Normalization, DDLs, DMLs, Views, OLTP, Database Integrity, Concurrency.

Text Books:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley
2. Statistics for Managers Using Microsoft Excel, 8th Edition, by David M. Levine , David F. Stephan , and Kathryn A. Szabat ,Publisher: Pearson.

Reference Books:

1. Data Mining in excel: Lecture Notes and cases by GalitShmueli, Publisher: Wiley

Course Outcomes

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

- Summarize the data using visual & summary analytics and common probability distributions
- Make inference about a sample & population using hypothesis test.
- Fit, interpret, and assess regression models and classification with one or more predictors.

Course No: **DS314**	Course Title: **DATA WAREHOUSING AND MINING**	L	P	U
		3	0	3

Course Learning Objectives

1. To introduce the fundamental concepts of data mining.
2. To study data mining tasks of classification, clustering, and finding association rules and be introduced to their algorithmic aspects of the three main data mining tasks, and their typical application domains
3. To introduce the components, and processes of a Data Warehouse, the architecture of a data warehouse, and collection of business requirements for a data warehouse
4. To learn dimensional modeling for designing database schemas for a Data Warehouse To understand the role of Data Marts & ODS in Data Warehousing .To be introduced to advanced Dimensional Modeling concepts
5. To understand the ETL process and to be introduced to OLAP, and the idea of multidimensional databases

Course Contents

UNIT-I -Introduction

Introduction to Big Data and the relevance of data mining. Learning what tasks constitute data mining. Real-world data mining applications. Relation to Business Intelligence techniques and predictive modeling. Real-world data mining applications, Data and Preprocessing, Understanding of Data, what is data? Types of attributes, properties of attribute values, types of data, data quality, Sampling, Data Normalization, Data Cleaning, Similarity Measures, Feature Selection/Instance Selection, the importance of feature selection/instance selection in various big data scenarios.

UNIT-II-Classification

Introduction to various classification techniques -Decision-Trees Rule-based, Instance-based classifiers like k-Nearest Neighbors, Support Vector Machines (SVMs) , Ensemble Learning, Classification Model , Selection and Evaluation. Application-B2B customer buying stage prediction, Recommender Systems The algorithmic and statistical aspects of the techniques.

UNIT-III

Clustering and Association Analysis: Clustering- introduction to partitional and hierarchical clustering methods, graph-based methods, density-based methods Applications- customer profiling, market segmentation. Association Analysis-Apriori algorithm and its extensions, Association Pattern Evaluation, Sequential Patterns and Frequent Sub graph Mining Applications- B2B Customer Buying Path Analysis, Medical Informatics, Telecommunication alarm diagnosis. The algorithmic and statistical aspects of the techniques to be covered as deemed necessary, in order to present the discussion of relevant applications

UNIT-IV

Data Warehouse Components, Processes and Architecture: Source Systems, Data Staging Area, Presentation Server, Data Marts, Operational Data Store (ODS),Metadata, Information Delivery, Basic Processes of a Data Warehouse, Architecture, Collecting Business Requirements, Data Marts and ODS=Architecture, Design and Cost. Advanced Dimensional Modeling Concepts like Surrogate Keys, Changing Dimensions, Conformed Dimensions, Fact less Fact Tables, Mini Dimensions and, Role playing Dimensions, Multivalued Dimension

UNIT- V

Extraction, Transformation, & Loading (ETL): Data Extraction, Data Transformation, Data Loading, ETL Data Structure, ETL Tools. Introduction to Online Analytical Processing (OLAP)Need for OLAP, Features & Functions, ROLAP, MOLAP, HOLAP, & DOLAP,OLAP Implementation ,SQL Features for DW-CUBE Operator, Roll-up Operator, Top-N Queries, Window Queries Metadata, and a Suitable Data Warehousing Case Study

Text Books:

1. Tan P. N., Steinbach M & Kumar V. "Introduction to Data Mining" Pearson Education, 2006

Reference Books:

1. Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Second Edition, 2006.
2. Zaki MJ & Wagner M JR, "Data Mining and Analysis-Fundamental Concepts and Algorithms" Cameridge Univ Press, 2014.
3. Dunhum M.H. & Sridhar S. "Data Mining-Introductory and Advanced Topics", Pearson Education, 2006.
4. Arun K. Pujari, "Data Mining Techniques", Universities Press, 2001

Course Outcomes

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

- Approach business problems data-analytically. Think carefully & systematically about whether & how data can improve business performance, to make better-informed decision for management, finance, marketing and some other business activities.
- Interact competently on the topic of data mining for business intelligence. Know the basics of data mining processes, algorithms, & systems well enough to interact with data mining experts, consultants, etc.

Course No: **DS321**	Course Title: **: Machine Learning**	L	P	U
		3	2	4

Course Learning Objectives

- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To understand the basic theory underlying machine learning.
- To be able to apply machine learning algorithms to solve problems of moderate complexity.
- To be able to read current research papers and understands the issues raised by current research

UNIT - I

Introduction - Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning

Concept learning and the general to specific ordering – Introduction, A concept learning task, Concept learning as search, Find-S, Version spaces and the candidate elimination algorithms , Remarks on candidate elimination algorithms

UNIT - II

Decision Tree learning – Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning Artificial Neural Networks – Introduction, Neural network representation, Appropriate problems for neural network learning, Perceptions, Multilayer networks and the back propagation algorithm, Remarks on the back propagation algorithm, An illustrative example face recognition, Advanced topics in artificial neural networks

UNIT - III

Evaluation Hypotheses – Motivation, Estimation hypothesis accuracy, Basics of sampling theory, A general approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms

Bayesian learning – Introduction, Bayes theorem, Bayes theorem and concept learning, Maximum likelihood and least squared error hypotheses, Maximum likelihood hypotheses for predicting probabilities, Minimum description length principle, Bayes optimal classifier, Gibs algorithm, Naïve Bayes classifier, An example learning to classify text, Bayesian belief networks The EM algorithm

UNIT -IV

Computational learning theory – Introduction, Probability learning an approximately correct hypothesis, Sample complexity for Finite Hypothesis Space, Sample Complexity for infinite Hypothesis Spaces, The mistake bound model of learning - Instance-Based Learning-Introduction, k -Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning

Genetic Algorithms – Motivation, Genetic Algorithms, An illustrative Example, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning, Parallelizing Genetic Algorithms Learning Sets of Rules – Introduction, Sequential Covering Algorithms,

Learning Rule Sets: Summary, Learning First Order Rules, Learning Sets of First Order Rules: FOIL, Induction as Inverted Deduction, Inverting Resolution

Analytical Learning - Introduction, Learning with Perfect Domain Theories: Prolog-EBG Remarks on Explanation-Based Learning, Explanation-Based Learning of Search Control Knowledge

UNIT - V

Combining Inductive and Analytical Learning – Motivation, Inductive-Analytical Approaches to Learning, Using Prior Knowledge to Initialize the Hypothesis, Using Prior Knowledge to Alter the Search Objective, Using Prior Knowledge to Augment Search Operators, Reinforcement Learning – Introduction, The Learning Task, Q Learning, Non-Deterministic, Rewards and Actions, Temporal Difference Learning, Generalizing from Examples, Relationship toDynamic Programming

TEXT BOOKS:

1. Machine Learning – Tom M. Mitchell, McGraw Hill Education; First edition, 2017.

2. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Chapman and Hall/CRC; 2nd Edition, 2014.

REFERENCE BOOKS:

1. Machine Learning Methods in the Environmental Sciences, Neural Networks, William WHsieh, Cambridge University Press; Reprint edition, 2018.
2. Pattern Classification, Richard O. Duda, Wiley-Blackwell; 2nd Edition, 2004.
3. Neural Networks for Pattern Recognition, Christopher M. Bishop, Clarendon Press, 1st Edition, 1995.
4. Machine Learning South Asia Edition: The Art And Science Of Algorithms That Make Sense Of Data, Peter Flach, Cambridge University Press, 1st Edition, 2015.

Course Outcomes

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

- Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
- Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
- Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
- Be able to design and implement various machine learning algorithms in a range of real-world applications.

Course No: **DS322**	Course Title: **Expert Systems**	L	P	U
		3	0	3

Course Learning Objectives

- Describe the concepts central to the creation of expert systems.
- Illustrate the tools and the processes used for the creation of an expert system.
- Demonstrate methods used to evaluate the performance of an expert system.
- Conduct an in-depth examination of an existing expert systems.
- Describe the program structure of LISP and PROLOG.

Unit-I

Introduction: Expert systems and AI, Separating knowledge and inference, Logic and Resolution: Propositional logic, First-order predicate logic, reasoning in logic: inference rules, Resolution and first-order predicate logic, Resolution strategies, applying logic for building expert systems, Logic as a representation formalism.

Unit-II

Production Rules and Inference: Knowledge representation in a production system, Inference in a production system, Pattern recognition and production rules, Production rules as a representation formalism. Frames and Inheritance: Semantic Nets, Frames and single inheritance, Frames and multiple inheritance, Frames as a representation formalism.

Unit-III

Reasoning with Uncertainty:

Production rules, inference and uncertainty, Probability theory, the subjective Bayesian method, the certainty factor model, The Dempster-Shafer theory, Network models. Tools for Knowledge and Inference Inspection: User interface and explanation, A user interface in PROLOG, Rule models.

Unit-IV

OPS5: Knowledge representation in OPS5, the OPS5 interpreter, the rete algorithm. CENTAUR: Limitations of production rules, Prototypes, Facets, Reasoning in CENTAUR.

Unit-V

Introduction to PROLOG: Logic programming, Programming in PROLOG, the declarative semantics, the procedural semantics and the interpreter, Overview of the PROLOG language, Arithmetical predicates, Examining instantiations, Manipulation of the database.

Introduction to LISP:

Fundamental principles of LISP, the LISP expression, Procedural abstraction in LISP, Overview of the language LISP, Symbol manipulation, Predicates, Control structures, the lambda expression, Enforcing evaluation by the LISP interpreter.

Text Book:

1.Principles of Expert Systems Peter J.F. Lucas & Linda C. van der Gaag,Addison-Wesley,1st Edition,1991.

References:

1. Introduction to Expert Systems, Jackson P., 3rd edition, Addison Wesley, 1998.

2. Giarratano J., Riley G., Expert Systems, Principles and Programming, Course Technology; 4thedition, 2004.

3. Introduction to Knowledge Systems, Stefik M., Morgan Kaufmann, 1st Edition, 1995.

Course Outcomes

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

- Define and describe expert system and its main constituents.
- Distinguish class of problems suitable for solving with expert systems.
- Breakdown the problem and select crucial parts.
- Assemble various parts of knowledge and skills in order to devise the approach to solution.
- Design and create expert system suitable for solving particular problem.
- Appraise the quality of solution and justify the employed techniques.

Course No: **CS323**	Course Title: **Computer Networks**	L	P	U
		3	0	3

Course Learning Objectives

- Build an understanding of the fundamental concepts of data communication and computer networking
- To study the foundational principles, architectures, and techniques employed in computer networks.
- To study the concepts of communication networks, protocols and their performance
- Allow the student to gain expertise in some specific areas of networking such as the design and maintenance of individual networks

Course Contents

UNIT-I

Uses of Computer Networks, Network Hardware , Network Software , Network protocol (syntax, semantics, and timing); Protocol suites (OSI and TCP/IP); Layered protocol software (stacks): Physical layer networking concepts; data link layer concepts; network layer concepts; transport and application layer concepts; Network Standards and standardization bodies.

UNIT-II

Bandwidth and Data Rate, Encoding and Modulation Techniques, Transmission modes, Multiplexing (FDM &TDM), Transmission media.

UNIT-III

LAN topologies (bus, ring, star), LAN technologies (Ethernet, token Ring, Gigabit Ethernet), Error detection and correction, Carrier sense multiple access networks (CSMA), Large networks and wide areas, Protocols (addressing, congestion control, virtual circuits, quality of service). Internet - addressing, routing, end point control; Internet protocols - IP, TCP, UDP, ICMP, HTTP, CIDR

UNIT-IV

Flooding; Minimal spanning trees; Bellman Ford, Dijkstra's, OSPF, BGP shortest path algorithms; The leaky bucket, floydwarshall and Random Early Detection congestion methods; Data security and integrity: Fundamentals of secure networks; cryptography; Encryption and privacy: Public key, private key, symmetric key; Authentication protocols; Packet filtering; Firewalls; Virtual private networks; Transport layer security

UNIT-V

Overview of the issues of network management; Domain names and name services; Issues for Internet service providers (ISPs); Quality of service issues: performance, failure recovery.

Text Books

1. W. Stallings, "*Data & Computer Communications*", Prentice-Hall,10th Edition, 2005.
2. A. S. Tanenbaum, "*Computer networks*", Prentice-Hall, 5th Edition, 2005

Reference Books

1. Behrouz A Forouzan, "*Data Communications and Networking*", Tata Mc-grawhill, 2nd Edition, 2007.
2. J.F.Kurose and K.W.Ross, "*Computer Networking: A Top-Down Approach Featuring the Internet*", Pearson Education, 6th Edition, 2001.

Course Outcomes

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

- understand basic computer network technology
- Understand and explain Data Communications System and its components
- Identify the different types of network topologies and protocols
- Understand about working of Intranet, LAN, WAN, MAN setups, different topologies
- Gain familiarity with common networking protocols and algorithms
- Configure network protocols and analyze its performance

ourse No: **DS324**	Course Title: **Neural Networks and Fuzzy Logic**	L	P	U
		3	0	3

Course Learning Objectives

- To impact knowledge on fuzzy logic principles
- To understand models of ANN
- To use the fuzzy logic and neural network for application related to design and manufacture

UNIT-I

ARCHITECTURES: Introduction –Biological neuron-Artificial neuron-Neuron modeling-Learning rules-Single layer-Multi layer feed forward network-Back propagation-Learning factors.

UNIT-II

NEURAL NETWORKS FOR CONTROL: Feedback networks-Discrete time hop field networks-Schemes of neuro –control, identification and control of dynamical systems-case studies (Inverted Pendulum, Articulation Control).

UNIT-III

FUZZY SYSTEMS: Classical sets-Fuzzy sets-Fuzzy relations-Fuzzification – Defuzzification- Fuzzy rules.

UNIT-IV

FUZZY LOGIC CONTROL: Membership function – Knowledge base-Decision –making logic –Optimizations of membership function using neural networks-Adaptive fuzzy systems-Introduction to generate to genetic algorithm.

UNIT-V

APPLICATION OF FLC: Fuzzy logic control-Inverted pendulum-Image processing-Home Heating system-Blood pressure during anesthesia-Introduction to neurofuzzy controller.

TEXT BOOKS:

1. Kosko, B, "*Neural Networks and Fuzzy Systems: A Dynamical Approach to Machine Intelligence*", PrenticeHall, NewDelhi, *2nd Edition,* 2004.
2. Timothy J Ross, "*Fuzzy Logic with Engineering Applications*", John Willey and Sons, West Sussex, England, 2nd Edition, 2005.

REFERENCE BOOKS:

1. Jack M. Zurada, "*Introduction to Artificial Neural Systems*", PWS Publishing Co., Boston, 2002.
2. Klir G.J. &Folger T.A., "*Fuzzy sets, Uncertainty and Information*", Prentice –Hall of India Pvt. Ltd., New Delhi, 2008.
3. Zimmerman H.J., "*Fuzzy set theory and its Applications*", Kluwer Academic Publishers Dordrecht, 2001.
4. Driankov, Hellendroonb, "*Introduction to fuzzy control*", Narosa Publishers, 2001.
5. Laurance Fausett, Englewood cliffs, N.J., "*Fundamentals of Neural Networks*", P
6. Rajasekaran, S. Vijayalakshmi Pai. G.A. "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003

Course Outcomes

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

- To Expose the students to the concepts of feed forward neural networks
- To provide adequate knowledge about feedback networks.
- To teach about the concept of fuzziness involved in various systems and to provide adequate knowledge about fuzzy set theory.
- To provide comprehensive knowledge of fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.
- To provide adequate knowledge of application of fuzzy logic control to real time systems.

Course No: **DS401**	Course Title: **Predictive Analytics**	L	P	U
		3	0	3

Course Learning Objectives

- Gain understanding of the computational foundations in Big Data Science.
- Develop critical inferential thinking.
- Gather a tool chest of R libraries for managing and interrogating raw and derived, observed, experimental, and simulated big healthcare datasets.
- Possess practical skills for handling complex datasets.

Unit – I

Introduction to Predictive Analytics & Linear Regression (NOS 2101): What and Why Analytics, Introduction to Tools and Environment, Application of Modelling in Business, Databases & Types of data and variables, Data Modelling Techniques, Missing imputations etc. Need for Business Modelling. Regression — Concepts, Blue property-assumptions-Least Square Estimation. Variable Rationalization, and Model Building etc.

Unit – II

Logistic Regression (NOS 2101): Model Theory, Model fit Statistics, Model Conclusion, Analytics applications to various Business Domains etc. Regression Vs Segmentation — Supervised and Unsupervised Learning, Tree Building — Regression, Classification, Overfitting, Pruning and complexity. Multiple Decision Trees etc.

Unit – III

Objective Segrnentation (NOS 2101): Regression Vs Segmentation — supervised and Unsupervised Learning, Tree Building — Regression, Classification, Overfitting, Pruning and complexity, Multiple Decision Trees etc. Develop Knowledge, Skill and Competences (NOS 9005) Introduction to Knowledge skills & competences, Training & Development, Learning & Development, Policies and Record keeping, etc.

Unit – IV

Time Series Methods I Forecasting, Feature Extraction (NOS 2101): Arima, Measures of Forecast Accuracy, STL approach, Extract features from generated model as Height, Average, Energy etc and Analyze for prediction. Project

Unit – V

Understanding Map Reduce Fundamentals and HBase :The MapReduce Framework; Techniques to Optimize MapReduce Jobs; Uses of MapReduce; Role of HBase in Big Data Processing; Storing Data in Hadoop : Introduction of HDFS, Architecture, HDFC Files, File system types, commands, org.apache.hadoop.io package, HDF, HDFS High Availability; Introducing HBase, Architecture, Storing Big Data with HBase , Interacting with the Hadoop Ecosystem; HBase in Operations Programming with HBase; Installation, Combining HBase and HDFS;

TEXT BOOK

1. BIG DATA and ANALYTICS, Seema Acharya, Subhasinin Chellappan, Wiley publications, 1st Edition, 2015.
2. Student's Handbook for Associate Analytics-III, Nasscom, 2nd Edition, 2014.

Course Outcomes

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

- Experiment with various techniques of predictive analytics and work on missing Data.
- Identify suitable data models for Logistic Regression.
- Compare regression and segmentation using Sigmoidal function.
- Build decision trees for classification and prune for accuracy.
- Analyze integrated processes for univariate stationary and non- stationary data.
- Define purpose, scope and format of project documentation.

Course No: **DS402**	Course Title: **System for Data Analytics**	L	P	U
		3	0	3

Course Learning Objectives

- To understand the various aspects of the computational infrastructure used for processing big data
- To understand the different types of computer architectures and how they influence the processing of data. The manner in which task parallelism and data parallelism interact with data processing
- To understand distributed and parallel database systems
- To understand the various processing frameworks, like batch processing, map-reduce, and stream processing
- To understand the fundamentals of cloud computing from the point of view of processing frameworks
- To become with platforms like AWS and Azure

Unit I

Introduction to data engineering – to appreciate the difference between data engineering and data science. To understand the data processing activities like partitioning, replication, grouping and sorting, and data locality

Unit II

A brief study of various computer architectures, Flynn's taxonomy. To understand task parallelism and data parallelism

Unit III

To study parallel and distributed databases. Their architecture and performance. The architecture of parallel databases – shared memory, shared disk, and shared-nothing. Pipeline and partitioned parallelism. Speed and scale. Partitioning of data. Introduction to parallel algorithms. Optimization issues

Unit IV

Various kinds of data processing frameworks – batch processing, map-reduce processing, stream processing, real time processing. Introduction to the map-reduce pattern, examples and computing platforms like Hadoop. Introduction to Stream processing, difference between stream and real time processing. Examples of stream processing applications

Unit V

Cloud computing fundamentals, virtualization, batch-transactional-continuous workloads, execution models. Identifying work loads.Scalable web apps, batch processing, disaster recovery. Examples of cloud platforms – AWS, Azure etc, and usage scenarios

Course Outcomes

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

- The student will have an appreciation of the various architectures used for data processing
- The student will understand the overall system architecture for data processing, and will be able to understand popular cloud platforms used for data processing in terms of their architecture

Course No: **DS403**	Course Title: **Data Visualization**	L	P	U
		3	0	3

Course Learning Objectives

- To introduce visual perception and core skills for visual analysis.
- To understand visualization for information and dashboard design.
- Understand the working of visualization software

Course Contents

UNIT-I

Foundation for a Science of Data Visualization: Need of visualization, block diagram of visualization, Visualization Stages, Experimental Semiotics Based on Perception, A Model of Perceptual Processing. Data and Image models: Types of Data, Coding Words and Images, The Nature of Language, Visual and Spoken Language, Animated Visual Languages

UNIT-II

Introduction of visualization design: The Perceptual Evaluation of Visualization Techniques and Systems, Structural Analysis, Statistical Exploration, Cross-Cultural Studies and Child Studies, Practical Problems in Conducting User Studies, Exploratory data analysis: Introduction to EDA, Basic statistical methods to understand the data.

UNIT-III

Visualizing Multidimensional Metadata: Interactive Tables, scatter plots, Parallel Coordinates, star plots, Interactive Histograms, circular histograms. Graphical perception: Visual perception, Simple Model of Visual Perception, different methods of graphical perception.

UNIT-IV

Visualization software: Tableau: Introduction to Tableau, Advantages and disadvantages of Tableau, basic functionality, different case studies using Tableau. Microsoft Power BI: Introduction to Power BI, Advantages and disadvantages of Power BI, basic functionality, different case studies using Power BI.

UNIT- V

Interacting with Visualizations: Data Selection and Manipulation Loop, Exploration and Navigation Loop. Thinking with Visualizations: Memory Systems, Eye Movements, Problem Solving with Visualizations, Creative Problem Solving. Introduction to colors: Color Measurement, CIE System of Color Standards, Opponent Process Theory, Color Appearance, Applications of Color in Visualization. Space Perception and the Display of Data in Space: Depth Cue Theory, Task-Based Space Perception

Text Books:

1. Information Visualization: perception and design, Colin Ware 2nd edition, Omrgan Kaufmann publisher, 2004
2. Visualizing data: Exploring and explaining data with the processing environment, Ben Fry O'Reilly, 1st edition, 2008.

Reference Books:

1. Data Points: Visualization that means something, Nathan Yau Wiley, 1st edition, 2013.
2. Now you see it: Simple Visualization techniques for quantitative analysis, Stephen Few Analytics Press, 1st edition, 2009.
3. Information Visualization, Dr. Keith Andrews, 2016.

Course Outcomes

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

- Understand and visualized the data in better way.
- Implement different case studies according to the data.
- Infer from data and tell stories based on data.

Course No: **DS404**	Course Title: **Big Data Systems**	L	P	U
		3	0	3

Course Learning Objectives

The course develops the following competencies:

- Student should estimate and analyze different known scientific methods and approaches in terms of data collection, storage and processing.
- Student should be capable to make managerial decisions, to assess their consequences and to bear responsibility for the outcomes.
- These indicated and contributed during the preparation of explanation and analysis of the particular area for data collection, storage and processing, particular market and business-model.
- Students should identify and make prognoses about modern approaches on increasing business efficiency.
- Students should identify and chose optimal solutions for improving it-infrastructure and business architecture of the company after implementation relevant big data collection, storage and processing processes.

Course Contents:

UNIT-I

What is Big Data and where it is produced? Rise of Big Data, Compare Hadoop vs traditional systems, Limitations and Solutions of existing Data Analytics Architecture, Attributes of Big Data, data warehouse v/s Data Lakes, other technologies vs Big Data. What is Hadoop? Hadoop History, Distributing Processing System, Core Components, HDFS Architecture, Hadoop Master – Slave Architecture, Daemon types - Learn Name node, Data node, Secondary Name node.

UNIT-II

What is Hadoop Cluster? Pseudo Distributed mode, Type of clusters, Hadoop Ecosystem, Pig, Hive, Oozie, Flume, SQOOP. Overview of MapReduce Framework, MapReduce Architecture, Learn about Jobtracker and Task tracker, Use cases of MapReduce, Anatomy of MapReduce Program.

UNIT-III

Hive DDL – Create/Show/Drop Tables, Hive DML – Load Files & Insert Data, Hive Architecture & Components, Partitions in Hive, PIG Architecture & Data types, Shell and Utility components, PIG Latin: File Loa ders and UDF, Programming structure in UDF, PIG, limitations of PIG.No SQL Databases: HBase Architecture, HBase Components, Storage Model of HBase, Object Data Stores-S3, HBase vs RDBMS, Introduction to Mongo DB, CRUD, Advantages of MongoDB over RDBMS, Use case.

UNIT-IV

Introduction to Data Analysis with Spark, Core Spark Concepts, Programming with RDDs, RDD Basics, Creating RDDs, RDD Operations, Passing Functions to Spark. Advanced Spark Programming: Accumulators, Broadcast Variables, Working on a Per-Partition Basis, Piping to External Programs, Numeric RDD Operations Spark Runtime Architecture, Deploying Applications with spark-submit,

UNIT- V

Spark SQL & Spark Streaming: Using Spark SQL in Applications, Loading and Saving Data From RDDs, JDBC/ODBC Server, and User-Defined Functions. Introduction to Mahout: Why Mahout, Data too large for single machine Data already on Hadoop, Algorithms implemented in Mahout, Setting up the development environment, Mahout API, Parallel versus in-memory execution mode.

Text Books:

1. Oreilly.Hadoop.The.Definitive.Guide.3rd.Edition.Jan.2012.

Reference Books:

1. Hadoop: The Definitive Guide, 4th Edition. Publisher: O'Reilly Media, Inc. Release Date: April 2015.
2. Learning Spark Lightning-Fast Big Data Analysis. 1st edition, 2015.
3. learning-apache-mahout. By Chandramani Tiwary, 1st Edition, Publisher: Packt Publishing, Release Date: March 2015.
(https://www.oreilly.com/library/view/learning-apache-mahout/9781783555215/)

Course Outcomes

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

- To understand Big Data concepts, including cloud and big data architectures.
- To motivate and explain trade-offs in big data processing technique design and analysis.
- To apply non-relational databases, the techniques for storing and processing large volumes of structured and unstructured data, as well as streaming data.
- To Integrate Apache Mahout with newer platforms such as Apache Spark

Course No: **DS405**	Course Title: **Real Time Analytics**	L	P	U
		3	0	3

Course Learning Objectives

- To know how to understand the social media data like Facebook, Twitter and YouTube.
- To understand how to extract and analyze the social media data
- To learn various text mining techniques
- To design and understand the different visualization tools and techniques

Course Contents

UNIT-I

Harnessing Social Data (Facebook): Connecting, Capturing, and Cleaning, Uncovering Brand activity, Emotions, Facebook API ecosystem and method to extract data. Feature extraction and content analysis using keywords, hashtags, and noun phrase. Case study: Emotion Analysis, Apache Kappa Architecture.

UNIT- II

Analyzing Twitter data: Twitter data extraction using REST and Streaming API, Sentiment analysis application. Case study: Sentiment Analysis.

UNIT-III

Analyzing YouTube data: Analysis of structured and unstructured data, Characteristics of YouTube, Channel popularity using traffic and sentiment data from user comments.

UINT – IV

Text Mining and Analytics: Text representation, word association mining and analysis, Description of stopword removal, stemming, and POS tagging, analyse and filter the Twitter data using MAXQDA, Flight data analysis.

UNIT-V

Visual Representation: Design principles, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

Text Books:

1. Python Social Media Analytics by Siddhartha Chatterjee and Michal Krystyanczuk, Publisher: Packt Publishing Limited, 1st Edition, 2017.
2. Mining Text Data, Editors, Charu C. Aggarwal, ChengXiang Zhai, Publisher Springer-Verlag New York, 1st Edition, 2012.

Reference Books:

1. Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data, 2016 by Dipanjan Sarkar, Publisher: Apress; 1st edition, 2016.
2. Mastering Social Media Mining with Python y Marco Bonzanini, Publisher: Packt Publishing Limited, 1st Edition, 2016.
3. Real-Time Big Data Analytics, Sumit Gupta, Shilpi Saxena, Packt Publishing Ltd, 1st Edition, 2016.
4. Kafka: The Definitive Guide Real-time Data And Stream Processing At Scale, Neha Narkhede, Gwen Shapira & Todd Palino, O'Reilly Media, Inc., 1st Edition, 2017

Course Outcomes

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

- Summarize and analyze the social media data
- Make inference about emotion and sentiment analysis from social media data
- Fit, interpret, and assess models with one or more predictors
- Visualize the data gathered from various social media

Course No: **DS406**	Course Title: **Natural Language Processing**	L	P	U
		3	0	3

Course Learning Objectives

- To teach students the leading trends and systems in natural language processing.
- To understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above mentioned concepts.
- Teach them to recognize the significance of pragmatics for natural language understanding.
- Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

UNIT I

Introduction – Human languages, models- Regular Expressions-Patterns – Finite State Automata, Morphology - Inflectional Morphology - Derivational Morphology, Finite-State Morphological Parsing, Porter Stemmer.

UNIT II

Ngrams Models of Syntax - Counting Words - Unsmoothed Ngrams, Smoothing- Backoff Deleted Interpolation – Entropy - English Word Classes - Tagsets for English, Part of Speech Tagging-Rule Based Part of Speech Tagging - Stochastic Part of Speech Tagging - Transformation-Based Tagging.

UNIT III

Context Free Grammars for English Syntax- Context Free Rules and Trees, Sentence- Level Constructions– Agreement – Sub Categorization, Parsing – Top-down – Earley Parsing - feature Structures – Probabilistic Context-Free Grammars.

UNIT IV

Representing Meaning - Meaning Structure of Language - First Order Predicate Calculus, Representing Linguistically Relevant Concepts –Syntax Driven Semantic Analysis - Semantic Attachments –Syntax Driven Analyzer - Robust Analysis - Lexemes and Their Senses – Internal Structure - Word Sense Disambiguation -Information Retrieval.

UNIT V

Discourse -Reference Resolution - Text Coherence - Discourse Structure – Coherence ,Dialog and Conversational Agents - Dialog Acts – Interpretation -Conversational Agents - Language Generation – Architecture - Surface Realizations - Discourse Planning ,Machine Translation - Transfer Metaphor–Interlingua –Statistical Approaches.

Text Books:

1. Daniel Jurafsky and James H Martin,"Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2008.

2. C. Manning and H. Schutze, "Foundations of Statistical Natural Language Processing", MIT Press. Cambridge, MA, Second Printing, 1999.

Reference Text Books:

1. James A. *Natural language Understanding*, Pearson Education, 2nd Edition, 1994.
2. Bharati A., Sangal R., Chaitanya V. *Natural language processing: a Paninian perspective*, PHI, 2000.
3. Siddiqui T., Tiwary U. S. *Natural language processing and Information retrieval*, OUP, 2008.

Course Outcomes

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

- Understand approaches to syntax and semantics in NLP.
- Understand approaches to discourse, generation, dialogue and summarization within NLP.
- Understand current methods for statistical approaches to machine translation.
- Provide the student with knowledge of various levels of analysis involved in NLP.
- Understand the applications of NLP.
- Gain knowledge in automated Natural Language Generation and Machine Translation.
- Understand the mathematical and linguistic foundations underlying approaches to the above areas in NLP

Course No: **DS407**	Course Title: **Soft Computing**	L	P	U
		3	0	3

Course Learning Objectives

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- Provide the mathematical background for carrying out the optimization associated with neural network learning and Particle Swam Optimization.
- To develop some familiarity with current research problems in Soft Computing by working on a research projects.

UNIT-I

Introduction to Soft Computing: Concept of computing systems, "Soft" computing versus "Hard" computing , Characteristics of Soft computing , Some applications of Soft computing techniques

UNIT-II

Fuzzy logic: Introduction to Fuzzy logic , Fuzzy sets and membership functions , Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

UNIT-III

Genetic Algorithms: Concept of "Genetics" and "Evolution" and its application to proablistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, Solving single-objective optimization problems using GAs.

UNIT-IV

Artificial Neural Networks: Biological neurons and its working , Simulation of biological neurons to problem solving ,Different ANNs architectures , Training techniques for ANNs , Applications of ANNs to solve some real life problems.

UNIT-V

Particle Swam Optimization: Introduction ,Convergence Analysis, Performance Illustration , Applications in Hidden Markov Models,SwamAlgorithms,Main Concerns to handle discrete problems, Applications to discrete problems.

Text Books:

1. Introduction to Soft Computing, Authors: Udit Chakraborty, Samir Roy, Pearson India, 1st Edition, 2013.
2. Swam Intelligence and Bio-Inspired Computation, 1st Edition, Elsiver, Xin-She Yang Zhihua Cui, 2nd Edition, 2013.

References:

1. Fuzzy Logic: A Pratical approach, F. Martin,, Mc neill, and Ellen Thro, Morgan Kaufmann Pub; Pap/Dskt edition (August 1, 1994)
2. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey, 3rd Edition, 2010.
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, First Priniting, MIT Press, 1998.
4. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, First Priniting, 2000.
5. Soft Computing, D. K. Pratihar, Narosa, Revised Edition, 2018.

Course Outcomes

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

- Describe Fuzzy logic and its applications.
- Analyze artificial neural networks and its applications.
- Analyze Particle Swam Optimization and its applications
- Solve single-objective optimization problem's using GAs.
- Solve multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Apply Soft computing techniques to solve problems in varieties of application domains.

Course No: **DS408**	Course Title: **Human Computer Interaction**	L	P	U
		3	0	3

Course Learning Objectives

- Demonstrate an understanding of guidelines, principles, and theories influencing
- Human computer interaction.
- Recognize how a computer system may be modified to include human diversity.
- Select an effective style for a specific application, design mock ups and carry out user and expert evaluation of interfaces.
- Carry out the steps of experimental design, usability and experimental testing, and evaluation of human computer interaction systems.
- Use the information sources available, and be aware of the methodologies and Technologies supporting advances in HCI

Unit-I

The User Interface: An introduction and Overview- Importance of user Interface-definition-importance of good design - Benefits of good design -A brief history of Screen design. The graphical user interface: Popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user –interface popularity, characteristics- Principles of user interface.

Unit-II

User Interface Design Process: Obstacles and Pitfalls in development-Designing for people-Usability – Common usability problems, Human interaction with computers, importance of human characteristics in design, Human consideration, Human interaction speeds, understanding business junctions.

Unit-III

Screen Designing: Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design. System Menus: Menu- Structures, Functions, Content, Formatting, Selecting menu choices.

Unit-IV

Navigation Schemes: Navigation Menus, Graphical Menus- Types-Examples, Windows-Characteristics, Components, Presentation Styles- Types, Window Operations. Web Systems, Device and Screen based Controls: Frames-Pop up Windows, Device based Controls – Characteristics and Selection, Operable, Read Only, selection, custom and presentation controls.

Unit-V

Texts & Messages: Words, Sentences, Messages and Texts, Multimedia, creating meaningful graphics, Icons and Images, Colors, Choosing Proper colors-Uses, problems- Choosing colors for textual and statistical graphics screens. Testing: OOTB,Ubiquitous Computing &augmented Realities, Usability Testing – Purpose, Importance, and Scope, prototypes, kinds of test, conducting the test

Text Books:

1. The Essential Guide to User Interface Design, Wilbert O.Galitz, Wiley India Edition, 2nd Edition, 2002.

Reference Book(s):

1. Human Computer Interaction, Alan Dix, Janet Finlay, Goryd, Abowd, Russell Beal, PEA, 3rd Edition, 2004.
2. Designing the User Interface, Ben Shneiderman, PEA, 4th Edition, 2004.
3. Building Interactive Systems: Principles for Human-Computer Interaction, Dan R. Olsen, Jr. ISBN-13:9789353500085, 1st Edition Cengage, 2010.

Course Outcomes

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

- Design, implement and evaluate effective and usable graphical computer interfaces.
- Describe and apply core theories, models and methodologies from the field of HCI.
- Describe and discuss current research in the field of HCI.
- Implement simple graphical user interfaces using the Java Swing toolkit.
- Describe special considerations in designing user interfaces for older adults.

Course No: **DS409**	Course Title: **Computer Vision**	L	P	U
		3	0	3

Course Learning Objectives

- Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision
- Describe the foundation of image formation and image analysis. Understand the basics of 2D and 3D Computer Vision.
- Get an exposure to advanced concepts leading to object and scene categorization from images.

Prerequisites:

- Data structures
- Programming (Python preferably)
- Math: Linear algebra, vector calculus, and probability.

Course Contents

UNIT-I

Introduction to Image Processing and Computer Vision: What is Computer Vision? History of computer vision. Digital Images. Structure of Human Eye and Vision. Goals and Tasks of Image Processing. Contrast and brightness correction.

UNIT-II

Image Formation and Filtering: Geometric primitives and transformations, Photometric image formation, the digital camera, Point operators, linear filtering, pyramids and wavelets, Hierarchical motion estimation.

UNIT-III

Feature Detection and Matching: Points and Patches, Feature descriptors, Feature matching, Feature tracking, Edges , Edge detection, Edge linking, Lines, Successive approximation, Hough transforms, Robust least squares and RANSAC, Applications on Points, Edges, Lines.

UNIT-IV

Multiple Views and Motions: Stereo intro and Camera calibration, Epipolar Geometry and Structure from Motion, Stereo Correspondence and Optical Flow.

UNIT- V

Recognition: Recognition and Bag of Words Detection with sliding windows: Viola Jones, Face Recognition, Instance Recognition.

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag, London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

References:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
4. **http://vision.stanford.edu/teaching/cs223b/syllabus.html**

Course Outcomes

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

- Understand the major technical approaches involved in computer vision.
- Describe various methods used for registration, alignment, and matching in images.
- Build computer vision applications.

Course No: **DS410**	Course Title: **Distributed Cloud Computing**	L	P	U
		3	0	3

Course Learning Objectives

- Understand the underlying infrastructure and architecture of clouds, techniques for enabling services and the quality of such services.
- Analyse various levels of services that can be achieved by cloud computing.
- Understand the programming aspects of cloud computing using different tools and techniques.
- Identify research related issues of cloud computing in performance, security and management.

Prerequisites:

- Basic programming

Course Contents

UNIT-I

Concepts of Distributed Computing: Introduction to distributed computing, Parallel vs Distributed computing, Elements of parallel computing, Elements of distributed computing, Service oriented computing.

UNIT-II

Concepts of Cloud Computing: About cloud computing, Building cloud computing environment, Cloud computing platforms and technologies, System models for distributed and cloud computing.

UNIT-III

Virtual machines and Virtualization of Clusters and Data centers: Implementation levels of virtualization, Virtualization structures/tools and mechanisms, Virtualization of CPU, memory and I/O devices, Virtual clusters and resource management, Virtualization for data-center automation.

UNIT-IV

Programming Enterprise Clouds using Aneka: Introduction, Aneka Architecture, Thread Programming using Aneka, Task Programming: using Aneka, Map Reduce Programming using Aneka. Monitoring, Management and Applications: An Architecture for Federated Cloud Computing, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Best Practices in Architecting Cloud Applications in the AWS cloud, Building Content Delivery networks using Clouds, Resource Cloud Mashups.

UNIT- V

Cloud Applications & Security: Scientific Applications, Business and Consumer Applications, security aspect of cloud computing.

Text Books:

1. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley, 1st Edition, 2013.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C.Fox, Jack J.Dongarra, Elsevier, 1st Edition, 2012.

References:

1. Cloud Computing: A Practical Approach, Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill, 1st Edition, 2017.
2. Enterprise Cloud Computing, GautamShroff, Cambridge University Press, 1st Edirion, 2010.
3. Cloud Computing: Implementation, Management and Security, John W. Ritting house, James F.Ransome, CRC Press, 1st Edition, 2009.
4. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly, 1st Edition, 2009.
5. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, 1st Edition, 2011

Course Outcomes

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

- Understand the distributed and cloud computing infrastructure, architecture, system models, enabling technologies and its paradigms
- Analyze the service and deployment models of cloud computing and related issues
- Program on cloud development platforms.

Course No: **DS411**	Course Title: **Internet of Things**	L	P	U
		3	0	3

Course Learning Objectives

- Smart Lighting, Smart Appliances, Intrusion Detection, and Smoke/Gas Detectors. Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response.
- Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection.
- Energy- Smart Grids, Renewable Energy Systems, Prognostics.
- Retail-Inventory Management, Smart Payments, Smart Vending Machines, Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring.
- Remote Vehicle Diagnostics, Agriculture-Smart Irrigation ,Green House Control , Industry –Machine Diagnosis & Prognosis Indoor Air Quality Monitoring ,Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics.

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Contents

UNIT- I

Introduction to Internet of Things: Introduction - Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs , IoT Enabling Technologies-Wireless Sensor Networks , Cloud Computing, Big Data Analytics , Communication Protocols , Embedded Systems, IoT Levels & Deployment Templates.

UNIT- II

Domain Specific IoTs: Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors. Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response. Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection .Energy- Smart Grids , Renewable Energy Systems , Prognostics.
Retail-Inventory Management, Smart Payments, Smart Vending Machines. Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics. Agriculture-Smart Irrigation, Green House Control. Industry –Machine Diagnosis & Prognosis Indoor Air Quality Monitoring, Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics

UNIT- III

IoT and M2M: Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization.

UNIT- IV

IoT Platforms Design Methodology: IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python IoT Physical Devices & Endpoints. What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices- pc Duino, Beagle Bone Black , Cubieboard.

UNIT- V

IoT & Beyond: Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

Text Books:

1. Internet of Things, A Hands on Approach, by Arshdeep Bahga & Vijay audisetti, University Press, 1st Edition, 2018.

Reference Books:

1. The Internet of Things, by Michael Millen, Pearson, 1st Edition, 2018
2. Sinha A.N and Udai A.D, Computer Graphics, 1st Ed., TMH, 2012

Course Outcomes

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

- Understand the building blocks of IoT technology and explore the vast spectrum of IoT applications.
- Use processors & peripherals to design & build IoT hardware.
- Assess, select and customize technologies for IoT applications.
- Connect the cyber world with the physical world of humans, automobiles and factories.
- Integrate geographically distributed devices with diverse capabilities.
- Design and implement IoT applications that manage big data.

Course No: **DS412**	Course Title: **Security and Privacy in Cloud Computing**	L	P	U
		3	0	3

Course Learning Objectives

- Cloud computing security to escalate in importance and evolve, it is important that enterprises understand how to best handle the paradigm change in business operations that the cloud presents.
- Introduces privacy aspects to consider within the context of cloud computing, and analyzes the similarities and differences with traditional computing models.
- To highlight legal and regulatory implications related to privacy in the cloud.

Course Contents

UNIT-I

INTRODUCTION: Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model, Cloud Deployment Models. INFRASTRUCTURE SECURITY: Network level model, The Host level, The Application level model.

UNIT-II

DATA SECURITY AND STORAGE: Aspects of Data Security, Data Security Mitigation, Provider Data and Its Security, Data privacy and security Issues.

UNIT-III

Access Management: Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.PRIVACY: What Is Privacy? What Is the Data Life Cycle, What Are the Key Privacy Concerns in the Cloud, Who Is Responsible for Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications?

UNIT-IV

AUDIT AND COMPLIANCE : Internal Policy Compliance , Governance, Risk, and Compliance (GRC) ,Illustrative Control Objectives for Cloud Computing , Incremental CSP-Specific Control Objectives , Additional Key Management Control Objectives , Control Considerations for CSP Users ,Regulatory/External Compliance , Other Requirements , Cloud Security Alliance .

UNIT- V

Description of data processing flows, Using PETs, International Telecommunication Union (ITU), International Organization for Standardization (ISO), Organization for the Advancement of Structured Information Standards (OASIS).

Text Books:

1. ***Cloud security and privacy-*** *Tim Mather, Subra Kumaraswamy, and Shahed Latif-O'REILLY Publications*-September 2009: First Edition.
2. Cloud Security: A Comprehensive Guide to Secure Cloud Computing. Krutz R. L. & Vines R. D. Wiley-India. 2010.

Reference Books:

1. Cloud Computing. Miller M. Pearson Education. New Delhi. 2009.

Course Outcomes

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

- To understand the concept of cloud computing and the evolution of computing into cloud computing.
- Able to understand infrastructure security refers to the established security capabilities at the network.
- Able to understand the current state of data security and the storage of data in the cloud, including aspects of confidentiality, integrity, and availability.
- To gain indepth knowledge of audit and compliance functions within the cloud, and the various standards and frameworks.

Course No: **DS413**	Course Title: **Cloud Administration**	L	P	U
		3	0	3

Course Learning Objectives

- Understand all aspects of cloud provisioning and administration
- Apply the administration concepts in an enterprise cloud computing environment.
- Establish best practices for performance measures and monitoring of cloud computing environment

Prerequisites:

- Networking
- Basic programming

Course Contents

UNIT-I

Cloud Resource Administration and Provisioning: Fundamentals of Cloud Computing and Administration, Planning and analysis of Workload and Capacity, Administering of various Cloud Technologies, Virtual Storage

UNIT-II

Cloud Administration using Scalability and Elasticity: Cloud Scalability Administration, Cloud Elasticity Administration.

UNIT-III

Cloud Interoperability & Portability: Introduction to Cloud Interoperability & Portability, Strategic Planning for Interoperability and Portability.

UNIT-IV

Cloud Administration Management: Various Policies Management for SLA, Metering and Billing Management, Privacy and Data Management.

UNIT- V

Disaster Recovery & Security Administration: Cloud Disaster Recovery, Fundamental Security issues in Cloud Administration

Text Book:

1.The Practice of Cloud System Administration, Designing and Operating Lagre Distributed Systems, Limoncelli Thomas A, Strata R, J. Hogan, Pearson Education, , 1st Edistion, 2014.

References:

1. Google Cloud Platform Administration, Ranjit Singh T, Packt Publishing Limited, 1st Edition, 2018
2. Hands-On Cloud Administration in Azure, Toroman Mustafa, Packt Publishing Limited, 1st Edition, 2018

Course Outcomes

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

- Design stratagic policies for cloud administration.
- Understand various aspects of disaster recovery & security administration.
- Analyse various management issues in cloud administration.

Course No: **DS414**	Course Title: **Fundamentals of Blockchain Technology**	**L**	**P**	**U**
		3	**0**	**3**

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Learning Objectives

This basic course makes the student to

- Understand the fundamentals of the Blockchain Technology.
- Identify, analyze, and model structural and behavioral concepts of the Blockchain system.
- Develop, explore the conceptual model into various scenarios and applications.
- Apply the concepts of architectural design for deploying the code for Blockchain Application.

Course Contents

UNIT- I

Introduction to Blockchain, Key vocabulary while discussing Blockchain, Distinction between databases and Blockchain Explaining distributed ledger Blockchain ecosystem. Transformation in trading units Cryptography and Cryptocurrency, Anonymity and Pseudonymity in Cryptocurrencies, Digital Signatures, Hash Codes, Distributed networks.

UNIT- II

Bitcoin and its history. Selling Bitcoins, Bitcoin transactions, How Bitcoin transactions work, what happens in case of invalid transactions, Parameters that invalidate the transactions, Scripting language in Bitcoin, Applications of Bitcoin script Nodes and network of Bitcoin, Various roles you can play in Bitcoin ecosystem.

UNIT- III

Introduction, Purpose of mining, Algorithm used in mining, mining hardware, how does Bitcoin mining work? Bitcoin mining pools how cloud mining of Bitcoin works? Mining incentives, Security and centralizations.

UNIT- IV

Introduction, Ethereum, Ether, use of Ethereum, the Ethereum ecosystem, DApps and DAOs, How Ethereum mining works? Learning Solidity: Contract classes, functions, and conditionals, Inheritance & abstract contracts, Libraries, Types & optimization of Ether, Global variables, Debugging, Future of Ethereum.

UNIT- V

Introduction to Hyperledger, Hyperledger Architecture, Consensus, Consensus & its interaction with architectural layers, Application programming interface, Application model, Network topology, Exploring Hyperledger frameworks.

Text Books:

1. Arshadeep Bagha, Vijay Madisetti, "Bkockchain Applications-A hands-on Approach", Universal Press 2018 (Part One).

Reference Books:

1. Mayukh Mukhopadhyay, "Ethereum Smart Contract Devlopment" Packt Press, 2018 Edition

Course Outcomes

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

- Understand the building blocks of Blockchain technology and explore the vast spectrum of Blockchain applications.
- Assess, select and customize technologies for Blockchain applications.
- Integrate geographically distributed devices with diverse capabilities.
- Design and implement Blockchain applications that manage big data.

Course No: **DS415**	Course Title: **Ethereum and Solidity Programming Essentials**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To Introduce Block chain, Ethereum, and Smart Contracts.
- Installing Ethereum and Solidity, Global Variables and Functions.
- Expressions and Control Structures.
- Writing Smart Contracts, Functions, Modifiers, and Fallbacks, Exceptions, Events, and Logging, Truffle Basics.
- Unit Testing, Debugging Contracts.

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Contents

UNIT- I

Cryptography, Symmetric encryption and decryption, Asymmetric encryption and decryption, Hashing, Digital signatures, Ether, Gas, Blockchain and Ethereum architecture, How are blocks related to each other?, How are transactions and blocks related to each other?, Ethereum nodes, EVM, Ethereum mining nodes, How does mining work?, Ethereum accounts, Externally owned accounts, Contract accounts, Transactions, Blocks, An end-to-end transaction, What is a contract?, What is a smart contract?, How to write smart contracts?, How are contracts deployed?

UNIT- II

Ethereum networks, Main network, Test network, Ropsten, Rinkeby, Kovan, Private network, Consortium network, Geth, Installing Geth on Windows, Creating a private network, ganache-cli, Solidity compiler, The web3 JavaScript library, Mist wallet, MetaMask. Ethereum Virtual Machine, Solidity and Solidity files, Pragma, Comments, The import statement, Contracts, Structure of a contract, State variables, Structure, Modifiers, Events, Enumeration, Functions, Data types in Solidity, Value types, Passing by value, Reference types, Passing by reference, Storage and memory data locations , Rule 1, Rule 2, Rule 3, Rule 4, Rule 5, Rule 6, Rule 7, Rule 8, Literals, Integers, Boolean, The byte data type, Arrays, Fixed arrays, Dynamic arrays, Special arrays, The bytes array, The String array, Array properties, Structure of an array, Enumerations, Address, Mappings.

UNIT- III

Types of variables. Variables hoisting, Variable scoping, Type conversion, Implicit conversion, Explicit conversion, Block and transaction global variables, Transaction and message global variables, Difference between tx.origin and msg.sender, Cryptography global variables, Address global variables, Contract global variables. Solidity expressions, The if decision control, The while loop, The for loop, The do...while loop, The break statement, The continue statement, The return statement.

UNIT- IV

Smart contracts, Writing a simple contract, Creating contracts, Using the new keyword, Using address of a contract, Constructors, Contract composition, Inheritance, Single inheritance, Multi-level inheritance, Hierarchical inheritance, Multiple inheritance, Encapsulation, Polymorphism, Function polymorphism, Contract polymorphism, Method overriding, Abstract contracts, Interfaces, Function input and output, Modifiers, The view, constant, and pure functions, The address functions, The send method, The transfer method, The call method, The callcode method, The delegatecall method, The fallback function.

UNIT- V

Error handling, The require statement, The assert statement, The revert statement, Events and logging, Application development life cycle management, Truffle, Development with Truffle, Testing with Truffle, Debugging, The Remix editor, Using events, Using a Block Explorer.

Text Books:

1. Solidity Programming Essentials, by Ritesh Modi, Packt Publishing, 2018.

Reference Books:

1. Mayukh Mukhopadhyay, "Ethereum Smart Contract Devlopment" Packt Press, 2018 Edition

Course Outcomes

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

- Learn the basics and foundational concepts of Solidity and Ethereum.
- Explore the Solidity language and its uniqueness in depth.
- Create new accounts and submit transactions to blockchain.
- Get to know the complete language in detail to write smart contracts.
- Learn about major tools to develop and deploy smart contracts.
- Write defensive code using exception handling and error checking.
- Understand Truffle basics and the debugging process.

Course No: **DS416**	Course Title: **: Blockchain with AI**	L	P	U
		3	0	3

Course Learning Objectives

- To teach Hared ledgers, distributed ledgers, bitcoin, and cryptography;
- Key concepts of artificial neural networks, machine learning, and deep learning with real-world examples.
- Smart services within a Blockchain ecosystem such as classification, regression, and image recognition.

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Contents

UNIT- I

Hyperledger framework, distributed ledgers, bitcoin, cryptography, Hashing, Application of Blockchain in healthcare, supply chain, finance, energy,

UNIT- II

AI through deep learning method, Artificial intelligence as a service, Neural network like CNN, RNN, auto-encoders for applications, Blockchain ecosystem such as classification, regression, image recognition, detection, recommendation & natural language processing.

UNIT- III

Blockchain can optimize the GPU for Better AI Services, ATOZ, DeepBrain Chain, singularity NET, Golem, Cortex, SONM, Tatau, iExec.

UNIT- IV

Creating a Blockchain network, Hyperledger framework such as Iroha, Fabric, Sawtooth, Indy, and Burrow.

UNIT- V

AI and DL in Blockchain dataset using AI algorithms & models, AIHPC Blockchain capabilities, predictive and sentiment analysis, ARIMA in cryptocurrency, end to end Decentralized Applications on Ethereum platform.

Text Books:

1. Hands-On Artificial Intelligence for Blockchain: Build powerful applications for Blockchain using Machine Learning, by Manish Kumar Saraf, Packt Publishing, 2019.

Reference Books:

1. Kiran Garimella, Peter Fingar and Vint Cerf, "AI + Blockchain" Meghan-Kiffer Press, 2019 Edition

Course Outcomes

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

- Understand Hyperledger framework and its components.
- Analysis the application of Blockchain in healthcare, supply chain, finance, energy.
- Choose neural network like CNN, RNN, auto encoders for applications.
- Apply AI and DL in Blockchain dataset using AI algorithms & models.

Course No: **DS417**	Course Title: **Blockchain with IoT**	L	P	U
		3	0	3

Course Learning Objectives

- Introduction to IoT and Blockchain
- Creating your own blockchain network with Hyperledger composer
- Installing your own blockchain network with Hyperledger Fabric and composer
- Addressing Food Safety: Building around the Blockchain regulations, Challenges and concerns in the modern Food chain.
- Applications related to IoT, Blockchain and Industry 4.0.

Course Contents

UNIT- I

Understanding IoT and Developing Devices on the IBM Watson IoT Platform, Common business use case of IoT, Technical Elements in IoT, Creating your first IoT solution, the gardening solution, coding the device firmware, creating the backend applications.

UNIT- II

Explaining Blockchain Technology and Working with Hyperledger, introduces you to blockchain and helps you to understand how it works with a ledger to record the history of transactions that provide a permissioned network with known identities. Creating your own blockchain network with Hyperledger composer, installing your own blockchain network with Hyperledger Fabric and composer, addressing Food Safety: Building around the Blockchain regulations, challenges and concerns in the modern Food chain.

UNIT- III

Designing the Solutions architecture, the business of food, challenges of the process, the process at the food factory, the process at the distribution center, the process at supermarket and stores, the technological approach, front-end applications, IoT-based asset tracking, API/SDK, Software components.

UNIT- IV

Creating a Blockchain network, concepts and Enumerations, Asset definitions, participants, Deploying and testing the business network for Hyperledger, Manipulating assets via transaction in the Blockchain, generating and exporting participants business cards, defining access control lists, creating the IoT part of the solution, hardware setup, firmware development, End to End Testing, creating a food box, transferring the asset to the transporter.

UNIT- V

The IoT, Blockchain and Industry 4.0, Simplifying Business chain, Developing cloud applications, Reference architecture, serverless computing, The Hyperledger composer Toolkit, The Hyperledger composer REST server, Authentication and multiuser mode, Data source configuration.

Text Books:

1. Hands On: IoT solution with Blockchain, by MaximilanoSatos, Packt Publishing, 2019.

Reference Books:

1. Mayukh Mukhopadhyay, "Ethereum Smart Contract Devlopment" Packt Press, 2018 Edition

Course Outcomes

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

- Learn the basics and foundational concepts of IoT and Blockchain.
- Explore the applications and its uniqueness in depth.
- Learn about major tools to develop and deploy Iot with Blockchain.
- Understand Hyperledger and Hyperledger Fabric.

Course No	Course Title	L	P	U
HS 311	Dynamics of Social Change	3	0	3

Learning Objectives

The objective of this course is to enable students to have an insight into the social processes, sociological thought, methodology, sociological concepts and recent trends in modernization so as to empower the students to become active citizens. Sociological study aids in comprehending one's identity, thinking and action, it makes one more tolerant of human differences.

Course Contents:

Unit I

Sociology: its fundamentals, development of its methods and theories; Sociology and its relationship with other social sciences. Society: concepts and theories. Socialization and its theories, Social groups: Crowd Community, Association, Institutions.

Unit II

Family & Marriage: concepts, theories of origin; types, functions and changing patterns. Demographic transition.

Culture and its determinants: Social norms, Folkways, Mores, Taboos, Social roles, Social responsibility. Culture and personality.

Unit III

Social stratification: Caste, class, their functions and changing patterns.

Social Change: Concepts, Theories and Process and Dynamics of social change, Factors, Resistance to social change.

Unit IV

Modernization Concept: Industry and social change, Urbanization and rural sociology.

The role of education as a vital force for social change and to highlight the role of social institutions in educational and social developments.

Unit V

Sociology of Religion: Aspects, origin, Hinduism. Social disorganization and delinquency.

Text Book

Fundamentals of Sociology, Gisbert. P, Orient Longman, 3rd Edition, 1994.

Reference book(s)

1. Sociology - Systematic Introduction. Johnson.M.Harry. Allied Publishers, 2001
2. Sociology – A Guide to Problems and Literature. Bottomore T. T. Blackie & Sons, 1986.

Learning Outcomes:

After going through this course, the student will be able to:

- Define what social change is.
- Differentiate between social change and cultural change.
- Understand various characteristics of social change.
- Understand various sources of social change.
- Understand various factors of social change.
- Understand various theories of social change given by various sociologists.
- Understand the role of education for social change.

Course No: HS312	Course Title: Introduction to Psychology	L	P	U
		3	0	3

Learning Objectives

- To familiarize the students with type concepts of mind processes, motives, reactions, feelings, motivation
- To inculcate group thinking
- To develop skills like conflict resolution, crisis management

Course Content

UNIT I

Introduction: Definition of psychology; historical antecedents of psychology and trends in the 21st century; psychology and scientific methods; psychology in relation to other social sciences and natural sciences; application of psychology to societal problems.
Methods of psychology: Types of research, descriptive, evaluative, diagnostic and prognostic; methods of research: survey, observation, case-study and experiments; characteristics of experimental design and non-experimental design, quasi-experimental designs; focussed group discussions, brain storming, grounded theory approach.

UNIT II

Development of Human Behaviour: Growth and development; principles of development, role of genetic and environmental factors in determining human behaviour; influence of cultural factors in socialization; life span development, characteristics, development tasks, promoting psychological well-being across major stages of the life span.
Sensation, attention and perception: Sensation; concepts of threshold, absolute and difference thresholds, signal-detection and vigilance; factors influencing attention including set and characteristics of stimulus; definition and concept of perception, biological factors in perception; perceptual organization-influence of past experiences, perceptual defence-factors influencing space and depth perception, size estimation and perceptual readiness; the plasticity of perception; extrasensory perception; culture and perception, subliminal perception.

UNIT III

Learning: Concept and theories of learning (behaviourists, gestaltalist and information processing models); the processes of extinction, discrimination and generalization; programmed learning, probability learning, self-instructional learning, concepts; types and the schedules of reinforcement, escape, avoidance and punishment, modeling and social learning.
Memory: Encoding and remembering; short term memory, long term memory, sensory memory, iconic memory, echoic memory: the multistore model, levels of processing; organization and mnemonic techniques to improve memory; theories of forgetting: decay, interference and retrieval failure: metamemory; amnesia: anterograde and retrograde.
Motivation and emotion: Psychological and physiological basis of motivation and emotion; measurement of motivation and emotion; effects of motivation and emotion on behaviour; extrinsic and intrinsic motivation; factors influencing intrinsic motivation; emotional competence and the related issues.

UNIT IV

Thinking, problem solving: Piaget's theory of cognitive development; concept formation processes; information processing, reasoning and problem solving, facilitating and hindering factors in problem solving, methods of problem solving: creative thinking and fostering creativity; factors influencing decision making and judgment; recent trends.
Intelligence and aptitude: Concept of intelligence and aptitude, nature and theories of intelligence - Spearman, Thurstone, Gullford Vernon, Sternberg and J.P; Das; emotional intelligence, social intelligence, measurement of intelligence and aptitudes, concept of IQ, deviation IQ, constancy of IQ; measurement of multiple intelligence; fluid intelligence and crystallized intelligence.

UNIT V

Personality: Definition and concept of personality; theories of personality (psychoanalytical, sociocultural, interpersonal, developmental, humanistic, behaviouristic, trait and type approaches); Measurement of personality (projective tests, pencil-paper test); The Indian approach to personality; training for personality development; latest approaches like big 5 factor theory; the notion of self in different traditions.
Work Psychology and Organisational Behaviour: Personnel selection and training; use of psychological tests in the industry; training and human resource development; theories of work motivation, Herzberg, Maslow, Adam Equity theory, Porter and Lawler, Vroom; Leadership and participatory management; advertising and marketing; stress and its management; ergonomics; consumer psychology; managerial effectiveness; transformational leadership; sensitivity training; power and politics in organizations.

Text Books

1. Passer, M.W. and Smith, R.E. (2010). *Psychology: The science of mind and behavior*. 4th edn. Boston, MA, USA: McGraw-Hill Higher Education.
2. Pareek, U. and Khanna, S. (2012). *Understanding organizational behaviour*. 3rd edn. New Delhi, India: Oxford University Press.

Reference Books

1. Luthans, F. (2010). *Organizational behavior: An evidence-based approach*. 12th edn. New York, NY, USA: McGraw Hill Higher Education.
2. Morris, C.G. and Maisto, A.A. (2004). *Psychology: An introduction*. 12th edn. Harlow, United Kingdom: Prentice Hall.

Learning Outcomes

Upon successful completion of the course student will be able to:

- Use critical thinking to evaluate and interpret evidence, and to apply psychological concepts, theories, and research findings to individual, social, and cultural issues
- Apply basic research methods in psychology, with sensitivity to ethical principles
- Demonstrate effective communication skills following professional conventions in psychology appropriate to purpose and context
- Understand the complexity of sociocultural diversity and societal inequality in the inquiry and analysis of psychological issues

Course No	Course Title	L	P	U
HS313	Heritage of India	3	0	3

Learning Objectives

Comprehending the heritage of the nation is a necessary pre condition for the making of conscientious citizenship. Knowledge of the nation's evolution and legacy enables to precisely define one's national self. Hence, this course is designed to serve the objective of enabling the students to take stock of the heritage and cultural evolution of their nation and its syncretic history.

Course Contents:

UNIT I: Indian Culture: An Introduction

Characteristics of Indian culture, Significance of Geography on Indian Culture. Society in India through ages- Ancient period- varna and jati, family and marriage in india, position of women in ancient india, Contemporary period; caste system and communalism. Religion and Philosophy in India: Ancient Period: Pre-Vedic and Vedic Religion, Buddhism and Jainism, Indian philosophy – Vedanta and Mimansa school of Philosophy.

UNIT II: Indian Languages and Literature

Evolution of script and languages in India: Harappan Script and Brahmi Script. Short History of the Sanskrit literature: The Vedas, The Brahmanas and Upanishads & Sutras, Epics: Ramayana and Mahabharata & Puranas. History of Buddhist and Jain Literature in Pali, Prakrit and Sanskrit, Sangama literature & Odia literature.

UNIT III: A Brief History of Indian Arts and Architecture

Indian Art & Architecture: Gandhara School and Mathura School of Art; Hindu Temple Architecture, Buddhist Architecture, Medieval Architecture and Colonial Architecture. Indian Painting Tradition: ancient, medieval, modern indian painting and odishan painting tradition. Performing Arts: Divisions of Indian classical music: Hindustani and Carnatic, Dances of India: Various Dance forms: Classical and Regional, Rise of modern theatre and Indian cinema.

UNIT IV: Spread of Indian Culture Abroad

Causes, Significance and Modes of Cultural Exchange - Through Traders, Teachers, Emissaries, Missionaries and Gypsies, Indian Culture in South East Asia, India, Central Asia and Western World through ages.

UNIT V: Understand and appreciate the heritage of India in various fields of applied sciences Applied Sciences: Geography, Astronomy, Mathematics, Physics, Chemistry, Physiology, Medicine, Coinage, Weights and Measures, India's contribution to the world civilizations and the external influences on Indian Heritage

Text Books

Basham, A.L, The Wonder That was India, Picador, London, 2004.

Reference Books

1. Nehru, Jawaharlal, the Discovery of India, Jawaharlal Memorial Fund, New Delhi, 1999.
2. Thapar, Romila, The History of India, Vol. I, Penguin, New Delhi, 1966
3. Basham, A.L, ed., A Cultural History of India, Penguin, New Delhi, 1988.
4. Jha, D.N, Ancient Indian in Historical Outline, Manohar, New Delhi, 2004.
5. Wolpert, Stanley, an Introduction to India, Penguin, New Delhi, 1994.
6. Mazumdar, R.C, et.al, an Advanced History of India, MUP, Michigan, 1969.
7. Malekandathil, Pius: Maritime India: Trade, Religion and Polity in the Indian Ocean, Primus Books, Delhi, 2010.
8. McPherson, Kenneth: The early Maritime Trade of the Indian Ocean, in: ib.: The Indian Ocean: A History of People and The Sea, OUP, 1993, pp. 16-75.
9. Christie, J.W., 1995, State formation In early Maritime Southeast Asia, BTLV

Course No	Course Title	L	P	U
HS314	Modern Political Science	3	0	3

Objectives

- To familiarise the students with the basic ideas of political science.
- To make them thorough in the concepts of political theory.
- To help them understand and distinguish between basic concepts like political theory, political thought and political philosophy.
- To help the students understand and relate the concepts and facts with the political realities of the country and different parts of the world.
- To equip them with the basics of the discipline and help them learn the basic underpinnings of the subject of Political Science.

Unit I Political Theory

Nature, scope and significance of political theory, procedure of different theoretical ideas in political theory, the various traditional and modern theories of political science., theories of origin of the state.

Unit II Political Theory

Concept of Democracy, its types and theories (Elitist, Pluralist and Marxist) relating to it, concept of Development and various views and Perspective relating to it. i.e. Liberal, Marxist, Sustainable Development, Human Development and Gandhian Model of Development, Understanding basic concepts of Justice, distributive justice, multiculturalism and social justice.

Unit III Politics in India

Philosophy of Indian constitutions, introducing the Indian Constitution with a focus on the evolution of it and examining the essence of the Preamble, e Fundamental Rights and Duties of Indian citizens with a study of the significance and status of Directive Principles.

Analyzing the important institutions of the Indian Union: the Executive: President; Prime Minister, Council of Ministers; Governor, Chief Minister and Council of Ministers; The legislature: Rajya Sabha, Lok Sabha, Speaker, Committee System, State Legislature, The Judiciary: Supreme Court and the High Court: composition and functions- Judicial Activism

Unit IV Politics in India

Centre-State Relations with focus on the Legislative, Administrative and Financial Relations., evaluating the Indian Party system – its development and looking at the ideology of dominant national parties, the Electoral Process in India with focus on the Election Commission: Composition, Functions and Role, the challenges to National Integration: Terrorism, Regionalism and Casteism.

Unit V International Relations

Overview about the nature, evolution and scope of international relations, the basic ideas of international relations, the different approaches to the study of International Relations,historical background of the discipline which will help them understand international politics in a better way, basic concepts of International Relations and also develop a preliminary understanding of the global economy, formation, charter and objectives of United Nations and its working on Millennium Development Goals, the working of United Nations in resolving conflict and peacekeeping operations, the international security; Disarmament, Arms Control and Nuclear nonproliferation

Text Books:

1. J.C. Johari – "Principles of Modern Political Science", Sterling Publishers PVT. Ltd., New Delhi, 2007
2. Perter Harris, "Foundations of Political Science", Oxford University Press

References:

1. Amal Ray and Mohit Bhattacharya – "Political Theory: Institutions and Ideas" - The World Press Private Ltd., Calcutta, 1988
2. O.P. Gauba – "An Introduction to Political theory" Macmillan India Ltd., 2008.
3. Robert Dahl – "Modern political Analysis." OUP 2007
4. Prof. A.C Kapoor - "Principles of Political Science", Sterling Publishers PVT. Ltd., New Delhi, 2005

Course Outcomes:

- Understanding of government institutions, electoral processes, and policies in a variety of countries around the world and the ability to compare the effectiveness or impact of various political arrangements across countries.
- Knowledge of some of the philosophical underpinnings of modern politics and government and the legal principles by which political disputes are often settled.
- Understand the changes in patterns of political behaviour, ideas and structures.
- Assess how global, national and regional developments affect polity and society.
- Develop the ability to make logical inferences about social and political issues on the basis of comparative and historical knowledge.
- Knowledge of key theories and concepts, historical developments, organizations, and modern issues in international relations.

Course No	Course Title	L	P	U
HS315	Public Administration	3	0	3

Learning Objectives

The course on Public Administration/Management has following objectives:

1. Understand the concept of public administration/ management/organization
2. Understand the evolution of the concept of public administration and its importance
3. Understand the role of government
4. Understand the role and core functions of public manager
5. Understand the structure of government /organizations
6. Create understanding about the skills required by the public manager in imparting duties
7. Understand the changing role of government and role of public managers.

Course Contents:

Unit I

Introduction:

Meaning, scope, and significance of Public Administration, Wilson's vision of Public Administration, Evolution of the discipline and its present status, New Public Administration, Public Choice approach, Challenges of liberalization, Privatisation, Globalisation, Good Governance: concept and application, New Public Management

Unit II

Administrative Thought, Scientific Management and Scientific Management movement, Classical Theory, Weber's bureaucratic model – its critique and post-Weberian Developments, Dynamic Administration, Human Relations School, Functions of the Executive, Simon's decision-making theory, Participative Management.

Unit III

Administrative Behaviour, Process and techniques of decision-making , Communication; Morale Motivation Theories – content, process and contemporary, Theories of Leadership: Traditional and Modern

Organisations - Theories – systems, contingency, Structure and forms:ministries & departments, corporations, companies, boards, commissions, ad hoc and advisory bodies, headquarters and field relationships, regulatory authorities, public-private partnerships.

Unit IV

Accountability and control - Concepts of accountability and control; Citizen and Administration, Legislative, Executive and Judicial control over administration, Role of media, interest groups & voluntary organizations. Civil society, Citizen's Charters, Right to Information, Social audit.

Unit V

Administrative Law - Meaning, scope, and significance, Dicey on Administrative law, Delegated legislation, Administrative Tribunals.

Comparative Public Administration - Historical and sociological factors affecting administrative systems, Administration and politics in different countries, Current status of Comparative Public Administration, Ecology and administration, Riggsian models and their critique,

Techniques of Administrative Improvement - Organisation and methods, Work-study and work management, Management aid tools like network analysis, MIS, PERT, CPM, e-governance and information technology.

Text Book:

1. Baker, R.J.S., 1972, Administrative Theory and Public Administration, Hutchinson University Library, London.
2. Bhattacharya, Mohit, 1998, New Horizons of Public Administration, Jawahar Publishers & Distributors, New Delhi.

References:

1. Bertram, M. Gross, 1964, The Managing of Organisations, The Administrative Struggle, The Free Press of Glencoe, CollierMacmillan., London.
2. Denhardt, Robert B. and Joseph W. Grubbs, 2003, Public Administration: An action Orientation, Fourth Edition, Thomson (Wadsworth), Canada.
3. Prasad, D. Ravindra, V.S. Prasad and P. Satyanarayan, 2004, Administrative Thinkers (Ed), Sterling Publishers, New Delhi.
4. Pugh, D.S., 1985, Organisation Theory: Selected Readings (Ed), Penguin Books, Middlesex, England.
5. Sharma, M.P. and B.L. Sardana, 1988, Public Administration in Theory and Practice, Kitab Mahal, New Delhi.
6. Srivastava, Om Prie, 1991, Public Administration and Management, The Broadening Horizons, Volume 1, Himalaya Publishing House, Delhi

COURSE OUTCOMES:

- To understand the nature and scope of Public Administration;
- To appreciate the methodological pluralism and synthesizing nature of knowledge in Public Administration;
- To comprehend the changing paradigms of Public Administration;
- To acquaint with the theories, approaches, concepts and principles of Public Administration;
- To understand the administrative theories and concepts to make sense of administrative practices.
- To Understand public administration theory and concepts from multiple perspectives

Course No: HS316	Course Title: Professional Ethics	L	P	U
		3	0	3

Learning Objectives

- To create an awareness on Ethics as applied in Engineering and Human Values
- Understand what morality is and how it connects to professional ethics
- Determine what characterizes a professional and distinguishes one from a nonprofessional

Course Content

UNIT I

Morals, values and ethics, integrity, work ethic, service learning, civic virtue, respect for others, living peacefully, caring, sharing, honesty, courage, valuing time, co-operation, commitment, empathy, self-confidence, character, spirituality.

UNIT II

Senses of 'Engineering Ethics', variety of moral issued, types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, consensus and controversy, models of professional roles, theories about right action, self-interest, customs and religion, uses of ethical theories.

UNIT III

Engineering as experimentation, engineers as responsible experimenters, codes of ethics, a balanced outlook on law, the challenger case study.

UNIT IV

Safety and risk, assessment of safety and risk, risk benefit analysis and reducing risk, the Three Mile Island and Chernobyl case studies. Collegiality and loyalty, respect for authority, collective bargaining, confidentiality, conflicts of interest, occupational crime, professional rights, employee rights, Intellectual Property Rights (IPR), discrimination.

UNIT V

Multinational corporations, environmental ethics, computer ethics, weapons development, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership, sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers(India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers(IETE), India, etc.

Text Books

1. Martin, M.W. and Schinzinger, R. (2004). *Ethics in engineering*. 4th edn. Boston, MA, USA: McGraw Hill Higher Education.
2. Govindarajan, M., Natarajan, S. and Senthilkumar, V.S. (2004). *Engineering ethics*. New Delhi, India: Prentice-Hall of India Pvt.

Reference Books

1. Fleddermann, C.B. (2011). *Engineering ethics*. 4th edn. Boston, MA, USA: Prentice Hall.
2. Harris, J.C.E., Rabins, M.J., Pritchard, M.S., James, R. and Englehardt, E. (2013). *Engineering ethics: Concepts and cases*. 5th edn. Boston, MA, USA: Wadsworth Cengage Learning.
3. Boatright, J.R. (2011). *Ethics and the conduct of business*. Boston, MA, USA: Pearson College Div.
4. Seebauer, E.G. and Barry, R.L. (2010). *Fundamentals of ethics for scientists and engineers*. New York, NY, USA: Oxford University Press.

Learning Outcomes

Upon successful completion of the course student will be able to:

- Choose their own personal, social, moral and spiritual values and be aware of practical methods for developing and deepening
- Assess their own ethical values and the social context of problems
- Identify an ethical issue and analyze that issue in relationship to the specific topic of study or discipline

B.Tech Data Science and Artificial Intelligence Program (DS & AI)

Course Handouts

Course No: **DS211**	Course Title: **Discrete Structures for Computer Science**	**L**	**P**	**U**
		3	**0**	**3**

Course Learning Objectives

- To write an argument using logical notation and determine if the argument is or is not valid
- To write and evaluate a proof or outline the basic structure of and give examples of each proof technique
- To understand the basic principles of sets and operations in sets
- To understand the basics of Boolean Algebra and Lattices
- To design and analysealgorithms
- To study finite state machines
- To understand phrase structure grammars
- To introduce error-correcting codes
- To applyNumber Theory in cryptography.

Course Contents

UNIT-I

Statement of Addition Principle, Sequences, Strings, Characteristic Function, Matrices, Boolean matrix operations Mathematical Structures,Logic, Logical Operations, Quantifiers, Conditional Statements,

UNIT-II

Methods of proof, Mathematical Induction, permutation, combinations. Pigeonhole Principle, Recurrence relations, Generating functions, Relations and Directed Graphs, Paths in relations anddirected, Equivalence relation and partitions,

UNIT-III

Graphs, Euler paths and Circuits, Hamiltonian paths and Circuits, Colouring Graphs, Chromatic polynomial, Closure and transitive closure, Warshall's Algorithm

UNIT-IV

Partially Ordered sets, Lattices, Hasse diagram, Boolean algebra and Boolean Expressions, Trees and their representations, labeled trees, Undirected trees, spanning trees, Minimal Spanning Trees, Prim's and Kruskal's algorithms for minimal spanning tree in a connected graph

UNIT- V

Definition of group and semi group, Languages and finite state machines, Coding of Binary information and Error detection, Error Correction,Factorization of integers, Greatest common divisor, residues, Fermat's theorem and RSA

Text Books:

1. Kolman Bernard, Robert Busby, Sharon Ross andNadeemurRehman, Discrete Mathematical Structures, PHI, 5th Edition, 2006.

Reference Books:

1. Liu.C.L, and D.P.Mohapatra, Elements of Discrete Mathematics,a Computer Oriented Approach, Tata McGraw Hill, 4th edition, 2013.
2. Gary Haggard and John Schlipf, Discrete Mathematics for Computer Science, Thomson 2006.
3. Mott.J.L, Kandel.A, Baker.T.P, Discrete Mathematics for Computer Scientists and Mathematicians, PHI 2006.
4. Rosen.K.H, Discrete Mathematics and its Applications, TMH,2011

Course Outcomes:

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

- use logical notation to determine if an argument is valid
- write and evaluate a proof
- Use graph theory in optimal circuit design
- understand the basics of Boolean Algebra and Lattices
- design and analyse algorithms
- analyse phrase structure grammars for languages
- develop error-correcting codes
- apply Number Theory in cryptography for computer security

Course No: DS221	Course Title: Data Structures	L	P	U
		2	2	3

Course Learning Objectives

- To understand the basics of all data structures.
- To choose the appropriate data structure for specific application.
- To understand and analyze various searching and sorting algorithms.
- To solve the complex problem using hashing, trees and graph.
- To implement various algorithms and data structures using C and to improve the programming skills.

Course Contents

UNIT-I

Introduction to Data Structures, need and advantages of data structure. Array, Pointers: basics, pointer with function, array of pointers, pointer to array, applications, advantages and disadvantages of pointer. Linear data structures: Stack, Queue, Linked list. Stack: Fundamentals, stack implementation using array and linked list, infix to postfix conversion and vice versa, postfix expression evaluation, recursion, stack operations: Traversing, insertion, deletion, searching (linear search and binary search), sorting (insertion sort, selection sort, bubble sort, quick sort, merge sort)

.

UNIT-II

Queue: Fundamentals, queue implementation using array and linked list. Queue operations: traversing, insertion and deletion. Double ended queue: Basics, implementation, operations. Circular queue: Basics, implementation, operations. Application of queue.

UNIT-III

Linked list: Fundamentals, difference between array and linked list. Single linked list: basics, representation, operations: insertion, deletion, traversing. Double linked list: basics, representation, operations: insertion, deletion, traversing. Circular linked list: basics, representation, operations: insertion, deletion, traversing.

UNIT-IV

Tree: Fundamentals, representation. Binary tree: Basics, representation, complete binary tree, tree, traversal: Inorder, preorder, postorder traversal, searching, sorting (heap sort, radix sort). Binary search tree: Basic, Inorder, preorder, postorder traversal, searching, sorting (heap sort, radix sort). B+ tree: Basic, traversing, searching, sorting. Red-black tree: Basic, traversing, searching, sorting. AVL tree: traversing, searching, sorting. Threaded binary tree: Basic, traversing, searching, sorting.

UNIT- V

Graph: Basics, Representation: adjacency matrix. Cyclic graph: basics, Acyclic graph: Basics, Traversal: Depth first search, Breadth first search. Minimum spanning tree, shortest path (Dijkstra algorithm), Prim's algorithm. Hashing.

Text Books:

1. Fundamentals of Data structures in C, E. Horowitz, S. Sahni and Susan Anderson-Freed, Universities Press. , 2nd Edition, 2007.
2. Data Structures, S. Lipscutz, Schaum's Outlines, TMH.McGraw Hill Education; 1st edition, July 2017.

Reference Books:

1. Data structures: A Pseudo code Approach with C, R. F. Gilberg and B. A. Forouzan, Cengage Learning, 2nd edition, November 2007.

2. Data structures A Programming Approach with C, D. S. Kushwaha and A.K. Misra, PHI.Phi Learning pvt Ltd, 1st edition, February 10, 2011.

List of Data Structures Laboratory Experiments:

S.No	Experiment / Program Name	Duration
1.	Implementing Stack using Array	1:40 H
2.	Implementing Queue using Array	1:40 H
3.	Solving an Arithmetic Expression using Stack	1:40 H
4.	Implementing Various Sorting Techniques - Bubble / index / radix / quick sort	1:40 H
5.	Implementing Single Linked List - Insertion / Deletion / Searching	1:40 H
6.	Implementing Doubly linked List - Insertion / Deletion / Searching	1:40 H
7.	Implementing Binary Tree Traversals - Inorder / Preorder / Postorder	1:40 H
8.	Implementing Binary Search Tree - Insertion / Deletion / Searching	1:40 H
9.	Implementing Depth First Search	1:40 H
10.	Implementing Breadth First Search	1:40 H

11.	Implementing Kruskal's Algorithm - Minimum Cost Spanning Tree	1:40 H
12.	Implementing Prim''s Algorithm - Minimum Cost Spanning Tree	1:40 H

Course Outcomes

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

- Understand how to use data structure concepts for realistic problems.
- Ability to identify appropriate data structure for solving computing problems in respective language.
- Ability to solve problems independently and think critically.
- Utilize the acquired skill sets and solve problems using the appropriate data structures.

Course No: DS311	Course Title: Artificial Intelligence	L	P	U
		3	0	3

Course Learning Objectives

- To explain basic concepts of machine learning and classical AI
- To compare advantages and disadvantages of some basic AI algorithms
- To choose appropriate algorithms for solving given AI problems in a memory- and time-efficient manner.
- To implement efficient AI algorithms in a suitable programming language.
- To analyze and critically discuss soft aspects of AI.

Course Contents

UNIT-I

Definitions of Artificial Intelligence, Different Perspectives, Historical background. Understanding those elements constituting problems and learning to solve it by various uninformed and informed (heuristics based) searching techniques.

UNIT-II

To understand those formal methods for representing the knowledge and the process of inference to derive new representations of the knowledge to deduce what to do

UNIT-III

To understand the notion of planning in AI and some techniques in the classical planning system

UNIT-IV

To understand the notion of uncertainty and some of probabilistic reasoning methods to deduce inferences under uncertainty

UNIT- V

To understand some of those mechanisms by which an AI system can improve it's behavior through its experience. Approaches to machine learning, AI-prospects, and dangers Ethical and Philosophical issues.

Text Books:

1. Artificial Intelligence A Modern Approach, by Stuart Russell and Peter Norvig, 3rd Edition, Pearson Education, 2010, ISBN 13:978-0-13-604259-4.

Reference Books:

1. Artificial Intelligence, structures and strategies for complex problem solving, by George F. Luger , 6th Edition, Pearson Education, 2008 ISBN-10:0321545893.
2. Artificial Intelligence Illuminated, by Ben Coppin, Jones and Bartlett, 2nd Edition, 2001, ISBN-13:978-0763732301

Course Outcomes

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

- give an overview of the field of artificial intelligence, its background, history, fundamental issues, challenges and main directions
- explain basic concepts, methods and theories for search - account for classical planning of proactive agents
- describe methods and theories for reactive agents, architectures based on subsumption, and potential fields
- explain concepts, methods and theories of embodied cognition and situatedness and theories of sensing
- explain basic concepts, methods and theories of artificial evolution, genetic algorithms, multiple autonomous agents and swarm intelligence

Course No: CS312	Course Title: Operating Systems	L	P	U
		3	2	4

Course Learning Objectives

- To provide a clear understanding of the concepts that underlies operating systems.
- To discuss Process Management and Concurrency control.
- To discuss memory management and virtual memory techniques.
- To introduce the practical aspects that pertain to the most popular operating systems such as Unix/Linux and Windows.
- To improve the programming skills of the students by implementing various operating system principles using C/C++/Java/Python.

Course Content

UNIT- I

Introduction to Operating System**:** Operating Systems Objectives and functions, Computer System Architecture, OS operations, Different types of O.S: batch, multi-programmed, time-sharing, real-time, distributed, parallel. Operating System services, System Calls and Types of System Calls, Operating System Structure, Virtual Machines.

UNIT-II

Process Management :The Process ,Process States, Process Control Block(PCB), Process Scheduling, Operations on process ,Inter Process Communication(IPC), Examples of IPC on Unix Operating System Thread Management: Overview of Thread, Advantages of Multithreaded Programming ,Thread libraries on Unix Operating System CPU scheduling**:** Basic Concepts, Scheduling criteria ,Scheduling Algorithms and Thread Scheduling.

UNIT- III

Concurrency: Principles of Concurrency ,Mutual Exclusion ,Critical Section Problems, Peterson's Solution, Semaphores, Classic Problems of Synchronization ,Monitors Deadlocks: Deadlock, Deadlock Characterization ,Methods to Handle deadlocks, Deadlock prevention, Detection and Recovery Techniques Memory Management: Background, Swapping ,Memory Management Algorithms ,paging ,Structure of Page Table , Segmentation.

UNIT- IV

Virtual Memory Management: Introduction to Virtual Memory , Demand paging ,Page Replacement Algorithms ,Allocation of Frames and Thrashing , Case studies on Unix and Windows File System: File Concept, Access Methods ,Directory and Disk Structure ,File System Mounting ,File Sharing and File Protection Implementing File System: File System Structure, File System Implementation, Directory Implementation, Allocation Methods ,Free Space Management and Efficiency and Performance

UNIT- V

Secondary Storage Structure: Mass-Storage Structure, Disk structure, Disk Scheduling ,Swap Space management , RAID Structures System Protection: Goals of Protection, Principles of Protection ,Domain of Protection, Access Matrix, Operation of Access Matrix, Revocation of Access rights ,Capability Based Protection System Security: The Security Problem, Program Threads , System and Network Threads, Cryptography, Firewalls to Protect Systems and Networks case study: The Linux System.

Text Books

1. Abraham Silberschatz, Peter B.Glavin, Greg Gagne, "Operating System Concepts", Wiley Publication, 8Th Edition,2011

Reference Books

1. D.M.Dhamdhere,"Operating System A concept based approach", Tata Mcgraw-Hill, 2nd Edition.
2. Andrew S Tanenbaum,"Operating System Design and Implementation", 3/E, Prentice Hall.
3. Achyut S Godbole,"Operating System", Tata Mcgraw Hill, 2nd Edition.
4. Maurice J. Bach,"The design of Unix Operating System", Prentice Hall.1986,1st edition
5. W .Richard Stevens "Advanced Programming in the Unix Environment", 2015, 3rd edition.

List of Operating Systems Laboratory Experiments:

No.s	Name of the Experiment	Duration
1	**Shell Scripting in Linux / Unix Environment**	**1: 40H**
2	**Implementing a Simple Client and Server using socket programming in C/C++**	**1: 40H**
3	**Implementing a Server and Client to transfer the requested file from the server to the client using socket programming in C/C++**	**1: 40H**
4	**Implementing a micro shell using C/C++, which implements the linux/unix commands – ls, mkdir, exit and clear**	**1: 40H**

5	**Implementing a micro shell using C/C++, which implements the linux/unix commands – ls -l, cd, rmdir, history.**	**1: 40H**
6	**Given the list of processes, their CPU burst times and arrival times. Compute and print the average waiting time and average turnaround time for FCFS and SJF**	**1: 40H**
7	**Given the list of processes, their CPU burst times and arrival times. Compute and print the average waiting time and average turnaround time for Priority and Round Robin Scheduling**	**1: 40H**
8	**Developing Application using Inter Process communication (using shared memory, pipes or message queues).**	**1: 40H**
9	**Implement the Producer – Consumer problem using semaphores (using UNIX system calls).**	**1: 40H**

Course Outcomes

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

- Gain extensive knowledge on principles and difference between different types of modern operating systems, virtual machines and their structure of implementation.
- Understand process management, concurrent processes and threads
- Compare performance of processor scheduling algorithms.
- Able to understand the concepts of deadlock in operating systems and how they can be managed / avoided and implement them in multiprogramming system.
- Produce algorithmic solutions to process synchronization problems.
- Able to understand the types of I/O management; disk scheduling, protection and security problems faced by operating systems and how to minimize these problems

Course No: DS313	Course Title: Introduction to Data Science	L	P	U
		3	0	3

Course Learning Objectives

- To know how to select, calculate, and report the suitable descriptive & visual statistics for a research problem.
- To understand the probability, hypothesis testing, and sampling.
- To know the current future analysis using parametric and non-parametric test
- To familiar with the multiple regression and logistic regression and DBMS.
- To experience the way of understanding the structure of data and extraction

Course Contents

UNIT-I

Exploratory Data Analysis (EDA): Different types of data, Summary Analytics (Descriptive Statistics): Central Tendency, Dispersions, Five number, Distributions, Cross Tabulations. Visual, Analytics: Histogram, Box Plot, Correlation Plot, Scatter Plot, Line Chart, Bar Chart, Pie Chart, Bubble Chart, Decision Tree, Cluster Charts.

UNIT-II

Hypothesis Testing: Confidence Intervals, Hypothesis Testing: Constructing a hypothesis, Null Hypothesis & Alternative Hypothesis, Type I and Type II errors, Power Value, Parametric test: Z test, One Sample T-TEST, Paired T-TEST, Independent Sample T-TEST, ANOVA, MANOVA, Level of significance, Power of a test. Non parametric test: Chi Square Test, Fisher's Test, Mann-Whitney U test, Kruskal-Wallis Rank Test, Wilcoxon sign rank.

UNIT-III

Regression Analysis: SLR Regression: Coefficient of determination, Significance, tests for predictor variables, Residual analysis, AutoCorrelation, Homoscedasticity, Multicollinearity, MAPR, VIF Analysis, Durbin Watson, AIC, BIC, Stepwise regression, Forward Regression, Backward Regression, Quadrant Regression, Transformed Regression and Dummy Regression, Multiple linear regression and Odd ratio.

UNIT-III

Classification: Logistic Regression, Discriminate Regression Analysis, Test of Associations, Chi-square strength of association, Maximum likelihood estimation, Confusion matrix (Model fit parameters), Support Vector Machines (SVM), Naive Bayes, Random Forests: Bagging & Boosting, CHAID Analysis, Decision trees, k-Nearest Neighbors, Neural Network.

UNIT -V:

Unsupervised Learning: Principal component analysis, Reliability Test, KMO tests, EigenValue Interpretation, Rotation and Extraction steps, Conformity Factor Analysis, Exploratory Factor Analysis, K Means clustering, Agglomerative Clustering. Introduction to DBMS: ER Modeling, Functional Dependencies, Normalization, DDLs, DMLs, Views, OLTP, Database Integrity, Concurrency.

Text Books:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley
2. Statistics for Managers Using Microsoft Excel , 8th Edition, by David M. Levine , David F. Stephan , and Kathryn A. Szabat ,Publisher: Pearson.

Reference Books:

1. Data Mining in excel: Lecture Notes and cases by GalitShmueli, Publisher: Wiley

List of Introduction to Data Science LAB Experiments

S.No	Experiment	Duration
1	Introduction to fundamentals of R studio and Python for data science	2Hr
2	Basic Statistics and Visualization in R	1.3Hr
3	Implementation of data following algorithms for analyzing the data.: K-means Clustering	1Hr
4	Implementation of data following algorithms for analyzing the data.: Association Rules	1Hr
5	Implementation of data following algorithms for analyzing the data.: Linear Regression	1Hr
6	Implementation of data following algorithms for analyzing the data.: Logistic Regression	1Hr

7	Implementation of data following algorithms for analyzing the data.: Naive Bayesian Classifier	1.2Hr
8	Implementation of data following algorithms for analyzing the data.: Decision Trees	1Hr
9	Implementation of data following algorithms for analyzing the data.: Simulate Principal component analysis	1.10Hr
10	Implementation of data following algorithms for analyzing the data.: Simulate Singular Value Decomposition	1.2Hr

Course Outcomes

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

- Summarize the data using visual & summary analytics and common probability distributions
- Make inference about a sample & population using hypothesis test.
- Fit, interpret, and assess regression models and classification with one or more predictors.
- Able to implement distinct algorithms in R or Python.

Course No: DS314	Course Title: DATA WAREHOUSING AND MINING	L	P	U
		3	0	3

Course Learning Objectives

1. To introduce the fundamental concepts of data mining.
2. To study data mining tasks of classification, clustering, and finding association rules and be introduced to their algorithmic aspects of the three main data mining tasks, and their typical application domains & case studies.
3. To introduce the components, and processes of a Data Warehouse, the architecture of a data warehouse, and collection of business requirements for a data warehouse
4. To learn dimensional modeling for designing database schemas for a Data Warehouse To understand the role of Data Marts & ODS in Data Warehousing .To be introduced to advanced Dimensional Modeling concepts
5. To understand the ETL process and to be introduced to OLAP, and the idea of multidimensional databases

Course Contents

UNIT-I -Introduction

Introduction to Big Data and the relevance of data mining. Learning what tasks constitute data mining. Real-world data mining applications. Relation to Business Intelligence techniques and predictive modeling. Real-world data mining applications, Data and Preprocessing, Understanding of Data, what is data? Types of attributes, properties of attribute values, types of data, data quality, Sampling, Data Normalization, Data Cleaning, Similarity Measures, Feature Selection/Instance Selection, the importance of feature selection/instance selection in various big data scenarios.

Case Study: Balance the Dataset (Preprocessing), Apply the Normalization technique for varying scale data (Normalization), Review rating dataset (Similarity Measures)

UNIT-II-Classification

Introduction to various classification techniques -Decision-Trees Rule-based, Instance-based classifiers like k-Nearest Neighbors, Support Vector Machines (SVMs) , Ensemble Learning, Classification Model , Selection and Evaluation. Application-B2B customer buying stage prediction, Recommender Systems The algorithmic and statistical aspects of the techniques.

Case Study: Play or not Play using Weather dataset (Decision Tree), Predicting heart disease or not Using heart disease dataset (SVM), Predicting diabetes using PimaIndians Diabetes(KNN)

UNIT-III

Clustering and Association Analysis: Clustering- introduction to partitional and hierarchical clustering methods, graph-based methods, density-based methods Applications- customer profiling, market segmentation. Association Analysis-Apriori algorithm and its extensions,

Association Pattern Evaluation, Sequential Patterns and Frequent Subgraph Mining Applications- B2B Customer Buying Path Analysis, Medical Informatics, Telecommunication alarm diagnosis. The algorithmic and statistical aspects of the techniques to be covered as deemed necessary, in order to present the discussion of relevant applications
Case Study: Group the medicine (Clustering), Find the pattern using transaction dataset (Apriori algorithm)

UNIT-IV

Data Warehouse Components, Processes and Architecture: Source Systems, Data Staging Area, Presentation Server, Data Marts, Operational Data Store (ODS),Metadata, Information Delivery, Basic Processes of a Data Warehouse, Architecture, Collecting Business Requirements, Data Marts and ODS=Architecture, Design and Cost. Advanced Dimensional Modeling Concepts like Surrogate Keys, Changing Dimensions, Conformed Dimensions, Fact less Fact Tables, Mini Dimensions and, Role playing Dimensions, Multivalued Dimension

UNIT- V

Extraction, Transformation, & Loading (ETL): Data Extraction, Data Transformation, Data Loading, ETL Data Structure, ETL Tools. Introduction to Online Analytical Processing (OLAP)Need for OLAP, Features & Functions, ROLAP, MOLAP, HOLAP, & DOLAP,OLAP Implementation ,SQL Features for DW-CUBE Operator, Roll-up Operator, Top-N Queries, Window Queries Metadata, and a Suitable Data Warehousing Case Study

Text Books:

1. Tan P. N., Steinbach M & Kumar V. "Introduction to Data Mining" Pearson Education, 2006

Reference Books:

1. Han J & Kamber M, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, Second Edition, 2006.
2. Zaki MJ & Wagner M JR, "Data Mining and Analysis-Fundamental Concepts and Algorithms" Cameridge Univ Press, 2014.
3. Dunhum M.H. & Sridhar S. "Data Mining-Introductory and Advanced Topics", Pearson Education, 2006.
4. Arun K. Pujari, "Data Mining Techniques", Universities Press, 2001

Course Outcomes

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

- Approach business problems data-analytically.
- Think carefully & systematically about whether & how data can improve business performance, to make better-informed decisions for management, finance, marketing and some other business activities that lead to employability opportunities.
- Interact competently on the topic of data mining for business intelligence. Know the basics of data mining processes, algorithms, & systems well enough to interact with data mining experts, consultants, etc.

Course No: DS321	Course Title: : Machine Learning	L	P	U
		3	2	4

Course Learning Objectives

- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To understand the basic theory underlying machine learning.
- To be able to apply machine learning algorithms to solve problems of moderate complexity.
- To be able to read current research papers and understands the issues raised by current research
- To be able to implement machine learning algorithms and retrieve the required data.

UNIT - I

Introduction - Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning

Concept learning and the general to specific ordering – Introduction, A concept learning task, Concept learning as search, Find-S, Version spaces and the candidate elimination algorithms , Remarks on candidate elimination algorithms

Case Study: Consider the checkers learning problem, design a solution that can improve the performance of the Checkers game.

UNIT - II

Decision Tree learning – Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning Artificial Neural Networks – Introduction, Neural network representation, Appropriate problems for neural network learning, Perceptions, Multilayer networks and the back propagation algorithm, Remarks on the back propagation algorithm, An illustrative example face recognition, Advanced topics in artificial neural networks

Case Study: Apply the decision tree for identifying the best rated movies from Movie dataset.

UNIT - III

Evaluation Hypotheses – Motivation, Estimation hypothesis accuracy, Basics of sampling theory, A general approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms

Bayesian learning – Introduction, Bayes theorem, Bayes theorem and concept learning, Maximum likelihood and least squared error hypotheses, Maximum likelihood hypotheses for

predicting probabilities, Minimum description length principle, Bayes optimal classifier, Gibs algorithm, Naïve Bayes classifier, An example learning to classify text, Bayesian belief networks The EM algorithm

Case study: Apply the Naive Bayes for predicting the severity of cancer from Cancer Dataset.

UNIT -IV

Computational learning theory – Introduction, Probability learning an approximately correct hypothesis, Sample complexity for Finite Hypothesis Space, Sample Complexity for infinite Hypothesis Spaces, The mistake bound model of learning - Instance-Based Learning-Introduction, k -Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning

Genetic Algorithms – Motivation, Genetic Algorithms, An illustrative Example, Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning, Parallelizing Genetic Algorithms Learning Sets of Rules – Introduction, Sequential Covering Algorithms,

Learning Rule Sets: Summary, Learning First Order Rules, Learning Sets of First Order Rules: FOIL, Induction as Inverted Deduction, Inverting Resolution

Analytical Learning - Introduction, Learning with Perfect Domain Theories: Prolog-EBG Remarks on Explanation-Based Learning, Explanation-Based Learning of Search Control Knowledge

Case Study: Apply the k-NN on pima-indians-diabetes dataset and identify the youngest person suffering from diabetic.

UNIT - V

Combining Inductive and Analytical Learning – Motivation, Inductive-Analytical Approaches to Learning, Using Prior Knowledge to Initialize the Hypothesis, Using Prior Knowledge to Alter the Search Objective, Using Prior Knowledge to Augment Search Operators, Reinforcement Learning – Introduction, The Learning Task, Q Learning, Non-Deterministic, Rewards and Actions, Temporal Difference Learning, Generalizing from Examples, Relationship toDynamic Programming

TEXT BOOKS:

1. Machine Learning – Tom M. Mitchell, McGraw Hill Education; First edition, 2017.

2. Machine Learning: An Algorithmic Perspective, Stephen Marsland, Chapman and Hall/CRC; 2nd Edition, 2014.

REFERENCE BOOKS:

1. Machine Learning Methods in the Environmental Sciences, Neural Networks, William WHsieh, Cambridge University Press; Reprint edition, 2018.
2. Pattern Classification, Richard O. Duda, Wiley-Blackwell; 2nd Edition, 2004.
3. Neural Networks for Pattern Recognition, Christopher M. Bishop, Clarendon Press, 1st Edition, 1995.
4. Machine Learning South Asia Edition: The Art And Science Of Algorithms That Make Sense Of Data, Peter Flach, Cambridge University Press, 1st Edition, 2015.

Course Outcomes

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

- Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
- Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
- Appreciate the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
- Be able to design and implement various machine learning algorithms in a range of real-world applications.
- Can implement machine learning algorithms and retrieve the required data.

Course No: DS322	Course Title: Expert Systems	L	P	U
		3	0	3

Course Learning Objectives

- Describe the concepts central to the creation of expert systems.
- Illustrate the tools and the processes used for the creation of an expert system.
- Demonstrate methods used to evaluate the performance of an expert system.
- Conduct an in-depth examination of existing expert systems.
- Describe the program structure of LISP and PROLOG.
- Few Case studies were carried out on Expert Systems and Knowledge Representation.

UNIT-I

Introduction: Expert systems and AI, Separating knowledge and inference, Logic and Resolution: Propositional logic, First-order predicate logic, reasoning in logic: inference rules, Resolution and first-order predicate logic, Resolution strategies, applying logic for building expert systems, Logic as a representation formalism.

UNIT-II

Production Rules and Inference: Knowledge representation in a production system, Inference in a production system, Pattern recognition and production rules, Production rules as a representation formalism. Frames and Inheritance: Semantic Nets, Frames and single inheritance, Frames and multiple inheritance, Frames as a representation formalism.

UNIT-III

Reasoning with Uncertainty:

Production rules, inference and uncertainty, Probability theory, the subjective Bayesian method, the certainty factor model, The Dempster-Shafer theory, Network models. Tools for Knowledge and Inference Inspection: User interface and explanation, A user interface in PROLOG, Rule models.Case Study: A Course Advisor Expert System

UNIT-IV

OPS5: Knowledge representation in OPS5, the OPS5 interpreter, the rete algorithm. CENTAUR: Limitations of production rules, Prototypes, Facts, Reasoning in CENTAUR.

A Case Study of Knowledge Representation in UC f.

UNIT-V

Introduction to PROLOG: Logic programming, Programming in PROLOG, the declarative semantics, the procedural semantics and the interpreter, Overview of the PROLOG language, Arithmetical predicates, Examining instantiations, Manipulation of the database.

Introduction to LISP:

Fundamental principles of LISP, the LISP expression, Procedural abstraction in LISP, Overview of the language LISP, Symbol manipulation, Predicates, Control structures, the lambda expression, Enforcing evaluation by the LISP interpreter.Paradigms of Artificial Intelligence Programming: Case Studies in Common Lisp.

Text Book:

1.Principles of Expert Systems Peter J.F. Lucas & Linda C. van der Gaag,Addison-Wesley,1st Edition,1991.

References:

1. Introduction to Expert Systems, Jackson P., 3rd edition, Addison Wesley, 1998.

2. Giarratano J., Riley G., Expert Systems, Principles and Programming, Course Technology; 4thedition, 2004.

3. Introduction to Knowledge Systems, Stefik M., Morgan Kaufmann, 1st Edition, 1995.

Course Outcomes

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

- Define and describe the expert system and its main constituents.
- Distinguish class of problems suitable for solving with expert systems.
- Breakdown the problem and select crucial parts.
- Assemble various parts of knowledge and skills in order to devise the approach to solution.
- Design and create an expert system suitable for solving particular problems.
- Appraise the quality of solution and justify the employed techniques.

- To meet the industry needs with help of a few case studies discussed and practiced technologies.

Course No: CS323	Course Title: Computer Networks	L	P	U
		3	0	3

Course Learning Objectives

- Build an understanding of the fundamental concepts of data communication and computer networking
- To study the foundational principles, architectures, and techniques employed in computer networks.
- To study the concepts of communication networks, protocols and their performance
- Allow the student to gain expertise in some specific areas of networking such as the design and maintenance of individual networks
- To study TCP & UDP socket and RIP, OSPF routing protocols

Course Contents

UNIT-I

Uses of Computer Networks, Network Hardware , Network Software , Network protocol (syntax, semantics, and timing); Protocol suites (OSI and TCP/IP); Layered protocol software (stacks): Physical layer networking concepts; data link layer concepts; network layer concepts; transport and application layer concepts; Network Standards and standardization bodies.

UNIT-II

Bandwidth and Data Rate, Encoding and Modulation Techniques, Transmission modes, Multiplexing (FDM &TDM), Transmission media.

UNIT-III

LAN topologies (bus, ring, star), LAN technologies (Ethernet, token Ring, Gigabit Ethernet), Error detection and correction, Carrier sense multiple access networks (CSMA), Large networks and wide areas, Protocols (addressing, congestion control, virtual circuits, quality of service). Internet - addressing, routing, end point control; Internet protocols - IP, TCP, UDP, ICMP, HTTP, CIDR

UNIT-IV

Flooding; Minimal spanning trees; Bellman Ford, Dijkstra's, OSPF, BGP shortest path algorithms; The leaky bucket, floydwarshall and Random Early Detection congestion methods; Data security and integrity: Fundamentals of secure networks; cryptography; Encryption and privacy: Public key, private key, symmetric key; Authentication protocols; Packet filtering; Firewalls; Virtual private networks; Transport layer security

UNIT-V

Overview of the issues of network management; Domain names and name services; Issues for Internet service providers (ISPs); Quality of service issues: performance, failure recovery.

Text Books

1. W. Stallings, "*Data & Computer Communications*", Prentice-Hall,10th Edition, 2005.
2. A. S. Tanenbaum, "*Computer networks*", Prentice-Hall, 5th Edition, 2005

Reference Books

1. Behrouz A Forouzan, "*Data Communications and Networking*", Tata Mc-grawhill, 2nd Edition, 2007.
2. J.F.Kurose and K.W.Ross, "*Computer Networking: A Top-Down Approach Featuring the Internet*", Pearson Education, 6th Edition, 2001.

List of Computer Networks Laboratory Experiments:

SNo	Experiments	Duration
1	Write a program to implement Connection oriented Client & Server (TCP Client & TCP Server)	1.40H
2	Write a program to implement Connection less Client & Server (UDP Client & UDP Server)	1.40H
3	Time of the day server and client using TCP	1.40H
4	Concurrent echo server & client using UDP	1.40H
5	How to configure Ethernet , Telnet and Console interface on CISCO router using Netsimk and CISCO Packet Tracer	1.40H
6	How to configure LAN & WAN interfaces on CISCO router	1.40H
7	How to configure static routing	1.40H
8	How to configure RIP , OSPF ,EIGRP protocols on CISCO router	1.40H
9	How to configure L2 & L3 switches	1.40H

Course Outcomes

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

- understand basic computer network technology
- Understand and explain Data Communications System and its components
- Identify the different types of network topologies and protocols
- Understand about working of Intranet, LAN, WAN, MAN setups, different topologies
- Gain familiarity with common networking protocols and algorithms
- Configure network protocols and analyze its performance
- Understand , configure, troubleshoot routing protocols using simulators like netsimk and CISCO packet tracer

ourse No: DS324	Course Title: Neural Networks and Fuzzy Logic	L	P	U
		3	0	3

Course Learning Objectives

- To impact knowledge on fuzzy logic principles
- To understand models of ANN
- To use the fuzzy logic and neural network for application related to design and manufacture

UNIT-I

ARCHITECTURES: Introduction –Biological neuron-Artificial neuron-Neuron modeling-Learning rules-Single layer-Multi layer feed forward network-Back propagation-Learning factors.

UNIT-II

NEURAL NETWORKS FOR CONTROL: Feedback networks-Discrete time hop field networks-Schemes of neuro –control, identification and control of dynamical systems-case studies (Inverted Pendulum, Articulation Control).

Case study : Application of fuzzy logic and neural networks to Measurement-Control- Adaptive Neural Controllers – Signal Processing and Image Processing.

UNIT-III

FUZZY SYSTEMS: Classical sets-Fuzzy sets-Fuzzy relations-Fuzzification – Defuzzification- Fuzzy rules.

UNIT-IV

FUZZY LOGIC CONTROL: Membership function – Knowledge base-Decision –making logic –Optimizations of membership function using neural networks-Adaptive fuzzy systems-Introduction to generate to genetic algorithm.

Case study : Fuzzy logic control-Inverted pendulum -Home Heating System-Blood pressure during anesthesia.

UNIT-V

APPLICATION OF FLC: Fuzzy logic control-Inverted pendulum-Image processing-Home Heating system-Blood pressure during anesthesia-Introduction to neurofuzzy controller.

TEXT BOOKS:

1. Kosko, B, "*Neural Networks and Fuzzy Systems: A Dynamical Approach to Machine Intelligence*", PrenticeHall, NewDelhi, *2nd Edition,* 2004.
2. Timothy J Ross, "*Fuzzy Logic with Engineering Applications*", John Willey and Sons, West Sussex, England, 2nd Edition, 2005.

REFERENCE BOOKS:

1. Jack M. Zurada, "*Introduction to Artificial Neural Systems*", PWS Publishing Co., Boston, 2002.
2. Klir G.J. &Folger T.A., "*Fuzzy sets, Uncertainty and Information*", Prentice –Hall of India Pvt. Ltd., New Delhi, 2008.
3. Zimmerman H.J., "*Fuzzy set theory and its Applications*", Kluwer Academic Publishers Dordrecht, 2001.
4. Driankov, Hellendroonb, "*Introduction to fuzzy control*", Narosa Publishers, 2001.
5. Laurance Fausett, Englewood cliffs, N.J., "*Fundamentals of Neural Networks*", P
6. Rajasekaran, S. Vijayalakshmi Pai. G.A. "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003

Course Outcomes

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

- To Expose the students to the concepts of feed forward neural networks
- To provide adequate knowledge about feedback networks.
- To teach about the concept of fuzziness involved in various systems and to provide adequate knowledge about fuzzy set theory.
- To provide comprehensive knowledge of fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.
- To provide adequate knowledge of application of fuzzy logic control to real time systems.

Course No: DS401	Course Title: Predictive Analytics	L	P	U
		3	0	3

Course Learning Objectives

Gain understanding of the computational foundations in Big Data Science.

- Develop critical inferential thinking.
- Gather a tool chest of R libraries for managing and interrogating raw and derived, observed, experimental, and simulated big healthcare datasets.
- Possess practical skills for handling complex datasets.

Unit – I

Introduction to Predictive Analytics & Linear Regression (NOS 2101): What and Why Analytics, Introduction to Tools and Environment, Application of Modelling in Business, Databases & Types of data and variables, Data Modelling Techniques, Missing imputations etc. Need for Business Modelling. Regression — Concepts, Blue property-assumptions-Least Square Estimation. Variable Rationalization, and Model Building etc.

Case study: Take any three data modeling techniques and implement them on a real time system.

Unit – II

Logistic Regression (NOS 2101): Model Theory, Model fit Statistics, Model Conclusion, Analytics applications to various Business Domains etc. Regression Vs Segmentation — Supervised and Unsupervised Learning, Tree Building — Regression, Classification, Overfitting, Pruning and complexity. Multiple Decision Trees etc.

Case study: Predict the best share to buy from a stock mart dataset using Logistic regression algorithm.

Unit – III

Objective Segrnentation (NOS 2101): Regression Vs Segmentation — supervised and Unsupervised Learning, Tree Building — Regression, Classification, Overfitting, Pruning and complexity, Multiple Decision Trees etc. Develop Knowledge, Skill and Competences (NOS 9005) Introduction to Knowledge skills & competencies, Training & Development, Learning & Development, Policies and Record keeping, etc.

Case study: Design a blueprint/system that have all phases of training the employees and developing the product

Unit –zIV

Time Series Methods I Forecasting, Feature Extraction (NOS 2101): Arima, Measures of Forecast Accuracy, STL approach, Extract features from generated model as Height, Average, Energy etc and Analyze for prediction. Project

Case study: Predict the winning chances of a politician by analyzing the social media data using the ARIMA model.

Unit – V

Understanding Map Reduce Fundamentals and HBase :The MapReduce Framework; Techniques to Optimize MapReduce Jobs; Uses of MapReduce; Role of HBase in Big Data Processing; Storing Data in Hadoop : Introduction of HDFS, Architecture, HDFC Files, File system types, commands, org.apache.hadoop.io package, HDF, HDFS High Availability; Introducing HBase, Architecture, Storing Big Data with HBase , Interacting with the Hadoop Ecosystem; HBase in Operations Programming with HBase; Installation, Combining HBase and HDFS;

TEXT BOOK

1. BIG DATA and ANALYTICS, Seema Acharya, Subhasinin Chellappan, Wiley publications, 1st Edition, 2015.
2. Student's Handbook for Associate Analytics-III, Nasscom, 2nd Edition, 2014.

Course Outcomes

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

- Experiment with various techniques of predictive analytics and work on missing Data.
- Identify suitable data models for Logistic Regression.
- Compare regression and segmentation using Sigmoidal function.
- Build decision trees for classification and prune for accuracy.
- Analyze integrated processes for univariate stationary and non- stationary data.
- Define purpose, scope and format of project documentation.
- Can predict the data/information from the dataset using machine learning algorithms

Course No: DS402	Course Title: System for Data Analytics	L	P	U
		3	0	3

Course Learning Objectives

- To understand the various aspects of the computational infrastructure used for processing big data
- To understand the different types of computer architectures and how they influence the processing of data. The manner in which task parallelism and data parallelism interact with data processing
- To understand distributed and parallel database systems
- To understand the various processing frameworks, like batch processing, map-reduce, and stream processing
- To understand the fundamentals of cloud computing from the point of view of processing frameworks
- To become with platforms like AWS and Azure

Unit I

Introduction to data engineering – to appreciate the difference between data engineering and data science. To understand the data processing activities like partitioning, replication, grouping and sorting, and data locality

Unit II

A brief study of various computer architectures, Flynn's taxonomy. To understand task parallelism and data parallelism

Unit III

To study parallel and distributed databases. Their architecture and performance. The architecture of parallel databases – shared memory, shared disk, and shared-nothing. Pipeline and partitioned parallelism. Speed and scale. Partitioning of data. Introduction to parallel algorithms. Optimization issues

Unit IV

Various kinds of data processing frameworks – batch processing, map-reduce processing, stream processing, real time processing. Introduction to the map-reduce pattern, examples and computing platforms like Hadoop. Introduction to Stream processing, difference between stream and real time processing. Examples of stream processing applications

Unit V

Cloud computing fundamentals virtualization, batch-transactional-continuous workloads, execution models. Identifying work loads.Scalable web apps, batch processing, disaster recovery. Examples of cloud platforms – AWS, Azure etc. and usage scenarios

Course Outcomes

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

- The student will have an appreciation of the various architectures used for data processing
- The student will understand the overall system architecture for data processing, and will be able to understand popular cloud platforms used for data processing in terms of their architecture

Course No: DS403	Course Title: Data Visualization	L	P	U
		3	0	3

Course Learning Objectives

- To get familiar with different visualization techniques using excel, python, Tableau and PowerBI.
- To introduce visual perception and core skills for visual analysis.
- To understand visualization for information and dashboard design.
- To understand the working of visualization software

Course Contents

UNIT-I

Foundation for a Science of Data Visualization: Need of visualization, block diagram of visualization, Visualization Stages, Experimental Semiotics Based on Perception, A Model of Perceptual Processing. Data and Image models: Types of Data, Coding Words and Images, The Nature of Language, Visual and Spoken Language, Animated Visual Languages

UNIT-II

Introduction of visualization design: The Perceptual Evaluation of Visualization Techniques and Systems, Structural Analysis, Statistical Exploration, Cross-Cultural Studies and Child Studies, Practical Problems in Conducting User Studies, Exploratory data analysis: Introduction to EDA, Basic statistical methods to understand the data.

Case study:

1. **Perform exploratory data analysis on 2012-13 European football(Soccer) dataset in excel and python**

UNIT-III

Visualizing Multidimensional Metadata: Interactive Tables, scatter plots, Parallel Coordinates, star plots, Interactive Histograms, circular histograms. Graphical perception: Visual perception, Simple Model of Visual Perception, different methods of graphical perception.

Case study:

1. **Use supermarket dataset to explore all visualization techniques in python**

UNIT-IV

Visualization software: Tableau: Introduction to Tableau, Advantages and disadvantages of Tableau, basic functionality, different case studies using Tableau. Microsoft Power BI: Introduction to Power BI, Advantages and disadvantages of Power BI, basic functionality, different case studies using Power BI.

Case study:

1. **Explore IPL 2020 dataset using Tableau**
2. **Explore 2012–13 European football (soccer) using PowerBI**

UNIT- V

Interacting with Visualizations: Data Selection and Manipulation Loop, Exploration and Navigation Loop. Thinking with Visualizations: Memory Systems, Eye Movements, Problem Solving with Visualizations, Creative Problem Solving. Introduction to colors: Color Measurement, CIE System of Color Standards, Opponent Process Theory, Color Appearance, Applications of Color in Visualization. Space Perception and the Display of Data in Space: Depth Cue Theory, Task-Based Space Perception

Case study:

Using real time examples to understand the application of colors in the visuals

Text Books:

1. Information Visualization: perception and design, Colin Ware 2nd edition, Omrgan Kaufmann publisher, 2004
2. Visualizing data: Exploring and explaining data with the processing environment, Ben Fry O'Reilly, 1st edition, 2008.

Reference Books:

1. Data Points: Visualization that means something, Nathan Yau Wiley, 1st edition, 2013.
2. Now you see it: Simple Visualization techniques for quantitative analysis, Stephen Few Analytics Press, 1st edition, 2009.
3. Information Visualization, Dr. Keith Andrews, 2016.

Course Outcomes

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

- Understand and visualize the data in a better way.
- Implement different case studies according to the data.
- Infer from data and tell stories based on data.
- Use different open source tools for data analysis and visualization.

Course No: DS404	Course Title: Big Data Systems	L	P	U
		3	0	3

Course Learning Objectives

The course develops the following competencies:

- Student should estimate and analyze different known scientific methods and approaches in terms of data collection, storage and processing.
- Student should be capable to make managerial decisions, to assess their consequences and to bear responsibility for the outcomes.
- These indicated and contributed during the preparation of explanation and analysis of the particular area for data collection, storage and processing, particular market and business-model.
- Students should identify and make prognoses about modern approaches on increasing business efficiency.
- Students should identify and choose optimal solutions for improving it-infrastructure and business architecture of the company after implementation relevant big data collection, storage and processing processes.Few Case studies were carried out on Map Reduce Concept, Hive and Spark.

Course Contents:

UNIT-I

What is Big Data and where it is produced? Rise of Big Data, Compare Hadoop vs traditional systems, Limitations and Solutions of existing Data Analytics Architecture, Attributes of Big Data, data warehouse v/s Data Lakes, other technologies vs Big Data. What is Hadoop? Hadoop History, Distributing Processing System, Core Components, HDFS Architecture, Hadoop Master – Slave Architecture, Daemon types - Learn Name node, Data node, Secondary Name node.

UNIT-II

What is Hadoop Cluster? Pseudo Distributed mode, Type of clusters, Hadoop Ecosystem, Pig, Hive, Oozie, Flume, SQOOP. Overview of MapReduce Framework, MapReduce Architecture, Learn about Jobtracker and Task tracker, Use cases of MapReduce, Anatomy of MapReduce Program.A case study of tuning MapReduce for efficient Bioinformatics in the cloud.

UNIT-III

Hive DDL – Create/Show/Drop Tables, Hive DML – Load Files & Insert Data, Hive Architecture & Components, Partitions in Hive, PIG Architecture & Data types, Shell and Utility components, PIG Latin: File Loaders and HDF, Programming structure in UDF, PIG, limitations of PIG.No SQL Databases: HBase Architecture, HBase Components, Storage Model of HBase, Object Data Stores-S3, HBase and RDBMS, Introduction to Mongo DB, CRUD, Advantages of MongoDB over RDBMS, Use case.A Case Study:Analysis of Airport Data using Hadoop-Hive.

UNIT-IV

Introduction to Data Analysis with Spark, Core Spark Concepts, Programming with RDDs, RDD Basics, Creating RDDs, RDD Operations, Passing Functions to Spark. Advanced Spark Programming: Accumulators, Broadcast Variables, Working on a Per-Partition Basis, Piping to External Programs, Numeric RDD Operations Spark Runtime Architecture, Deploying Applications with spark-submit,

UNIT- V

Spark SQL & Spark Streaming: Using Spark SQL in Applications, Loading and Saving Data From RDDs, JDBC/ODBC Server, and User-Defined Functions. Introduction to Mahout: Why Mahout, Data too large for single machine Data already on Hadoop, Algorithms implemented in Mahout, Setting up the development environment, Mahout API, Parallel versus in-memory execution mode.A case study : Apache Spark at Yahoo.

Text Books:

1. Oreilly.Hadoop.The.Definitive.Guide.3rd.Edition.Jan.2012.

Reference Books:

1. Hadoop: The Definitive Guide, 4th Edition. Publisher: O'Reilly Media, Inc. Release Date: April 2015.
2. Learning Spark Lightning-Fast Big Data Analysis. 1st edition, 2015.
3. learning-apache-mahout. By Chandramani Tiwary, 1st Edition, Publisher: Packt Publishing, Release Date: March 2015.
(https://www.oreilly.com/library/view/learning-apache-mahout/9781783555215/)

Course Outcomes

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

- To understand Big Data concepts, including cloud and big data architectures.
- To motivate and explain trade-offs in big data processing technique design and analysis.
- To apply non-relational databases, the techniques for storing and processing large
- volumes of structured and unstructured data, as well as streaming data.
- To Integrate Apache Mahout with newer platforms such as Apache Spark

- To meet the industry needs with help of a few case studies discussed and practiced technologies.

Course No: DS405	Course Title: Real Time Analytics	L	P	U
		3	0	3

Course Learning Objectives

- To know how to understand the social media data like Facebook, Twitter and YouTube.
- To understand how to extract and analyze the social media data using real time case studies.
- To learn various text mining techniques
- To design and understand the different visualization tools and techniques

Course Contents

UNIT-I

Harnessing Social Data (Facebook): Connecting, Capturing, and Cleaning, Uncovering Brand activity, Emotions, Facebook API ecosystem and method to extract data. Feature extraction and content analysis using keywords, hashtags, and noun phrase. Case study: Emotion Analysis, Apache Kappa Architecture.

UNIT- II

Analyzing Twitter data: Twitter data extraction using REST and Streaming API, Sentiment analysis application. Case study: Sentiment Analysis.

UNIT-III

Analyzing YouTube data: Analysis of structured and unstructured data, Characteristics of YouTube, Channel popularity using traffic and sentiment data from user comments.

UINT – IV

Text Mining and Analytics: Text representation, word association mining and analysis, Description of stopword removal, stemming, and POS tagging, analyse and filter the Twitter data using MAXQDA, Flight data analysis. Case Study : Segregare the Restaurants reviews (Text Analytics)

UNIT-V

Visual Representation: Design principles, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

Text Books:

1. Python Social Media Analytics by Siddhartha Chatterjee and Michal Krystyanczuk, Publisher: Packt Publishing Limited, 1st Edition, 2017.
2. Mining Text Data, Editors, Charu C. Aggarwal, ChengXiang Zhai, Publisher Springer-Verlag New York, 1st Edition, 2012.

Reference Books:

1. Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data, 2016 by Dipanjan Sarkar, Publisher: Apress; 1st edition, 2016.
2. Mastering Social Media Mining with Python y Marco Bonzanini, Publisher: Packt Publishing Limited, 1st Edition, 2016.
3. Real-Time Big Data Analytics, Sumit Gupta, Shilpi Saxena, Packt Publishing Ltd, 1st Edition, 2016.
4. Kafka: The Definitive Guide Real-time Data And Stream Processing At Scale, Neha Narkhede, Gwen Shapira & Todd Palino, O'Reilly Media, Inc., 1st Edition, 2017

Course Outcomes

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

- Summarize and analyze the social media data
- Make inference about emotion and sentiment analysis from social media data that will create employability opportunities for the diverse stakeholder groups.
- Fit, interpret, and assess models with one or more predictors
- Visualize the data gathered from various social media

Course No: DS406	Course Title: Natural Language Processing	L	P	U
		3	0	3

Course Learning Objectives

- To teach students the leading trends and systems in natural language processing.
- To understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the above mentioned concepts.
- Teach them to recognize the significance of pragmatics for natural language understanding using real time case studies.
- Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

UNIT I

Introduction – Human languages, models- Regular Expressions-Patterns – Finite State Automata, Morphology - Inflectional Morphology - Derivational Morphology, Finite-State Morphological Parsing, Construction of a finite-state lexicon, Finite state Transducers (FST), Porter Stemmer, Word and Sentence Tokenization, Spelling Correction: Minimum Edit Distance

UNIT II

N-Grams Models of Syntax - Counting Words - Unsmoothed Ngrams, Training & Test Sets, Smoothing- Interpolation -Back-off Deleted Interpolation – Entropy - English Word Classes – Tag-sets for English, Part of Speech Tagging-Rule Based Part of Speech Tagging - Stochastic Part of Speech Tagging - Transformation-Based Tagging.

Case Study: Word Prediction Using Stupid Backoff With a 5-gram Language Model on Corpus data from a list of blog posts.

UNIT III

Context Free Grammars for English Syntax- Context Free Rules and Trees, Sentence- Level Constructions– Agreement – Sub Categorization, Parsing – Top-down – Bottom-Up-CKY Parsing- The Earley Algorithm, Statistical Parsing– Probabilistic Context-Free Grammars, Feature Structures

UNIT IV

Representing Meaning - Meaning Structure of Language - First Order Predicate Calculus, Representing Linguistically Relevant Concepts –Syntax Driven Semantic Analysis - Semantic Attachments –Syntax Driven Analyzer - Robust Analysis - Lexemes and Their Senses – Internal Structure - Word Sense Disambiguation -Information Retrieval.

Case Study: The case study is to introduce a predictive approach, which consists of predicting sentiments based on opinions collected from the well-known social network Twitter.

UNIT V

Discourse -Reference Resolution - Text Coherence - Discourse Structure – Coherence ,Dialog and Conversational Agents - Dialog Acts – Interpretation -Conversational Agents - Language Generation – Architecture - Surface Realizations - Discourse Planning ,Machine Translation - Transfer Metaphor–Interlingua –Statistical Approaches.. Named Entity.

Case Study: Basic NLP and Named Entity Extraction from any of the Wikipedia page

Text Books:

1. Daniel Jurafsky and James H Martin,"Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition,·2008.

2. C. Manning and H. Schutze, "Foundations of Statistical Natural Language Processing", MIT Press. Cambridge, MA, Second Printing, 1999.

Reference Text Books:

1. James A. *Natural language Understanding*, Pearson Education, 2nd Edition, 1994.
2. Bharati A., Sangal R., Chaitanya V. *Natural language processing: a Paninian perspective*, PHI, 2000.
3. Siddiqui T., Tiwary U. S. *Natural language processing and Information retrieval*, OUP, 2008.

List of Natural Language Processing Laboratory Experiments:

S No.	Experiments	Duration
1	**File Handling in Documents in PYTHON**	**1:40 H**
2	**Regular Expressions in Natural Language Processing**	**1:40 H**
3	**Data Preprocessing: Tokenization**	**1:40 H**
4	**Data Preprocessing: Stemming and Lemmatization**	**1:40 H**
5	**Language Modeling using N-Grams**	**1:40 H**
6	**Part Of Speech Tagging using Corpus**	**1:40 H**

Course Outcomes

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

- Understand approaches to syntax and semantics in NLP.
- Understand approaches to discourse, generation, dialogue and summarization within NLP.
- Understand current methods for statistical approaches to machine translation.
- Provide the student with knowledge of various levels of analysis involved in NLP.
- Understand the applications of NLP.
- Gain knowledge in automated Natural Language Generation and Machine Translation.
- Understand the mathematical and linguistic foundations underlying approaches to the above areas in NLP
- Understand the underlying concepts of Autocorrect and Autocomplete, Language Translator, Social Media Monitoring, Chabot, Survey Analysis, Targeted Advertising, Voice Assistants, Grammar Checkers and Email Filtering.

Course No: DS407	Course Title: Soft Computing	L	P	U
		3	0	3

Course Learning Objectives

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- Provide the mathematical background for carrying out the optimization associated with neural network learning and Particle Swarm Optimization.
- To develop some familiarity with current research problems in Soft Computing by working on research projects.
- Few Case studies were carried out on Genetic Algorithms,Artificial Neural Networks and Particle Swarm Optimization.

UNIT-I

Introduction to Soft Computing: Concept of computing systems, "Soft" computing versus "Hard" computing , Characteristics of Soft computing , Some applications of Soft computing techniques

UNIT-II

Fuzzy logic: Introduction to Fuzzy logic , Fuzzy sets and membership functions , Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

UNIT-III

Genetic Algorithms: Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, Solving single-objective optimization problems using GAs.Electricity estimation using genetic algorithm approach: a case study of Turkey.

UNIT-IV

Artificial Neural Networks: Biological neurons and its working , Simulation of biological neurons to problem solving ,Different ANNs architectures , Training techniques for ANNs , Applications of ANNs to solve some real life problems.An artificial neural network case study: the control of work-in-process inventory in a manufacturing line.

UNIT-V

Particle Swarm Optimization: Introduction ,Convergence Analysis, Performance Illustration , Applications in Hidden Markov Models,SwamAlgorithms,Main Concerns to handle discrete problems, Applications to discrete problems.Particle swarm optimization for sequencing problems: a case study.

Text Books:

1. Introduction to Soft Computing, Authors: Udit Chakraborty, Samir Roy, Pearson India, 1st Edition, 2013.
2. Swam Intelligence and Bio-Inspired Computation, 1st Edition, Elsiver, Xin-She Yang Zhihua Cui, 2nd Edition, 2013.

References:

1. Fuzzy Logic: A Pratical approach, F. Martin,, Mc neill, and Ellen Thro, Morgan Kaufmann Pub; Pap/Dskt edition (August 1, 1994)
2. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey, 3rd Edition, 2010.
3. Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, Nikola K. Kasabov, First Priniting, MIT Press, 1998.
4. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press, First Priniting, 2000.
5. Soft Computing, D. K. Pratihar, Narosa, Revised Edition, 2018.

Course Outcomes

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

- Describe Fuzzy logic and its applications.
- Analyze artificial neural networks and its applications.
- Analyze Particle Swam Optimization and its applications
- Solve single-objective optimization problem's using GAs.
- Solve multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Apply Soft computing techniques to solve problems in varieties of application domains.

- To meet the industry needs with help of a few case studies discussed and practiced technologies.

Course No: DS408	Course Title: Human Computer Interaction	L	P	U
		3	0	3

Course Learning Objectives

- Demonstrate an understanding of guidelines, principles, and theories influencing
- Recognize how a computer system may be modified to include human diversity.
- Select an effective style for a specific application, design mock ups and carry out user and expert evaluation of interfaces.
- Carry out the steps of experimental design, usability and experimental testing, and evaluation of human computer interaction systems.
- Use the information sources available, and be aware of the methodologies and Technologies supporting advances in HCI
- Understand the Industry oriented projects through Case Study

Unit-I

The User Interface: An introduction and Overview- Importance of user Interface-definition-importance of good design - Benefits of good design -A brief history of Screen design. The graphical user interface: Popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user –interface popularity, characteristics- Principles of user interface.

Case Study on User interface designs

Unit-II

User Interface Design Process: Obstacles and Pitfalls in development-Designing for people-Usability – Common usability problems, Human interaction with computers, importance of human characteristics in design, Human consideration, Human interaction speeds, understanding business junctions.

Case study on Business Case Analysis.

Unit-III

Screen Designing: Design goals, Screen planning and purpose, organizing screen elements, ordering of screen data and content, screen navigation and flow, Visually pleasing composition, amount of information, focus and emphasis, presentation information simply and meaningfully, information retrieval on web, statistical graphics, Technological consideration in interface design. System Menus: Menu- Structures, Functions, Content, Formatting, Selecting menu choices.

Unit-IV

Navigation Schemes: Navigation Menus, Graphical Menus- Types-Examples, Windows-Characteristics, Components, Presentation Styles- Types, Window Operations. Web Systems, Device and Screen based Controls: Frames-Pop up Windows, Device based Controls – Characteristics and Selection, Operable, Read Only, selection, custom and presentation controls.

Unit-V

Texts & Messages: Words, Sentences, Messages and Texts, Multimedia, creating meaningful graphics, Icons and Images, Colors, Choosing Proper colors-Uses, problems- Choosing colors for textual and statistical graphics screens. Testing: OOTB,Ubiquitous Computing and augmented Realities, Usability Testing – Purpose, Importance, and Scope, prototypes, kinds of test, conducting the test
Case study on Digital Promise

Text Books:

1. The Essential Guide to User Interface Design, Wilbert O.Galitz, Wiley India Edition, 2nd Edition, 2002.

Reference Book(s):

1. Human Computer Interaction, Alan Dix, Janet Finlay, Goryd, Abowd, Russell Beal, PEA, 3rd Edition, 2004.
2. Designing the User Interface, Ben Shneiderman, PEA, 4th Edition, 2004.
3. Building Interactive Systems: Principles for Human-Computer Interaction, Dan R. Olsen, Jr. ISBN-13:9789353500085, 1st Edition Cengage, 2010.

Course Outcomes

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

- Design, implement and evaluate effective and usable graphical computer interfaces.
- Describe and apply core theories, models and methodologies from the field of HCI.
- Describe and discuss current research in the field of HCI.
- Implement simple graphical user interfaces using the Java Swing toolkit.
- Describe special considerations in designing user interfaces for older adults.
- Develop Various Case Studies in the Industry

Course No: **DS409**	Course Title: **Computer Vision**	L	P	U
		3	0	3

Course Learning Objectives

- Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision
- Describe the foundation of image formation and image analysis. Understand the basics of 2D and 3D Computer Vision.
- Get an exposure to advanced concepts leading to object and scene categorization from images.

Prerequisites:

- Data structures
- Programming (Python preferably)
- Math: Linear algebra, vector calculus, and probability.

Course Contents

UNIT-I

Introduction to Image Processing and Computer Vision: What is Computer Vision? History of computer vision. Digital Images. Structure of Human Eye and Vision. Goals and Tasks of Image Processing. Contrast and brightness correction.

UNIT-II

Image Formation and Filtering: Geometric primitives and transformations, Photometric image formation, the digital camera, Point operators, linear filtering, pyramids and wavelets, Hierarchical motion estimation.

UNIT-III

Feature Detection and Matching: Points and Patches, Feature descriptors, Feature matching, Feature tracking, Edges , Edge detection, Edge linking, Lines, Successive approximation, Hough transforms, Robust least squares and RANSAC, Applications on Points, Edges, Lines.

UNIT-IV

Multiple Views and Motions: Stereo intro and Camera calibration, Epipolar Geometry and Structure from Motion, Stereo Correspondence and Optical Flow.

Case study: Development of Image Analysis Software for Automated Optical Inspections.

UNIT- V

Recognition: Recognition and Bag of Words Detection with sliding windows: Viola Jones, Face Recognition, Instance Recognition.

Case study : Development of a Facial Recognition Application for Retail.

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag, London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

References:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
4. **http://vision.stanford.edu/teaching/cs223b/syllabus.html**

Course Outcomes

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

- Understand the major technical approaches involved in computer vision.
- Describe various methods used for registration, alignment, and matching in images.
- Build computer vision applications.

Course No: DS410	Course Title: Distributed Cloud Computing	L	P	U
		3	0	3

Course Learning Objectives

- Understand the underlying infrastructure and architecture of clouds, techniques for enabling services and the quality of such services.
- Analyse various levels of services that can be achieved by cloud computing.
- Understand the programming aspects of cloud computing using different tools and techniques.
- Identify research related issues of cloud computing in performance, security and management.
- Analyse real life case studies and showcase importance of computing models

Prerequisites:

- Basic programming

Course Contents

UNIT-I

Concepts of Distributed Computing: Introduction to distributed computing, Parallel vs Distributed computing, Elements of parallel computing, Elements of distributed computing, Service oriented computing.

UNIT-II

Concepts of Cloud Computing: About cloud computing, Building cloud computing environment, Cloud computing platforms and technologies, System models for distributed and cloud computing.

Case study: Education training organization's implementation of cloud on AWS

UNIT-III

Virtual machines and Virtualization of Clusters and Data centers: Implementation levels of virtualization, Virtualization structures/tools and mechanisms, Virtualization of CPU, memory and I/O devices, Virtual clusters and resource management, Virtualization for data-center automation.

UNIT-IV

Programming Enterprise Clouds using Aneka: Introduction, Aneka Architecture, Thread Programming using Aneka, Task Programming: using Aneka, Map Reduce Programming using Aneka. Monitoring, Management and Applications: An Architecture for Federated Cloud Computing, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Best Practices in Architecting Cloud Applications in the AWS cloud, Building Content Delivery networks using Clouds, Resource Cloud Mashups.

Case study: MOOC implementation of cloud on AWS

UNIT- V

Cloud Applications & Security: Scientific Applications, Business and Consumer Applications, security aspect of cloud computing.

Case study: Online hospitality service implementation on AWS cloud

Text Books:

1. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley, 1st Edition, 2013.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C.Fox, Jack J.Dongarra, Elsevier, 1st Edition, 2012.

References:

1. Cloud Computing: A Practical Approach, Anthony T.Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill, 1st Edition, 2017.
2. Enterprise Cloud Computing, GautamShroff, Cambridge University Press, 1st Edirion, 2010.
3. Cloud Computing: Implementation, Management and Security, John W. Ritting house, James F.Ransome, CRC Press, 1st Edition, 2009.
4. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly, 1st Edition, 2009.
5. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, 1st Edition, 2011

Course Outcomes

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

- Understand the distributed and cloud computing infrastructure, architecture, system models, enabling technologies and its paradigms
- Analyze the service and deployment models of cloud computing and related issues
- Program on cloud development platforms.
- Apply computing concepts and models in real life situations by analysing the case studies

Course No: DS411	Course Title: Internet of Things	L	P	U
		3	0	3

Course Learning Objectives

- Smart Lighting, Smart Appliances, Intrusion Detection, and Smoke/Gas Detectors. Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response.
- Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection.
- Energy- Smart Grids, Renewable Energy Systems, Prognostics.
- Retail-Inventory Management, Smart Payments, Smart Vending Machines, Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring.
- Remote Vehicle Diagnostics, Agriculture-Smart Irrigation ,GreenHouse Control , Industry –Machine Diagnosis & Prognosis Indoor Air Quality Monitoring ,Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics.

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Contents

UNIT- I

Introduction to Internet of Things: Introduction - Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs , IoT Enabling Technologies-Wireless Sensor Networks , Cloud Computing, Big Data Analytics , Communication Protocols , Embedded Systems, IoT Levels & Deployment Templates.

UNIT- II

Domain Specific IoTs: Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors. Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response. Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection .Energy- Smart Grids , Renewable Energy Systems , Prognostics.
Retail-Inventory Management, Smart Payments, Smart Vending Machines. Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics. Agriculture-Smart Irrigation, Green House Control. Industry –Machine Diagnosis & Prognosis Indoor Air Quality Monitoring, Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics

UNIT- III

IoT and M2M: Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization.

UNIT- IV

IoT Platforms Design Methodology: IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python IoT Physical Devices & Endpoints. What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices- pc Duino, Beagle Bone Black , Cubieboard.

UNIT- V

IoT & Beyond: Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

Text Books:

1. Internet of Things, A Hands on Approach, by Arshdeep Bahga & Vijay audisetti, University Press, 1st Edition, 2018.

Reference Books:

1. The Internet of Things, by Michael Millen, Pearson, 1st Edition, 2018

2. Sinha A.N and Udai A.D, Computer Graphics, 1st Ed., TMH, 2012

List of Internet of Things Laboratory Experiments:

S.no	Experiments	Duretion
1	Familiarization with Raspberry Pi and perform necessary software installation.	1:40 H
2	To interface LED/Buzzer with Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.	1:40 H
3	To interface Push button/Digital sensor (IR/LDR) with Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.	1:40 H
4	To interface DHT11 sensor with Raspberry Pi and write a program to print temperature and humidity readings.	1:40 H
5	To interface motor using relay with Raspberry Pi and write a program to turn ON motor when push button is pressed.	1:40 H
6	To interface OLED with Raspberry Pi and write a program to print temperature and humidity readings on it.	1:40 H
7	To interface Bluetooth with Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.	1:40 H
8	Write a program on Raspberry Pi to upload temperature and humidity data to Thing speak cloud.	1:40 H
9	write a program on Raspberry Pi to retrieve temperature and humidity data from Thing speak cloud.	1:40 H
10	To install SQLite3 database on Raspberry Pi and perform basic SQL queries.	1:40 H
11	Write a program on Raspberry Pi to publish temperature data to MQTT broker.	1:40 H
12	Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.	1:40 H
13	Write a program to create TCP server on Raspberry Pi and respond with humidity data to TCP client when requested.	1:40 H
14	Write a program to create UDP server on Raspberry Pi and respond with humidity data to UDP client when requested.	1:40 H

Course Outcomes

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

- Understand the building blocks of IoT technology and explore the vast spectrum of IoT applications.
- Use processors & peripherals to design & build IoT hardware.
- Assess, select and customize technologies for IoT applications.
- Connect the cyber world with the physical world of humans, automobiles and factories.
- Integrate geographically distributed devices with diverse capabilities.
- Design and implement IoT applications that manage big data.

Course No: DS412	Course Title: Security and Privacy in Cloud Computing	L	P	U
		3	0	3

Course Learning Objectives

- Cloud computing security escalates in importance and evolves, it is important that enterprises understand how to best handle the paradigm change in business operations that the cloud presents.
- Introduces privacy aspects to consider within the context of cloud computing, and analyzes the similarities and differences with traditional computing models.
- To highlight legal and regulatory implications related to privacy in the cloud.
- Understand the Industry oriented projects through Case Study

Course Contents

UNIT-I

INTRODUCTION: Cloud Computing Defined, The SPI Framework for Cloud Computing, The Traditional Software Model, The Cloud Services Delivery Model, Cloud Deployment Models. INFRASTRUCTURE SECURITY: Network level model, The Host level, The Application level model.
Case Study:The Cloud Security Alliance

UNIT-II

DATA SECURITY AND STORAGE: Aspects of Data Security, Data Security Mitigation, Provider Data and Its Security, Data privacy and security Issues.
Case Study: Data Security Improvement In Azure And AWS Platforms

UNIT-III

Access Management: Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations.PRIVACY: What Is Privacy? What Is the Data Life Cycle, What Are the Key Privacy Concerns in the Cloud, Who Is Responsible for Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing, Legal and Regulatory Implications?
Case study: On AWS Identity and Access Management

UNIT-IV

AUDIT AND COMPLIANCE : Internal Policy Compliance , Governance, Risk, and Compliance (GRC) ,Illustrative Control Objectives for Cloud Computing , Incremental CSP-Specific Control Objectives , Additional Key Management Control Objectives , Control Considerations for CSP Users ,Regulatory/External Compliance , Other Requirements , Cloud Security Alliance . Case study on Centralizing SSH Key Management with AWS EC2

UNIT- V

Description of data processing flows, Using PETs, International Telecommunication Union (ITU), International Organization for Standardization (ISO), Organization for the Advancement of Structured Information Standards (OASIS).

Text Books:

1. ***Cloud security and privacy-*** *Tim Mather, Subra Kumaraswamy, and Shahed Latif-O'REILLY Publications*-September 2009: First Edition.

2. Cloud Security: A Comprehensive Guide to Secure Cloud Computing. Krutz R. L. & Vines R. D. Wiley-India. 2010.

Reference Books:

1. Cloud Computing. Miller M. Pearson Education. New Delhi. 2009.

Course Outcomes

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

- To understand the concept of cloud computing and the evolution of computing into cloud computing.
- Able to understand infrastructure security refers to the established security capabilities at the network.
- Able to understand the current state of data security and the storage of data in the cloud, including aspects of confidentiality, integrity, and availability.
- To gain indepth knowledge of audit and compliance functions within the cloud, and the various standards and frameworks.
- To Develop Various Case Studies in the Industry.

Course No: DS413	Course Title: Cloud Administration	L	P	U
		3	0	3

Course Learning Objectives

- Understand all aspects of cloud provisioning and administration
- Apply the administration concepts in an enterprise cloud computing environment.
- Establish best practices for performance measures and monitoring of cloud computing environment
- Understand the Industry oriented projects through Case Study

Prerequisites:

- Networking
- Basic programming

Course Contents

UNIT-I

Cloud Resource Administration and Provisioning: Fundamentals of Cloud Computing and Administration, Planning and analysis of Workload and Capacity, Administering of various Cloud Technologies, Virtual Storage.
Case study: Migrate with AWS

UNIT-II

Cloud Administration using Scalability and Elasticity: Cloud Scalability Administration, Cloud Elasticity Administration.
Case Study: OPenstack Installation and Cloud Manage Resource management.

UNIT-III

Cloud Interoperability & Portability: Introduction to Cloud Interoperability & Portability, Strategic Planning for Interoperability and Portability.
Case Study: Healthcare Data Interoperability with the AWS Cloud

UNIT-IV

Cloud Administration Management: Various Policies Management for SLA, Metering and Billing Management, Privacy and Data Management.
Case Study:Amazon Compute Service Level Agreement

UNIT- V

Disaster Recovery & Security Administration: Cloud Disaster Recovery, Fundamental Security issues in Cloud Administration

Text Book:

1.The Practice of Cloud System Administration, Designing and Operating Lagre Distributed Systems, Limoncelli Thomas A, Strata R, J. Hogan, Pearson Education, , 1st Edistion, 2014.

References:

1. Google Cloud Platform Administration, Ranjit Singh T, Packt Publishing Limited, 1st Edition, 2018
2. Hands-On Cloud Administration in Azure, Toroman Mustafa, Packt Publishing Limited, 1st Edition, 2018

Course Outcomes

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

- Design strategic policies for cloud administration.
- Understand various aspects of disaster recovery & security administration.
- Analyse various management issues in cloud administration.
- Develop Various Case Studies in the Industry.

Course No: DS414	Course Title: Fundamentals of Blockchain Technology	L	P	U
		3	0	3

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Learning Objectives

This basic course makes the student to

- Understand the fundamentals of Blockchain Technology.
- Identify, analyze, and model structural and behavioral concepts of the Blockchain system.
- Develop, explore the conceptual model into various scenarios and applications.
- Apply the concepts of architectural design for deploying the code for Blockchain Application.
- Understanding the Industry oriented projects through Case Study

Course Contents

UNIT- I

Introduction to Blockchain, Key vocabulary while discussing Blockchain, Distinction between databases and Blockchain Explaining distributed ledger Blockchain ecosystem. Transformation in trading units Cryptography and Cryptocurrency, Anonymity and Pseudonymity in Cryptocurrencies, Digital Signatures, Hash Codes, Distributed networks.

Case Study: Crypto-currency

UNIT- II

Bitcoin and its history. Selling Bitcoins, Bitcoin transactions, How Bitcoin transactions work, what happens in case of invalid transactions, Parameters that invalidate the transactions, Scripting language in Bitcoin, Applications of Bitcoin script Nodes and network of Bitcoin, Various roles you can play in the Bitcoin ecosystem.

Case Study: Bitcoin-It' Still Speculation

UNIT- III

Introduction, Purpose of mining, Algorithm used in mining, mining hardware, how does Bitcoin mining work? Bitcoin mining pools how cloud mining of Bitcoin works? Mining incentives, Security and centralizations.

Case Study: Bitcoin Mining

UNIT- IV

Introduction, Ethereum, Ether, use of Ethereum, the Ethereum ecosystem, DApps and DAOs, How Ethereum mining works? Learning Solidity: Contract classes, functions, and conditionals, Inheritance & abstract contracts, Libraries, Types & optimization of Ether, Global variables, Debugging, Future of Ethereum.

UNIT- V

Introduction to Hyperledger, Hyperledger Architecture, Consensus, Consensus & its interaction with architectural layers, Application programming interface, Application model, Network topology, Exploring Hyperledger frameworks.

Text Books:

1. Arshadeep Bagha, Vijay Madisetti, "Bkockchain Applications-A hands-on Approach", Universal Press 2018 (Part One).

Reference Books:

1. Mayukh Mukhopadhyay, "Ethereum Smart Contract Devlopment" Packt Press, 2018 Edition

Course Outcomes

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

- Understand the building blocks of Blockchain technology and explore the vast spectrum of Blockchain applications.
- Assess, select and customize technologies for Blockchain applications.
- Integrate geographically distributed devices with diverse capabilities.
- Design and implement Blockchain applications that manage big data.
- Develop Case Study for real life scenario in the Industry.

Course No: DS415	Course Title: Ethereum and Solidity Programming Essentials	L	P	U
		3	0	3

Course Learning Objectives

- To Introduce Block chain, Ethereum, and Smart Contracts.
- Installing Ethereum and Solidity, Global Variables and Functions.
- Expressions and Control Structures.
- Writing Smart Contracts, Functions, Modifiers, and Fallbacks, Exceptions, Events, and Logging, Truffle Basics.
- Unit Testing, Debugging Contracts.
- Understanding the Industry oriented projects through Case Study

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Contents

UNIT- I

Cryptography, Symmetric encryption and decryption, Asymmetric encryption and decryption, Hashing, Digital signatures, Ether, Gas, Blockchain and Ethereum architecture, How are blocks related to each other?, How are transactions and blocks related to each other?, Ethereum nodes, EVM, Ethereum mining nodes, How does mining work?, Ethereum accounts, Externally owned accounts, Contract accounts, Transactions, Blocks, An end-to-end transaction, What is a contract?, What is a smart contract?, How to write smart contracts?How are contracts deployed?

Case Study: Ethereum

UNIT- II

Ethereum networks, Main network, Test network, Ropsten, Rinkeby, Kovan, Private network, Consortium network, Geth, Installing Geth on Windows, Creating a private network, ganache-cli, Solidity compiler, The web3 JavaScript library, Mist wallet, MetaMask. Ethereum Virtual Machine, Solidity and Solidity files, Pragma, Comments, The import statement, Contracts, Structure of a contract, State variables, Structure, Modifiers, Events, Enumeration, Functions, Data types in Solidity, Value types, Passing by value, Reference types, Passing by reference, Storage and memory data locations , Rule 1, Rule 2, Rule 3, Rule 4, Rule 5, Rule 6, Rule 7, Rule 8, Literals, Integers, Boolean, The byte data type, Arrays, Fixed arrays, Dynamic arrays, Special arrays, The bytes array, The String array, Array properties, Structure of an array, Enumerations, Address, Mappings.

Case Study: Ethereum Networks

UNIT- III

Types of variables, Variables hoisting, Variable scoping, Type conversion, Implicit conversion, Explicit conversion, Block and transaction global variables, Transaction and message global variables, Difference between tx.origin and msg.sender, Cryptography global variables, Address global variables, Contract global variables. Solidity expressions, The if decision control, The while loop, The for loop, The do...while loop, The break statement, The continue statement, The return statement.

UNIT- IV

Smart contracts, Writing a simple contract, Creating contracts, Using the new keyword, Using address of a contract, Constructors, Contract composition, Inheritance, Single inheritance, Multi-level inheritance, Hierarchical inheritance, Multiple inheritance, Encapsulation, Polymorphism, Function polymorphism, Contract polymorphism, Method overriding, Abstract contracts, Interfaces, Function input and output, Modifiers, The view, constant, and pure functions, The address functions, The send method, The transfer method, The call method, The callcode method, The delegatecall method, The fallback function.

Case Study: Smart Contract for Government Processes

UNIT- V

Error handling, The require statement, The assert statement, The revert statement, Events and logging, Application development life cycle management, Truffle, Development with Truffle, Testing with Truffle, Debugging, The Remix editor, Using events, Using a Block Explorer.

Text Books:

1. Solidity Programming Essentials, by Ritesh Modi, Packt Publishing, 2018.

Reference Books:

1. Mayukh Mukhopadhyay, "Ethereum Smart Contract Devlopment" Packt Press, 2018 Edition

Course Outcomes

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

- Learn the basics and foundational concepts of Solidity and Ethereum.
- Explore the Solidity language and its uniqueness in depth.
- Create new accounts and submit transactions to blockchain.
- Get to know the complete language in detail to write smart contracts.
- Learn about major tools to develop and deploy smart contracts.
- Write defensive code using exception handling and error checking.
- Understand Truffle basics and the debugging process.
- Develop Case Study for real life scenario in the Industry.

Course No: **DS416**	Course Title: **: Blockchain with AI**	L	P	U
		3	0	3

Course Learning Objectives

- To teach Hared ledgers, distributed ledgers, bitcoin, and cryptography;
- Key concepts of artificial neural networks, machine learning, and deep learning with real-world examples.
- Smart services within a Blockchain ecosystem such as classification, regression, and image recognition.
- Understanding the Industry oriented projects through Case Study

Prerequisites

Operating Systems, Computer Networks, computer Architecture, Programming Languages

Course Contents

UNIT- I

Hyperledger framework, distributed ledgers, bitcoin, cryptography, Hashing, Application of Blockchain in healthcare, supply chain, finance, energy.

Case Study: Hyperledger Fabrics

UNIT- II

AI through deep learning method, Artificial intelligence as a service, Neural network like CNN, RNN, auto-encoders for applications, Blockchain ecosystem such as classification, regression, image recognition, detection, recommendation & natural language processing.
Case Study: Blockchain Ecosystem

UNIT- III

Blockchain can optimize the GPU for Better AI Services, ATOZ, DeepBrain Chain, singularity NET, Golem, Cortex, SONM, Tatau, iExec.

Case Study: Blockchain GPU

UNIT- IV

Creating a Blockchain network, Hyperledger framework such as Iroha, Fabric, Sawtooth, Indy, and Burrow.

UNIT- V

AI and DL in Blockchain dataset using AI algorithms & models, AIHPC Blockchain capabilities, predictive and sentiment analysis, ARIMA in cryptocurrency, end to end Decentralized Applications on Ethereum platform.

Text Books:

1. Hands-On Artificial Intelligence for Blockchain: Build powerful applications for Blockchain using Machine Learning, by Manish Kumar Saraf, Packt Publishing, 2019.

Reference Books:

1. Kiran Garimella, Peter Fingar and Vint Cerf, "AI + Blockchain" Meghan-Kiffer Press, 2019 Edition

Course Outcomes

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

- Understand Hyperledger framework and its components.
- Analysis the application of Blockchain in healthcare, supply chain, finance, energy.
- Choose neural network like CNN, RNN, auto encoders for applications.
- Apply AI and DL in Blockchain dataset using AI algorithms & models.
- Develop Case Study for real life scenario in the Industry.

Course No: **DS417**	Course Title: **Blockchain with IoT**	L	P	U
		3	0	3

Course Learning Objectives

- Introduction to IoT and Blockchain
- Creating your own blockchain network with Hyperledger composer
- Installing your own blockchain network with Hyperledger Fabric and composer
- Addressing Food Safety: Building around the Blockchain regulations, Challenges and concerns in the modern Food chain.
- Applications related to IoT, Blockchain and Industry 4.0.
- Understanding the Industry oriented projects through Case Study

Course Contents

UNIT- I

Understanding IoT and Developing Devices on the IBM Watson IoT Platform, Common business use case of IoT, Technical Elements in IoT, Creating your first IoT solution, the gardening solution, coding the device firmware, creating the backend applications.

UNIT- II

Explaining Blockchain Technology and Working with Hyperledger, introduces you to blockchain and helps you to understand how it works with a ledger to record the history of transactions that provide a permissioned network with known identities. Creating your own blockchain network with Hyperledger composer, installing your own blockchain network with Hyperledger Fabric and composer, addressing Food Safety: Building around the Blockchain regulations, challenges and concerns in the modern Food chain.

UNIT- III

Designing the Solutions architecture, the business of food, challenges of the process, the process at the food factory, the process at the distribution center, the process at supermarket and stores, the technological approach, front-end applications, IoT-based asset tracking, API/SDK, Software components.

Case Study: Blockchain Smart Home

UNIT- IV

Creating a Blockchain network, concepts and Enumerations, Asset definitions, participants, Deploying and testing the business network for Hyperledger, Manipulating assets via transaction in the Blockchain, generating and exporting participants business cards, defining access control lists, creating the IoT part of the solution, hardware setup, firmware development, End to End Testing, creating a book box, transferring the asset to the transporter.

Case Study: Logistics with IoT Blockchain

UNIT- V

The IoT, Blockchain and Industry 4.0, Simplifying Business chain, Developing cloud applications, Reference architecture, serverless computing, The Hyperledger composer Toolkit, The Hyperledger composer REST server, Authentication and multiuser mode, Data source configuration.

Case Study: Blockchain and IoT to provide Smart Parking Tools

Text Books:

1. Hands On: IoT solution with Blockchain, by MaximilanoSatos, Packt Publishing, 2019.

Reference Books:

1. Mayukh Mukhopadhyay, "Ethereum Smart Contract Devlopment" Packt Press, 2018 Edition

Course Outcomes

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

- Learn the basics and foundational concepts of IoT and Blockchain.
- Explore the applications and its uniqueness in depth.
- Learn about major tools to develop and deploy Iot with Blockchain.
- Understand Hyperledger and Hyperledger Fabric.
- Develop Case Study for real life scenario in the Industry.

5. REGISTRATION

The structuring of the courses in terms of lecture hours, lab hours, etc., is done through the timetable for each semester/term. On the first day of the semester/term, every student, whether newly admitted or already on rolls, is required to make his/her own timetable for all the courses for which he/she is permitted to register. The student next completes a process of registration for each of the courses in his/her timetable. It shall be the responsibility of the student to complete his/her registration in person, failing which he/she shall not be permitted to attend classes or use the facilities of the Institute.

Eligibility Conditions for Registration

Every student on the rolls of the institute is required to register for the courses to be taken in the semester. A student is not permitted to register in a semester/term if

(i) He/she has dues outstanding to the institute, hostel, library or any recognized organ of the institute.

(ii) His/her results of the preceding semester/term are withheld.

(iii) He/she has an Incomplete (I) report in the immediately preceding semester/term.

(iv) He/she has been specifically asked to stay away from that semester.

Original Registration

On the first day of the semester, every student must register for all the courses to be taken in the given semester. The Chairperson, Academic Registration and Counseling Division along with his/her team of registration coordinators, ensures smooth completion of the registration process. After ensuring that there is no default of fee payment, every student is given a randomly generated priority number for registration. The order /queue followed by students for registration are based on the priority number. Every student is provided with a master timetable with the following information: course titles, course codes and units of courses offered in the semester, number of sections for each course, timings and venue, common hour details, tests and examination schedules and faculty names. The student is expected to make his/her own timetable exercising his/her choices while ensuring that the sections of his/her choice are still available and there are no clashes in the timings of different courses. The choices that he/she can exercise will in general be decided by his/her priority number. The registration process is completed once he/she submits the filled in registration card with details of courses taken and the same is approved by the Chairperson.

Conditions for registration of Backlog courses

If a student has not cleared a named course (other than electives) mentioned in his/her semester-wise chart by the time under consideration, then the said course becomes a backlog course until he/she clears it at the next possible opportunity. During registration, the student should first register for all backlog courses which are offered in that semester before taking other courses.

Provisional Registration

A student may be permitted for a provisional registration even if he/she has some outstanding dues. The student can complete his/her registration with the written permission from the Director. The dues must be cleared within the stipulated time decided by the Institute. The provisional registration is subject to cancellation without notice, if the student is found defaulting after the grace period.

Late Registration

Under exceptional circumstances, a student may be permitted to opt for late registration. The student should apply to the Director through Chairperson-Academic Registration and Counseling Division and obtain prior permission for late registration. Late registration is done on the 8th day of the semester. A student who fails to meet the late registration deadline has lost the last opportunity to register for that semester. Students are advised to avoid late registrations as the choice of sections for various courses can be limited by the delay.

Amendment to Registration

The Chairperson-Registration can amend the registration of a student under the following circumstances:

(i) If the registration of a student in a course is not found to be in accordance with the regulations, like a student not fulfilling prior preparation conditions or pre-requisite conditions for a course his/her registration in that course will be cancelled.

(ii) In case of timetable clashes or clashes in tests/examination schedule, the registration is amended by removing the said course(s) from the students registration card.

Substitution of Courses

Course substitution can be done when

(i) Any time within one week from the beginning of the semester, a student requests for substitution of a course in which he/she has already registered, with another course.

(ii) ACC recommends for substitution of one course with another for a student under its purview.

Withdrawal from Courses

(i) If a student desires to withdraw from a course, he/she may submit a formal application for withdrawal within ten weeks from the beginning of the semester.

(ii) In exceptional circumstances, a student may be permitted to completely withdraw from all the courses and drop the semester/term when the Director is satisfied with the reasons that warrant the withdrawal.

Pre-requisite Courses

Certain courses have pre-requisite conditions attached to them which the student should have fulfilled before registering in such courses. If a course is a pre-requisite,then the student should have a valid grade, not a report, in the pre-requisite course

Prior Preparation

For certain courses or a group of courses, a specified prior preparation is required.These requirements are described in the following table.

For first degree students:	
IP I for single/dual degree	Normally all courses in the semesters preceding IP I for his/her program/composite program.
IPII/TS for single/dual degree	All named courses of his/her program/composite program, other than TS/IP-II.
For any other prescribed semester of single / dual degree	All named courses in semesters and terms preceding this set of courses in his/her program / composite program

* If IP-I is delayed by one year for a student with the permission of the appropriate authority, he/she would be permitted to register for CDC's with prior preparation package not including IP I.

6. TEACHING AND EVALUATION

Teaching

The objective of classroom education is to awaken curiosity, generate habits of rational thinking and train students to be independent and face unfamiliar situations. Classroom instructions help a student to organize and correlate facts, comprehend ideas and to use knowledge creatively.

Multi-Section Operations

A number of courses offered in the first two years at IcfaiTech are multi-section in operation and many of these are interdisciplinary in nature. Some of the salient features of multi-section operation are enumerated below:

• Every course, is conducted by a member of the faculty called an Instructor-in-Charge (IC), with the assistance of required number of Instructors - who will partner in meeting the full academic responsibilities and organizational needs of teaching and evaluation.

• The IC with the team of instructors makes a comprehensive plan with respect to the conduct of the course. The team remains in continuous interaction throughout the semester, to ensure smooth operation of the course.

• While the style of teaching may vary from instructor to instructor, the team makes all effort to ensure that the pace of delivery of the content is uniform.

• The question papers, its solutions and detailed break-up of marks for tests/quizzes and other examinations are prepared by the entire team.

To ensure uniformity in marking, a given question is marked by the same instructor for all the students registered in the course. All this ensures that the operational aspects including grading are free from arbitrariness.

Course Handout

For a smooth conduct of a course, the instructors share all the important details of the course, including assessment scheme with students at the beginning of the semester. This is done through a 'Course Handout' that provides information like the

• scope & objectives of the course

• text books, reference books, and other digital resources like NPTEL, SWAYAM

• content and operational aspects (pace, coverage and level of treatment)

• frequency/duration of classes, credits

• components of evaluation like quizzes/tests (announced or unannounced, open-book or closed-book), laboratory exercises, list of experiments, home assignments and their relative weights

• course outcomes

• attendance policy

• policy on make-up tests

• chamber consultation hours

Evaluation Components

Teaching and evaluation form a coherent function and operate on the basis of mutual understanding and trust at IcfaiTech. All components of evaluation are internal; conducted and evaluated by the Instructors/team of instructors handling the course. The evaluation components are evenly spread out in the semester. Various attributes like spontaneous recall, practical application of concepts, ability to work on their own, competence in conceptualized arguments, aptitude to face unfamiliar situations are put to test. The various components of evaluation that the instructor may employ to evaluate a student are tests, quizzes, seminars, presentations, assignments, projects, laboratory-based experiments etc. The evaluation methods, components and their weights depend on the nature of the course. The suggested components normally include two or three written tests, quizzes, and assignments. The quizzes and assignments are interspersed between the tests. All tests and quizzes are conducted during the common hours without disturbing the normal academic schedule. All test and end semester examinations are conducted as per the schedules announced to the students through Course Handouts. One of the components of evaluation (End-Semester examination) is comprehensive enough to include the entire course and is held at the end of the semester. The written examination normally consists of objective questions, short-answer questions, descriptive-answer questions, problems etc. The pattern and type of questions may vary depending on the nature of the course.

Component	Weights	Duration
Test-I	15%	50 minutes
Test-II	15%	50 minutes
Test-III	15%	50 minutes
Assignments/quizzes/presentations/projects	15%	
End Semester Examination	40%	3 hours

Evaluation components and their weights for a typical theory course.

Evaluation and Feedback on performance

Just as evaluation is done in a continuous and transparent manner, feedback on performance in the evaluation components is also made available at regular intervals. The answer scripts are promptly evaluated and shown to the students. The performance of the students with reference to the highest, lowest and average marks is discussed in the class. Solutions with the marking scheme are displayed immediately on the department notice board after every test and examination.

In case of any subjectivity in the evaluation, or discrepancy from the discussed/displayed evaluation scheme, or any totaling errors in the answer script, the student reserves the right to request for a rechecking or retotalling.

Mid-semester grading for each course, based on the evaluation components conducted until the middle of the semester, is made available to the students. This grade alert will help the students to improve their performance in the remaining evaluation components.

Attendance Policy

Every student is normally expected to maintain a minimum of 75% attendance in every course for which he/she is registered. In courses with both theory and laboratory components, the student must maintain a minimum of 75% attendance in both the components.

The IC/instructor in consultation with the Chairperson Academics can recommend to the Director, IcfaiTech for condonation up to a maximum of 10% for those students who face genuine difficulty in maintaining 75% attendance.

Condoning process has the following steps:

• Instructor-in-Charge/instructors make a list of students with attendance between 65 and 75%.

• The data of these students on performance indicators like marks in tests, quizzes and assignments is examined.

• Assignments and tasks are designed for each student to make up for deficiency in academic performance and the shortage of attendance.

• who complete the task to the satisfaction of the Instructor are permitted to appear for the examination.

If a student does not write the end-semester examination or is not permitted to take the end-semester examination in any course, he/she will be given RRA report. He/she will be required to Register Again (RRA) for the course when it is next offered.

Periodic alerts given by the instructors regarding attendance must be taken seriously and every effort made to reach the required attendance.

Make-up Policy

If a student anticipates a genuine difficulty in meeting the date of component of evaluation, he/she should take the IC/Instructor into confidence prior to the event and request for a makeup. Whenever a student misses a component of evaluation for genuine and unanticipated reasons and has therefore not taken prior permission, the student must immediately after the test approach the IC/Instructor with a request for make-up.

If the IC is satisfied with the request, a make-up test/examination would be conducted one week after the date of the missed component of evaluation.

The students must note that there will be no makeup for laboratory experiments, lab exams, quizzes and presentations.

Unfair Practices in Examinations/Academics

Students must not resort to unfair means during any evaluation component. Any of the following events will be considered as unfair practice(s) during examinations/evaluation.

a) Possessing unauthorized materials like notes or slips in pockets, vanity bags and purses.

b) Having notes and formulas written on the body.

c) Using cell phones or programmable calculators.

d) Copying from other students.

e) Allowing/enabling other students to copy from one's paper/computer screen.

f) Taking or giving any kind of assistance from/to other students.

g) Communicating with the students in or outside the exam hall.

h) Going out of the examination hall other than to the rest room.

i) Plagiarism in project work/assignments.

In the judgement of the Invigilator, if a student has indulged in unfair means in the examination hall, the following steps are taken by the invigilator:

• The student is asked to surrender the answer book and any possible material evidence and leave the exam hall.

• A report is filed with the Director, IcfaiTech after handing over the answer book with material evidence. The examination committee conducts an enquiry where the student is given opportunity to defend himself.

Use of unfair means if established, would result in one of the two punishments:

a. Cancellation of registration (RC) for the course in which use of unfair means was established.

b. Cancellation of registration for the course along with suspension for a full semester. Suspension for a full semester implies that the student cannot register for any course offered in that semester.

7. GRADING

The IcfaiTech system emphasizes on continuous and regular evaluation, which includes numerical marking in grading the student. At the end of a semester, letter grades are awarded to the students based on their overall performance in the course. These grades are relative to the performance of all the students evaluated for that course.

Letter Grades

The list of letter grades, the grade points associated with them and their qualitative meanings are given below:

Letter	Qualitative Grade	Points attached
A	Excellent	10
B	Good	8
C	Fair	6
D	Poor	4
E	Exposed	2

In order to arrive at letter grades, the histogram based on the total marks in a particular course for all the students pursuing the course is made. The histogram normally shows clusters, gaps between clusters or dips between clusters. The grading in the course is guided with reference to the highest, lowest, average marks, and the gaps and dips between clusters of students. In courses where the registered number of students runs into hundreds, the range of C grade usually covers the average marks. This may however not be case when the histogram is skewed, and the average marks of the class is unusually high or low.

In case of absence of clear gap between clusters, the grade border may be drawn in a dip in the cluster. The decision on whether the students appearing on the borderline are pushed to the higher grade or to the lower grade is taken on a case by case basis. Some of the factors that guide the instructor in grading the borderline students are attendance, participation in the class and overall attitude.

In courses with a small number of registered students, the instructor opts for absolute grading. In such cases, the instructor announces to the students at the beginning of the semester, the anticipated mark ranges for various grades.

Reports

At the time of final grading, in certain cases, the Instructor-in-Charge can report certain events/facts in place of letter grades. These reports are not to be construed as grades. The various reports listed below are elaborated in the subsequent paragraphs.

1. Incomplete (I)

2. Grade Awaited (GA)

3. Withdrawn (W)

4. Registration Cancelled (RC), Required to Register Again (RRA) and Discontinued from the Program (DP)

5. Not Cleared (NC).

Incomplete (I)

An Instructor-in-Charge who finds that a student has not fulfilled some requirement of a course before the deadline for transmitting the grades, is satisfied that the student is able to transmit a grade or a report without this fulfillment; can use his/her discretion to give the student an opportunity.

The Instructor-in-Charge can within the deadline, send a report 'I' (Incomplete) for the student and also inform the student of the same. It shall be the responsibility of the student to contact the Instructor-in-Charge and fulfill the requirement for replacement of the 'I' report within two weeks after the end of the semester; failing which the Instructor-in-Charge will communicate whatever grade/report is possible for that situation.

Grade Awaited (GA)

'GA' is given in situations where operational and practical difficulties may cause a delay in transmitting of a grade or a report. Some instances when GA is given are as follows:

(i) pending case of unfair means

(ii) pending case of indiscipline

(iii) for IP courses where the student is at an off campus center and the dissemination of information between the Institute and the IP center is delayed

(iv) if due to genuine reasons a student is unable to appear for end-semester examination on the scheduled date and his/her request for make-up has been granted After the case has been decided, or the IP grade getting transmitted or the makeup taken and evaluated, the GA report is converted into a valid grade or report.

Whenever the report GA appears in the grade sheet, it must be converted into a letter grade or a report before the next semester registration.

Withdrawn (W)

A student may seek withdrawal from course(s) in a semester for any of the following reasons:
(i) The student is unable to attend classes for the course(s) for a genuine reason.

(ii) The student is unable to cope up with the normal load and withdraws from the course(s) to reduce his/her academic load for the semester.

Request for withdrawal should be made to Chairperson-Academics, within ten weeks of commencement of the semester. In case of withdrawal within the stipulated time, the grade sheet/transcript of the student will indicate 'W' (withdrawn) against the course(s) from which the student has withdrawn his/her registration. If the withdrawal is made after the due date, the event will be reported as 'RC'. In either of the situations, the student will have to register for the course(s) at the next offer and obtain a valid letter grade.

Registration Cancelled (RC), Required to Register Again (RRA), Discontinued from Program (DP)

If a student's registration for a course has been cancelled, it will be reported in the grade sheet as 'RC'. The following are the situations when an RC report is issued:

(i) Cancellation is recommended as a part of disciplinary action against the student for resorting to unfair means during examination or other unprofessional behavior

(ii) Cancellation is recommended due to less than the minimum required percentage of attendance.

(iii) Cancellation is recommended if a provisionally admitted student fails to submit the proof of necessary documents required for registration and/or does not satisfy the minimum eligibility requirements for the admission within the prescribed time limit.

(iv) Cancellation is recommended when a student persistently and/or deliberately does not pay his/her dues.

RC itself has many contextual meanings:

(i) When it is clearly known that the student is required to register again in the same course, the event will be reported as RRA (Required to Register Again).

(ii) If RC amounts to discontinuation from the program, it will be reported as DP (Discontinued from the Program).

(iii) If the cancellation of registration is not reported either as RRA or as DP but as RC, it does not necessarily mean that it is free from any constraint but that the meaning of the constraint must be construed from the context in which the RC is reported.

Not Cleared (NC)

If a student continued to remain registered in a course (with or without lab component) but gave the instructor inadequate opportunity to evaluate him by not attending the quizzes/ tests/examinations/lab sessions and other components of evaluation, or by appearing in the same for the sake of appearing, without applying himself to the task at hand, the student will be given NC (Not Cleared). It is to be noted that a NC cannot be ignored, except under the situations described in (ii) and (iii) below:

(i) Whenever a student gets a NC report in a course which is in the compulsory package of his/her program, he/she is required to register again in the same course and get a valid grade.

(ii) If a student has a NC report in an elective course, he/she can either repeat the course to get a valid grade or ignore it to choose another course. However, a student must get valid grades in at least the prescribed number of electives in his/ her program.

(iii) If a student record has a NC report in a course which remains unaccounted for, after a process of transfer has been completed, although it will not be possible for him/her to wipe out the NC report from his/her transcript, he/she can still graduate. (iv) If a student gets a NC in IP/Thesis, he/she will be required to register in the same for one more semester.

Cumulative Grade Point Average (CGPA)

The Cumulative Grade Point Average (CGPA) is used to describe the overall performance of a student in all courses in which he/she is awarded letter grades since his/her entry into the Institute. It is also used for the declaration of division when the program is completed.

CGPA is the weighted average of the grade points of all the letter grades received by the student from his/her entry into IcfaiTech and is computed as follows:

$$CGPA = \frac{\Sigma u_i g_i}{\Sigma u_i} = \frac{(u_1 g_1 + u_2 g_2 + u_3 g_3 + \ldots)}{(u_1 + u_2 + u_3 + \ldots)}$$

Where u1 , u2 , u3 , ... denote units associated with the courses taken by the student and g1 , g2 , g3 ..... denote grade points of the letter grades awarded in the respective courses. Reports will not alter the CGPA, since the same are not accounted for in the CGPA calculations.

When a student repeats a course in which he/she has already received a grade, as soon as a new grade is obtained, it will replace the earlier one in the calculation of CGPA. It is to be noted that only the latter grade in a course would be considered for the calculation of CGPA and not the better of the two grades.

Grade Sheet

A student's grades, reports, CGPA, etc., at the end of every semester/term will be recorded on a grade sheet, a copy of which will be issued to him/her. The grade sheet will be withheld when a student has not paid his/her dues or when there is a case of breach of discipline or unfair means pending against him/her.

While registration with approval of the appropriate authority is a token of permission to pursue studies, the grade sheet is a complete record of the outcome of what was intended in the registration. The various grades and reports discussed in the handbook will be appropriately used to tally the grade sheet with the registration data. It would be evident that this tally between what was registered for and what was obtained in terms of grades and

reports will apply to all courses except for any course which was originally registered for, but subsequently replaced by another course through substitution.

The tally is made on a course by course basis at the end of the term to determine which of the courses have been cleared. A course is deemed to have been cleared if the student obtains a grade in the course. However, mere clearing of the prescribed courses does not tantamount to fulfilling the requirements of graduation.

While all grades secured, reports and other pertinent information for a semester are given in a grade sheet, the chronologically organized information from the grade sheets of a student with necessary explanation constitutes his/her transcript, which is issued at the time he/she leaves the institute or on request at an intermediate point.

Minimum Academic Requirements

The education philosophy of IcfaiTech interlinks and at the same time distinguishes between the performance of a student in a single course and his/her cumulative performance. Accordingly, the student of the first-degree program has to maintain the expected minimum academic requirement at the end of each semester.

They are as follows:

(i) A student should not have secured more than one 'E' grade in the semester.

(ii) A student should have CGPA of at least 4.50.

(iii) A student should have at least cleared with his/her latest performance, such courses (counted from the point of his/her entry into the Institute) as are prescribed for a period that corresponds to two-thirds of the number of semesters spent by him/ her since his/her entry into the Institute with reference to his/her current program. This means that at any stage of reckoning, the student should not have spent more than 50% extra time than what is prescribed for him/her up to that stage.

Academic Counseling Committee (ACC)

The minimum academic requirements that every first-degree student should meet at the end of every semester are mentioned above. Failure to meet even one of these requirements will automatically bring the student under the purview of the ACC or the designated authority.

The ACC will take immediate charge of the student and ask him/her to follow a specific path so that he/she can be rehabilitated at the earliest. The student under ACC will not undergo normal registration process but will be guided by the ACC in selection of the courses for the semester registration.

Once a student has been placed under the purview of the ACC, he/she should continue to be under its direct guidance until,ACC after being satisfied with his/her overall progress and performance, declares him/her to be outside its purview. All decisions of the ACC shall be final.

Students under the purview of ACC are cautioned from time to time if they fail to improve in the following stages.

Warning: A student, who comes under the purview of the ACC for the first time due to a CGPA between 4.2 and 4.5 is warned to take studies seriously and improve the performance in order come out of ACC list by the next semester.

Severe Warning and Reduction in Course Load: If a student has CGPA between 3.0 and 4.2 or continues to remain under the purview of the ACC in the subsequent semester, he/ she would be severely warned. The ACC, based on its evaluation of the student, decides that the student would not be able to cope up with the normal load of courses for the semester. The ACC will work out a package of courses with reduced load for the ensuing semester, so that the student gets a chance to improve and come out of the purview of the ACC.

The implication of a reduced load is that the period of study gets extended.

Probation: If the advice and guidance of the ACC is not taken seriously by the student,and he/she continues to give deteriorating performance, he/she might be given a last chance and kept on probation during the next semester. During this semester his/her progress will be closely monitored.

Discontinued from Program: If a student on probation during a semester fails to improve his/her performance to the satisfaction of the ACC and his/her CGPA falls to below 3.0, he/ she would be Discontinued from the Program (DP) and would be asked to leave IcfaiTech.

It must be noted that any student under the purview of the ACC found to be involved in any act of indiscipline or unfair means in examination at any time would be immediately asked to discontinue from the program. It should therefore be the single-minded objective of the

student to fulfill the minimum academic requirements stipulated,thus enabling himself/herself to be declared outside the purview of the ACC at the earliest.

Graduation Requirements

A student is deemed to have fulfilled the requirement of graduation for the first-degree program when he/she satisfies the following conditions-

(i) Has cleared all the courses prescribed for him/her in his/her program.

(ii) Has obtained a minimum CGPA of 4.5.

(iii) Has remained outside the purview of the ACC or has been declared outside its purview.

(iv) Has overcome all the consequential stipulations of an NC report; except where there is NC report in an elective course over and above the prescribed number of elective courses or in a course which has ceased to be a part of his/her current program because of transfer of program.

A student is deemed to have become eligible for the Bachelors degree if, in addition to the above requirements he/she has no case of indiscipline or unfair means pending against him/her. If a student has outstanding dues against him/her to be paid to IcfaiTech, the student hostel or any other recognized affiliate/ associate organization of IFHE, his/her degree will be withheld until the said dues are cleared.

Certification

The following classification based on CGPA will be made and mentioned in the graduation certificate of the first Degree program student.

Distinction	CGPA 9.00 or above
I Division	CGPA 7.00 or more but less than 9.00
II Division	CGPA 4.50 or more but less than 7.00

Every student is expected to familiarize himself with the following documents associated with academic progress and program completion: Grade Sheet: Grade sheet is a complete record of courses done, grades obtained by the student, showing GPA and CGPA and other information for a semester. Students can obtain duplicate copies of grade sheet on payment of nominal fee.

Transcript: Transcript is chronologically organized information of courses, grades,GPA, CGPA obtained in various semesters during the Program which is issued on successful completion of the Program. Students can obtain additional transcript on payment of ` nominal fee. Provisional Certificate: Students who fulfill the graduation criteria will be given a provisional certificate before the convocation.

Degree Certificate:

Students who fulfill the graduation criteria will be awarded the Degree certificate at the formal convocation.

Awards

All students who successfully complete the prescribed course work and examinations will receive their degree from IFHE.

Gold and Silver medals will be awarded to the students scoring the first rank and second rank respectively on completion of the program. A student against whom disciplinary action has been taken or has any backlog of course(s) will not be eligible to get merit scholarship/medals.

ICFAI Foundation for Higher Education
(Deemed-to-be University under Section 3 of the UGC Act, 1956)

IcfaiTech

Faculty of Science & Technology (FST)

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