CURRICULUM
&
SYLLABUS
B.Sc - Data Analytics

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

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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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.

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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 overstay, 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 level or 6th level) course or an

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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.	170
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

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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

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 becomea successful professional in Electronics and Communication Engineering.

PROGRAM OUTCOMES (POs):

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
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 SPECIFIC OUTCOMES (PSOs):

PSO1	The ability to analyze, design and implement application specific complex engineering problems by applying the knowledge of basic sciences, engineering mathematics and engineering fundamentals.
PSO2	The ability to adapt for rapid changes in tools and technology with an understanding of societal and ecological issues relevant to professional engineering practice through life-long learning.
PSO3	Excellent adaptability to function in multi-disciplinary work environment, good interpersonal skills as a leader in a team in appreciation of professional ethics and societal responsibilities.

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Data Analytics - Semester-wise pattern

Year	Course code	I Semester	L P U	Course code	II Semester	L P U
I (Induction level)	EGL111	English language skills	3 0 3	EGL 121	Professional Communication	3 0 3
	MATH112	Linear algebra	3 0 3	**MATH 122**	**Higher Calculus**	3 0 3
	MATH113	Differential Equations and Fourier series	3 0 3	MATH 123	Probability & Statistics	3 0 3
	DAC114	Programming in C	2 2 3	DAC124	Data Structures	2 2 3
	DAC115	Foundation of Data Analytics	3 0 3	DAC125	Applied data analytics using python	3 0 3
	DAC116	Introduction to FinTech	3 0 3	**ME126**	**Thermodynamics***	3 0 3
Total No of Units			**18**	**Total No of Units**		**18**
INTERNSHIP (2+1 months) 5+3 credits = 18+18+8 = 44						
		III Semester			**IV Semester**	
II (Diploma level)	DAC211	**Object Oriented Programming using Java**	2 2 3	DAC221	**Programming in R**	2 2 3
	DAC212	Data Wrangling	3 0 3	DAC222	Data Operations	3 0 3
	DAC213	Data Base Management System	3 0 3	MATH 223	Optimization techniques	3 0 3
	DAC214	Discrete structures for computer science	3 0 3	DAC224	Data Visualization in Data Science	3 0 3
	MATH215	Complex variables	3 0 3	DAC225	**Machine Learning**	2 2 3
	DAC216	Operating systems	3 0 3	DAC226	Data warehousing and mining	3 0 3
Total No of Units			**18**	**Total No of Units**		**18**
INTERNSHIP (2+1 months) 5+3 credits = 18+18+8 = 44						
		V Semester			**VI Semester**	
III (Degree level)	MATH311	Numerical methods	3 0 3	DAC321	**software Engineering**	4 0 4
		Electives (3)	3 0 3		Electives (3)	3 0 3
		Humanities Elective (1)	3 0 3		Humanities Elective (1)	3 0 3
	CP-I	Capstone Project-I (TIC)	5 +1 =6 credits	CP-II	Capstone Project-II (TIC)	5 +1 =6 Credits
Total No of Units			**21**	**Total No of Units**		**22+21 =43**
Total Units/Credits						**131**

***Hands-on Mini project/Case study on Analytics domain**

Electives		
Course code	**The students of B.Sc Data Analytics are allowed to choose the electives offered by B.Tech CSE and B.Tech DS and AI of IcfaiTech. The list of electives has to be included in the list**	**L P U**
DAC312	Natural language processing for ML with Python	3 0 3
DAC313	ML modelling and ML Architecting	3 0 3
DAC314	Principles of Artificial intelligence	3 0 3
DAC322	Predictive modelling and analytics	3 0 3
DAC323	Artificial neural networks	3 0 3
DAC324	Advanced Deep learning	3 0 3
Humanities Electives		
Coursec ode	**Name of the course**	**L P U**
HS315	Dynamics of social change	3 0 3
HS316	Introduction to Psychology	3 0 3
HS317	Heritage of India	3 0 3
HS325	Modern Political Science	3 0 3
HS326	Public Administration	3 0 3
HS327	Professional Ethics	3 0 3

The total units required at each level are Induction (44), Diploma (44) and Degree level (43). Thus, it is imperative that to earn B.Sc. Degree in Data Analytics, one has to successfully complete 131 (44+44+43) units.

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Course Code	Course Title	L P U	Course Description
EGL111	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.
MATH112	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.
MATH113	Differential Equations and 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 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.
DAC114	Programming in C	2 2 3	Overview of C, Constants, Variablesand Data types, Operators and Expressions, Input/output operations, Decision making and branching Looping, Understanding functions User defined function, Arrays, Understanding pointers, Programming with pointers, Characters and strings Pointers and arrays, Dynamic memory allocation, Understanding Structures and unions Low Level programming File management
DAC115	Foundations of Data Analytics	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.
DAC116	Introduction to FinTech	3 0 3	FinTech: Introduction, FinTech evolution 1, 2, 3 & 3.5, FinTech Typology, Emerging economics: opportunities and challenges. Payment, Cryptocurrencies and blockchain: Introduction, individual payments, mobile money and regulation of mobile money, RTGS system, Cryptocurrencies, Blockchain. Digital Finance and alternative finance: Introduction, Digitization of finance services, FinTech and funds, Crowdfunding-Regards, charity and equity, FinTech Regulation and regTech: Introduction, FinTech regulations, evolution of RegTech, RegTech ecosystem: financial institution, startups, challenges, regulators, Regulatory sandboxes, smart regulation. Data and TechFin: data regulation, data in financial services, open banking API for startups, digital identity, new challenges of AI and Machine learning, data, metadata and differential privacy. The future of data-driven finance: Introduction, case studies, fintech big trends
EGL121	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.
MATH122	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
MATH123	Probability & Statistics	3 0 3	Probability spaces, conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial; Poisson and distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling

			distributions.
DAC124	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.
DAC125	Applied data analytics using python	3 0 3	Introduction, Data and Operations, Data Types, Variables and Constants, Operators, Expressions, Operator Precedence, Scope. Conditional Statements and Control Structures, If Else, Elif Clause, While, for,Parallel Iteration, Numbered Iteration, Functions: Function Definition, Blocks, Calling Function,Function Parameters, Function Return Values, Lambda Expressions, Modules, Recursion, Exception Handling, Collections, Sequences, Lists, Strings Tuples, Mappings (Dictionaries), Array Module. Modules: Module use, Creating modules, Exploring available Python modules, The standard library. Object-Oriented Python: Defining a Class, Constructors, Encapsulation, Inheritance, Interfaces, Iterators, Generators, Polymorphism, Introspection, Static and Class Methods, Magic Methods, Web Interaction and File Access a. Python HTML Code Generation, CGI Code Generation, Templating Systems. Form Input, Reading/Writing Files, File Iterators, SQL and the MySQL Database, Introduction to SQL Syntax, Designing and Creating a Table in MySQL, MySQL Data Types, MySQLdb Module, Dynamic Python Applications with Django and MySQL a. Model-View-Controller Architecture b. Connecting to MySQL c. Object-Relational Mapping d. Authentication e. Testing and Debugging
ME126	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.
DAC211	Object Oriented Programming using C++	2 2 3	C++ Programming Basics: Understanding OOP's principles Abstraction, encapsulation, Polymorphism, Inheritance, Data Types and Operators: C++ Programming Basics, Data types, Type Conversions, Operators, Loops and Decisions: for loop, while loop, do loop, if statement, if.:. else statement, switch statement Structures: A Simple Structure, Defining the Structure, Defining a Structure Variable, Functions: Simple Functions, Passing Arguments to Functions, Returning Values from Functions, Reference Arguments, Overloaded Functions, Operator Overloading: Overloading Unary Operators, Overloading Binary Operators, Data Conversion. Inheritance: Derived Class, Base Class, Class Hierarchies,

			Levels of Inheritance, Multiple Inheritance. Pointers: Pointers & Arrays, Pointers & Functions, Pointers & Strings, Streams and Files: Stream Classes, Stream Errors, File I/O with Streams, Error Handling in File, File Pointers, Error Handling in File. Templates
DAC212	Data Wrangling	3 0 3	Advanced Pandas, MongoBD for data wrangling, Hive operations for data wrangling, MapReduce and Hadoop-2, Apache Spark, Understanding Data Lake, Data Architecture
DAC213	Data Base Management System	3 0 3	Overview of Database Systems- Elements of the E/R Model-Design Principles-The Modeling of Constraints-Weak Entity Sets, Basics of the Relational Model-From E/R Diagrams to Relational Designs, Relational Algebra: Relational Operations-Extended- Normalization - Normal Forms, Simple Queries in SQL-Sub queries-Full-Relation Operations-Database Modifications-Defining a Relation Schema-View Definitions- Constraints and Triggers: Keys and Foreign Keys-Constraints on Attributes and Tuples Modification of Constraints-Schema-Level Constraints and Triggers -ar Database Connectivity- Stored Procedures, The memory hierarchy -RAID-Index Structures: Indexes on Sequential Files-Secondary Indexes-B-Trees-Hash Tables-. QUERY EVALUATION: Operator Evaluation, Query Optimization Estimating the Cost of Operations-Cost-Based Plan Selection -Order for Joins-Physical-Query Plan, ACID- Transactions and Schedules, CONCURRENCY CONTROL: Serial and Serializable Schedules-Conflict Serializability-Enforcing Serializability by Locks-Locking Systems with Several Lock Modes-Concurrency Control by Timestamps, validation. TRANSACTION MANAGEMENT: Serializability and Recoverability-View Serializability-Resolving Deadlocks-Distributed Databases: Commit and Lock
DAC214	Discrete structures for computer science	3 0 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.
MATH215	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.
DAC216	Operating systems	3 0 3	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.
DAC221	Enterprise JAVA applications	2 2 3	Java Enterprise Edition (JavaEE) Intro - Java Technology Levels- Java Standard Edition(tm) (JavaSE or JSE)- Java Micro Edition(tm) (JavaME)- Java Enterprise Edition(tm) (JavaEE, JEE, EE4J, or Jakarta EE) Why Enterprise? JavaEE Architecture - JavaEE Specifications- JavaEE Version Highlights
DAC222	Data Operations	3 0 3	Data Science tools-Dashboards in Data Science-Cloud data architecture-Data compliance and strategies-Data governance and access strategies-Data streamsScalable data architechture- Data pipelines-Data sources and integrations-Data rollbacks
MATH223	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.
DAC224	Data Visualization in Data Science	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.
DAC225	Machine Learning and Deep Learning	2 2 3	Data anomalies and rectification- Inferential statistics Data research techniques- Machine learning and Deep learning for data science
DAC226	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.

MATH311	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.
DAC312	Natural language processing for ML with Python (NLP)	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.
DAC313	ML modelling and ML Architecting	3 0 3	ML in Enterprise- Development and Deployment-ML in Enterprise- Infrastructure-ML in Enterprise- AWSML in Enterprise- Azure-ML in Enterprise- GCP-Enterprise architecture-Architecting balance-Hybrid cloud solution-Refactoring ML/DL algorithms
DAC314	Principles of Artificial intelligence (AI)	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.
DAC322	Predictive modelling and 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
HS315	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
HS316	Introduction to Psychology	3 0 3	The development of psychology as a science individual and environment; nature; kinds and determinants of perceptions; response mechanism and kinds of responses, motivations, modifications of behavior through learning, memory and transfer of training; thought process, problem solving and creative thinking; nature and evaluation techniques of intelligence and personality.
HS317	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.
CP-I	Capstone Project-I	5 credits	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.
DAC321	Software Project Management	4 0 4	Unit 1: The Management Spectrum; Organizational Structure; Types of Organizational Structures – Hierarchical Organizational Structure, Flat Organizational Structure, Matrix Organizational Structure, Networked Organizational Structure, T-form Organization; Job Roles in Software Development. Overview of Project Management: Project Management – Definitions; Factors Influencing Project Management – Project Manager, Project Management Activities, Stakeholders; Project Communication; Project Development Phases; Project Charter; Statement of Work (SoW); Project Management Associations. Unit 2: Project Planning: Tasks in Project Planning; Work Breakdown Structures (WBS); Planning Methods; Development Life Cycle Models; A Generic Project Model. Estimation and Budgeting of Projects: Software Cost Estimation; COCOMO Model; Budgeting. Project Scheduling: Scheduling Techniques – Program Evaluation and Review Technique (PERT), Gantt Chart, Critical Path Method (CPM), Automated Tools. Project Monitoring and Controlling: Project Status Reporting; Project Metrics; Earned Value Analysis (EVA); Project Communication Plan & Techniques; Steps for Process Improvement. Unit 4: Risk Management: Concepts of Risks and Risk Management; Risk Management Activities; Effective Risk Management; Risk Categories; Aids for Risk Identification; Potential Risk Treatments; Risk Components and Drivers; Risk Prioritization. Configuration Management: Software Configuration Management (SCM) – Baselines, Software Configuration Items (SCI); SCM Process; Identification of Objects in the Software Configuration; Version Control; Change Control; Configuration Audit; Status Reporting; Goals of SCM. Team Development and Conflict Management: Basic Concepts; Organization Types – Centralized-control team organization, Decentralized-control team organization, Mixed-control team organization; Case Study 1: Open-Source Development Team Organization; An Assessment of Team Organizations; Case Study 2: Nokia Software Factories; Team Discipline; Conflict Management. Unit 5: Software Quality Assurance: Software Quality

			Assurance Activities; Software Qualities; Software Quality Standards – ISO Standards for Software Organization, Capability Maturity Model (CMM), Comparison between ISO 9001 & SEI CMM, Other Standards. Computer Aided Software Engineering (CASE) Tools: CASE Concepts; Classification of CASE Tools; Steps for CASE Tool Implementation; Integrated CASE Environments; Architecture of CASE Environment. Testing Techniques : Software Testing Concepts; Types of Software Testing – Manual Testing, Automated Testing; Black Box Testing; White Box Testing Techniques. Unit 6 Software Re-Engineering: Software Maintenance Problems; Redevelopment vs. Reengineering; Business Process Reengineering; Software Reengineering Process Model; Technical Problems of Reengineering. Project Closure: Project Closure Analysis; Case Study 1: Infosys Project Closure Analysis Report; Case Study 2: ACIC Project Closure Analysis Report.
DAC323	Artificial neural networks	3 0 3	Structure of biological neurons relevant to ANNs, Models of ANNs; Feedforward & feedback networks; learning rules; Hebbian learning rule, perception learning rule, delta learning rule, Widrow-Hoff learning rule, correction learning rule, Winner –lake all elarning rule, etc Single layer Perception, Single layer continuous perceptron networks for linearly separable classifications, Multi-layer Feed forward Networks, Single layer feedback Networks, Associative memories,Self-organizing networks
DAC324	Advanced Deep learning	3 0 3	Predictive modeling-Implementing Deep learning-Applied deep learning-Applied Reinforcement learning-Machine learning work flow and best practices-Deep learning with Keras
HS325	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.
HS326	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.
HS327	Professional Ethics	3 0 3	Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering; global ethical issues.
CP-II	Capstone Project-II	5 credits	This is an unstructured open ended where under the overall supervision of an instructor-in-charge, batches of students will be attached to different institutions. 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.

Equivalent courses:

S. No.	Proposed Course code	Course name	Equivalency course code of the subjects offered under Integrated first degree programme of IcfaiTech
1.	EGL111	English language skills	EGL112
2.	MATH112	Linear algebra	MATH113
3.	MATH113	Differential Equations and Fourier series	MATH216
4.	DAC115	Foundation of Data Analytics	DS313
5.	EGL121	Professional Communication	TA223
6.	MATH122	Higher Calculus	MATH123
7.	MATH123	Probability & Statistics	AO122
8.	DAC124	Data Structures	DS221
9.	ME126	Thermodynamics	ES121
10.	DAC214	Discrete structures for computer science	DS211
11.	MATH215	Complex variables	MATH215
12.	DAC216	Operating systems	CS312
13.	MATH223	Optimization techniques	AO225
14.	DAC224	Data Visualization in Data Science	DS403
15.	DAC226	Data warehousing and mining	DS314
16.	MATH311	Numerical methods	AO311
17.	DAC312	Natural language processing for ML with Python	DS406
18.	DAC314	Principles of Artificial intelligence	DS311
19.	DAC322	Predictive modelling and analytics	DS401
20.	HS315	Dynamics of social change	HS311
21.	HS316	Introduction to Psychology	HS312
22.	HS317	Heritage of India	HS313
23.	HS325	Modern Political Science	HS314
24.	HS326	Public Administration	HS315
25.	HS327	Professional Ethics	HS316

Course No: **EGL111**	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

Module-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.

Module -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

Module -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.

Module -IV

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

Module - 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, 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: **MATH112**	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

Module 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

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

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

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

Module - 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

REGISTRAR
THE ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deemed-to-be-University)

Course No: MATH113	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

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

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

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

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

Module- 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

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

Course No: DAC114	Course Title: Programming in C	L	P	U
		2	2	3

Course Learning Objectives

- To introduce the concepts like flow chart, algorithms.
- To understand the fundamentals of Problem Solving.
- To learn how to design and program in C.
- To learn how to design program modules in C using functions and recursive functions.
- To learn how to use derived data types and perform operations on files.

Course Contents

Module -I

Introduction to the C Language – Algorithm, Pseudo code, Flow chart, Background, C Programs, Identifiers, Data Types, Variables, Constants, Input / Output, Operators(Arithmetic, relational, logical, bitwise etc.), Expressions, Precedence and Associatively, Expression Evaluation, Type conversions.

Module -II

Statements- Selection Statements(making decisions) – if and switch statements, Repetition statements (loops)-while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Simple C Program examples.

Module -III

Functions- Introduction to Structured Programming, Functions- basics, user defined functions, inter function communication(call by value, call by reference), Standard functions. Storage classes-auto, register, static, extern, scope rules, arrays to functions, recursive functions, example C programs.

Module -IV

Arrays– Basic concepts, one-dimensional arrays, two – dimensional arrays, multidimensional arrays, C programming examples Pointers – Introduction (Basic Concepts), pointers to pointers, compatibility, Pointer Applications, Arrays and Pointers, Pointer Arithmetic, memory allocation functions, array of pointers, pointers to void, pointers to functions, command –line arguments, Introduction to structures and unions.

Module -V

Strings – Concepts, C Strings, String Input / Output functions, string manipulation functions, string /data conversion. Input and Output – Concept of a file, streams, text files and binary files, Differences between text and binary files, State of a file, Opening and Closing files, file input / output functions (standard library input / output functions for files), file status functions (error handling),Positioning functions.

Text Books:

1. Computer Science: A Structured Programming Approach Using C, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. The C Programming Language by Brian Kernighan and Dennis Ritchie 2nd edition.

Reference Books:

1. Let Us C Yashavantkanetkar BPB.
2. Absolute beginner's guide to C, Greg M. Perry, Edition 2, Publisher: Sams Pub., 1994.
3. Computer Programming and Data Structures by E Balagurusamy, Tata McGraw Hill.

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

Course No: DAC115	Foundation of Data Analytics	L	P	U
		3	0	3

Course Learning Objectives

- Find a meaningful pattern in data
- Graphically interpret data
- Implement the analytic algorithms
- Handle large scale analytics projects from various domains
- Develop intelligent decision support systems

Course Contents

Module -I

Introduction: What is Data Science? Big Data and Data Science – Datafication - Current landscape of perspectives - Skill sets needed; Matrices - Matrices to represent relations between data, and necessary linear algebraic operations on matrices -Approximately representing matrices by decompositions (SVD and PCA); Statistics: Descriptive Statistics: distributions and probability - Statistical Inference: Populations and samples - Statistical modeling - probability distributions - fitting a model - Hypothesis Testing - Intro to R/ Python.

Module -II

Data Pre-processing: Data cleaning - data integration - Data Reduction Data Transformation and Data Discretization.Evaluation of classification methods – Confusion matrix, Students T-tests and ROC curves-Exploratory Data Analysis - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA - The Data Science Process.

Module -III

Basic Machine Learning Algorithms: Association Rule mining - Linear Regression- Logistic Regression - Classifiers - k-Nearest Neighbors (k-NN), k-means -Decision tree - Naive Bayes-Ensemble Methods - Random Forest. Feature Generation and Feature Selection - Feature Selection algorithms - Filters; Wrappers; Decision Trees; Random Forests.

Module -IV

Clustering: Choosing distance metrics - Different clustering approaches - hierarchical agglomerative clustering, k-means (Lloyd's algorithm), - DBSCAN - Relative merits of each method - clustering tendency and quality.

Module -V

Data Visualization: Basic principles, ideas and tools for data visualization.

Text Books:

1. Mohammed J. Zaki and Wagner Miera Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.
2. Cathy O'Neil and Rachel Schutt, " Doing Data Science, Straight Talk From The Frontline", O'Reilly, 2014.
3. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015.

Reference Books:

1. Jiawei Han, MichelineKamber and Jian Pei, " Data Mining: Concepts and Techniques", Third Edition. ISBN 0123814790, 2011.
2. Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , O'Reilly, 2016.
3. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, 2012.

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

Course No: DAC116	Course Title: Introduction to FinTech	L	P	U
		2	2	3

Course Learning Objectives

- To introduce recent FinTech developments
- To introduce the impact on the financial services industries.
- To Apply machine learning in robo-advising and FinTech.
- To understand the technologies underlying cryptocurrencies and block-chains
- To Understand alternative lending, P2P technologies, and assess their impact on traditional banking and payment industries

Course Contents

Module 1: Fintech industry overview

Introduction: What is the Fintech Industry? Areas of Fintech, Short History of Fintech, Why is Fintech Important?, Why has Fintech Become Popular Now?Major players in the Fintech ecosystem, Fintech business models- Payment, P-P lending, crowdfunding, insurtech, wealth tech, regtech, digital banking **New Banking Entrants in a Flash**, The Traditional Banking Landscape, New Operating Models for Banking, Neo-banks, Challenger Banks, and ibanks and Key Players (Use cases)

Module 2 : Fintech disruptions in banking business

Digital Payments and Remittances: Payments and Remittances in a Flash, Traditional Remittances, Upcoming Trends in Remittances, Innovative Ways of Sending Money, Social Media-based Remittances and Nano payments Key Players (Use cases)

Digital Lending Innovation: Digital Lending Innovation in a Flash, Short History of ending, Peer-to-Peer Lending, P2P Marketplace Lending Business Model Consumer Lending, Digital Lending for Students, Digital Lending for SMEs Digital Mortgages. Commercial Banking Transformation in a Flash, How Commercial Banking Works, The Impact of Fintech on Business Banking, The Impact of Fintech on Corporate Banking Key Players (Use cases).

Module 3: Fintech disruptions in capital markets and insurance

Digital Crowdfunding and Crowd investing: Crowdfunding and Crowd investing in a digital ear, How Businesses Traditionally Fund Themselves, digital Crowdfunding Business Model, Key Crowdfunding Platforms, Top Crowdfunding Campaigns Crowd investing, Key Crowd investing Platforms **Innovative Wealth Management- Wealthtech,** Innovative Wealth Management in a Flash, How Wealth Management Works, Changes in Customer Expectations, Changes in Advisors, Changes in Data Analytics, Changes in Access to Products, Social Investing, Some Novel Investment Ideas, Key Players Serving Individual Investors, Key Players Serving Investment Managers Personal Finance Management

The Rise of Insurtech, How Insurance Works, Technology Drivers of Disruption, Peer-to-Peer Insurance, Applications of Machine Learning in insurance, Wearables in Insurance, What Traditional Insurance Firms Can Do, Interesting InsurTech Ideas , Key Players in Insurtech

Module -4 : Power of Technology

The Power of Big Data: The power of big data in a flash, History of Data, How Big Data Works, How to Use Big Data Innovatively, Big Data in the Financial Services Industry

Key Players in Big Data Analytics. **The Internet of Things in a Flash**, What Drives the Growth of IoT?, The Impact of IoT on Businesses, The IoT in Categories, The IoT in Financial Services, O2O and IoT in FinTech, Challenges Faced by the IoT, Successful IoT Use Cases in the Financial Sector

Module 5: Identification and cyber security

Identification, Cybersecurity, Traditional Ways of Using Identification, Unique Identification System in India, Identification for the Unbanked, Using Biometrics as Identification, Cybercrime and Its History, Types of Cybercrime, Cybersecurity Categories

Text Books:

1. Fintech in a flash: financial technology made easy, Agustin Rubini. Walter de Gruyter GmbH & Co KG, 2018

Reference Books:

1. The Future of FinTech Integrating Finance and Technology in Financial Services, Bernardo Nicoletti, Springer, 2017.
2. FinTech The Technology Driving Disruption in the Financial Services Industry, Parag Y. Arjunwadkar, CRC Press, 2018.
3. The FinTech Book The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Susanne Chishti, Janos Barberis, Wiely, 2016.

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Course No: EGL121	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

Module -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.

Module -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.

Module -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.

Module -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.

Module - 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: **MATH122**	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:

Module -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.

Module -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.

Module -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.

Module -IV

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

Module -V

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

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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., EinarHille 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.

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Course No:**MATH123**	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:

Module -I

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

Module -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.

Module -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.

Module -IV

Joint Distributions—Discrete and Continuous, Moment Generating Functions.

Module - 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.

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Course No: DAC124	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

Module -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)

.

Module -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.

Module -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.

Module -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.

Module - 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:

- To learn about traditional linear data structures like linked-list, stack, queue and nonlinear data structures like trees and graphs.
- To understand various searching and sorting techniques.

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- To identify efficient data structures to organize data for real-time problems.
- Apply important algorithmic design paradigms and methods of analysis. Utilize the acquired skill sets and solve problems using the appropriate data structures.
- Synthesize efficient algorithms in common engineering design situations.
- Use some traditional design methods and programming languages which emphasize on data structures, rather than algorithms, as the key organizing factor in software design and implementation.

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Course No: DAC125	Applied Data Analytics using Python	L	P	U
		3	0	3

Course Learning Objectives

- To understand the built-in data structures,functions in Python.
- To introduce the concepts Pandas, Numpy, Data Frames
- To learn how to collect data from various sources.
- To introduce the machine learning and building models using the scikit-learn library.

Course Contents

Module -I

Introduction to Data Analytics – The fundamentals of data analysis, Data collection, Data wrangling, Exploratory data analysis, Statistical foundations. Built-in Data Structures, Functions,and Files.NumPy Basics-Arrays and vectorised computation, A multidimensional array object, Universal functions.

Module -II

Working with Pandas Data Frames- Pandas data structures, series, data frames, inspecting data frame object, grabbing subset of the data, adding and removing data. Using Pandas for Data Analytics-Data Wrangling with Pandas, Aggregating Pandas DataFrames, Visualizing Data with Pandas and Matplotlib, Plotting with Seaborn and Customization Techniques.Real-word Analysis using Pandas.

Module -III

Fundamentals of Machine Learning-Getting Started with Machine Learning in Python, Making Better Predictions – Optimizing Models, Machine Learning Anomaly Detection, classification, training models, Support vector machines, Decision trees, ensemble learning and random forest, dimensionality reduction, unsupervised learning techniques.

Module -IV

Neural Networks and Deep Learning-Introduction to Artificial Neural Networks with Keras, Training Deep Neural Networks, Custom Models and Training with TensorFlow, Loading and Pre-processing Data with Tensor Flow, Deep Computer Vision Using Convolutional Neural Networks, Processing Sequences Using RNNs and CNNs.

Module -V

Natural Language Processing with RNNs and Attention, Representation Learning and Generative Learning Using Auto-encoders and GANs, Reinforcement Learning, Training and Deploying TensorFlow Model sat Scale.

Text Books:

4. Absolute Python Data Science Handbook Essential Tools for Working with Data, *Jake*VanderPlas, O'Reilly,2017.
5. Hands-On Data Analysis with Pandas, Second Edition, Stefanie Molin, Packt Publishing, 2021.
6. Hands-On Machine Learningwith Scikit-Learn, Keras, andTensorFlow, AurélienGéron, Second Edition, O'Reilly,2019.

Reference Books:

4. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly Media, 2012.
5. Matt Harrison, "Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , O'Reilly, 2016.
6. Mohammed J. Zaki and Wagner Miera Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", Cambridge University Press, 2014.

Course No:**ME126**	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

Module -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.

Module -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

Module -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

Module -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

Module -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: DAC211	Course Title: **Object Oriented Programming using C++**	L	P	U
		3	0	3

Course Learning Objectives

- Allow programmers to think on the structure of the problem rather than the structure of the machine while writing code.
- Analyse the problem into a set of objects
- To solve the challenge, objects interact with one another.
- To create new type of objects to model elements from the problem space

Course Contents

Module -I

Introduction to Object Oriented Programming, Basic Concepts of Object Oriented Programming, Benefits of Object Oriented Programming,Object Oriented Languages, Applications of Object Oriented Programming, Begining with C++: Structure of C++ program with simple C++ program.

Module -II

C++ data types, Symbolic constants and Reference by variables, Operators in C++ and Operator precedence Control structures, Function in C++ , the main function, Function prototyping, Call by reference & Return by reference Inline function Function overloading Classes, Messages Association, Interfaces) Implementation of class in C++, C++ Objects as physical object, C++ object as data types constructor. Object as function arguments.

Module III

The Main Function, Function Prototyping, Call by Reference, Return by Reference, Inline Functions, Function Overloading, Friend and Virtual Functions. Specifying a class, Member Functions, Arrays within a class, Static Member Functions, Arrays of Objects, Friendly Functions.

Module -IV

Constructors, Parameterized Constructors, Copy Constructors, Dynamic Constuctors, Destructors, Defining Operator Overloading, Overloading Operators, Rules for Overloading Operators, Type Conversions

Module - V

Pointers, Pointers to Objects, this pointer, Pointer to Derived Classes, Virtual Functions, Classes for File Stream Operations, Opening and Closing a File, File Mode File Pointers, Input Output Operations, Updating a File. Object Orientation O Development O Themes, Modelling, Abstraction Models.

Text Books:

1. Object-oriented programming in Turbo C++ By Robert Lafore, Galgotia Publication.

Reference Books:

1. E. Balagurusamy – Object Oriented Programming with C++, Fifth edition, Tata McGraw Education Hill , 2011.
2. Object Oriented Programming in C++ Saurav Sahay Oxford University Press..
3. Ashok N. Kamthane, Object oriented Programming with ANSI & Turbo C++, First Edition, Pearson India

Course Outcomes:

- Upon successful completion of the course, student will be able to:
- Master the fundamental principles of OOPS programming,
- Master key principles in Object Oriented analysis, design, and development.
- Be familiar with the application of the Unified Modeling Language (UML) towards
- analysis and design.
- Master common patterns in OO design and implement them.

Course No: DAC212	Course Title: **Data Wrangling**	L	P	U
		3	0	3

Course Learning Objectives

- Allow programmers to think on the structure of the problem rather than the structure of the machine while writing code.
- Analyse the problem into a set of objects
- To solve the challenge, objects interact with one another.
- To create new type of objects to model elements from the problem space

Course Contents

Module -I

Introduction: Magic Thresholds, PYMK, and User Growth at Facebook, A Data Workflow Framework: How Data Flows During and Across Projects, Connecting Analytic Actions to Data Movement: A Holistic Workflow, Framework for Data Projects, Raw Data Stage Actions: Ingest Data and Create Metadata, Ingesting Known and Unknown Data, Creating Metadata, Refined Data Stage Actions: Create Canonical Data and Conduct Ad Hoc Analyses, Designing Refined Data, Refined Stage Analytical Actions, Production Data Stage Actions: Create Production Data and Build Automated Systems, Creating Optimized Data, Designing Regula r Reports and Automated Products/Services, Data Wrangling within the Workflow Framework

Module -II

The Dynamics of Data Wrangling: Data Wrangling Dynamics, Additional Aspects: Sub setting and Sampling, Core Transformation and Profiling Actions, Data Wrangling in the Workflow Framework, Ingesting Data, Describing Data, Assessing Data Utility, Designing and Building Refined Data, Ad Hoc Reporting, Exploratory Modeling and Forecasting, Building an Optimized Dataset, Regular Reporting and Building Data-Driven Products and Services.

Profiling: Overview of Profiling, Individual Value Profiling: Syntactic Profiling, Individual Value Profiling: Semantic Profiling, Set-Based Profiling, Profiling Individual Values in the Candidate Master File, Syntactic Profiling in the Candidate Master File, Set-Based Profiling in the Candidate Master File.

Module -III

Transformation: Structuring: Overview of Structuring, Intrarecord Structuring: Extracting Values, Positional Extraction, Pattern Extraction, Complex Structure Extraction, Intrarecord Structuring: Combing, Multiple Record Fields, Interrecord Structuring: Filtering Records and Fields, Interrecord Structuring: Aggregations and Pivots, Simple Aggregations, Column- to-Row Pivots, Row-to-Column Pivots.

Transformation: Enriching: Unions, Inserting Metadata, Derivation of Values, Generic, Proprietary

Module -IV

Using Transformation to Clean Data: Addressing Missing/ NU LL Values, Addressing Invalid Values, Roles and Responsibilities: Skills and Responsibilities, Data Engineer, Data Architect, Data Scientist, Analyst, Roles Across the Data Workflow Fran1ework, Organizational Best Practices.

Module - V

Data Wrangling Tools: Data Size and Infrastructure, Data Structures, Excel, SQL, Trifacta Wrangler Transformation Paradigms, Excel, SQL, Trifacta Wrangler Choosing a Data Wrangling Tool..

Text Books:

1. Tye Rattenbury, Joe Hellerstein "Principles of Data Wrangling: Practical Techniques for Data Preparation" O'Reilly Publications, First Edition.

Reference Books:

1. Bradley C. Boehmke "Data Wrangling with R" Sringer, First Edition.

Course No: DAC213	Course Title: **Data Base Management System**	L	P	U
		3	0	3

Course Learning Objectives

- Introduction to database management systems, with an emphasis
- organize, maintain and retrieve the data efficiently and effectively
- Information from a DBMS

Course Contents

Module-I

Overview of DBMS, Relational DB, Entities, Relationships, Attributes, ER-diagrams, Case Study, keys, integrity rules, constraints, types of constraints, SQL: DDL, DML, Joins, Sub queries, Exercise: Queries.

Module -II

Overview of DBMS, Relational DB, Entities, Relationships, Attributes, ER-diagrams, Case Study, keys, integrity rules, constraints, types of constraints, SQL: DDL, DML, Joins, Sub queries, Exercise: Queries.

Module -III

Tree Structured Indexing, Hash Based Indexing, Query Evaluation, System Catalog, Operator Evaluation.

Module -IV

Query Optimization, Query Optimizer, SQL Query to Algebra, Cost Estimation, R Optimizer, Transaction Management, ACID Properties, Serializability, Anomalies.

Module - V

Concurrency Control, 2PL, Serializability, Recoverability, Lock Management, Deadlocks, Crash Recovery, Over View of Data Warehousing and mining, various databases.

Text Books:

1. Ramakrishna R & Gehrke J, Database Management Systems, McGrawhill, Singapore, 3 rd Ed, 2002.

Reference Books:

1. Ramez Elmasri and SB Navathe, Fundamentals of Database Systems, Pearson Education,India, 5 th Ed, 2008.
2. Database Systems – The Complete Book, Hector G Molina, Jeffrey D Ullman and Jennifer Widom, Pearson Education,India, 2nd Ed, 2008.

3. Database System Concepts, Silberschatz, Korth,Sudarshan, Mc-Grawhill,India, 4th Ed,2002.

Course Outcomes:

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

- Understand the fundamental elements of relational database management systems
- Understand the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
- Design ER-models to represent simple database application scenarios
- Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.

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Course No: DAC214	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

Module -I

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

Module -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,

Module -III

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

Module -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

Module - 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:

4. Liu.C.L, and D.P.Mohapatra, Elements of Discrete Mathematics,a Computer Oriented Approach, Tata McGraw Hill, 4th edition, 2013.
5. Gary Haggard and John Schlipf, Discrete Mathematics for Computer Science, Thomson 2006.
6. Mott.J.L, Kandel.A, Baker.T.P, Discrete Mathematics for Computer Scientists and Mathematicians, PHI 2006.
7. 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

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Course No: DAC215	Course Title: **Complex Variables**	L	P	U
		3	0	3

Course Learning Objectives

- Know complex numbers and the basic properties of functions of complex variables.
- Define complex line integrals and compute them for elementary functions
- Understand the representation of complex functions as mappings form R2 to R2 .
- Find the Taylor's and Laurent series expansion of complex functions
- Learn complex differentiation and apply the Cauchy-Riemann equations
- Use the Residue theorem to solve real integrals.
- Find all solutions to a set of linear equations
- Completely understand matrix manipulations; Find inverse of a matrix;

Course Contents

Module I

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

Module II

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

Module III

Contour integrals, Anti derivatives, Cauchy theorem, Cauchy Integral Formula,

Module IV

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

Module V

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

Text Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, Inc., 8th Edition

Reference Books:

1. Complex Variables and Applications, J.W. Brown, R.V. Churchill, Mc Graw-Hill, 7th ed,2003.Gary Haggard and John Schlipf, Discrete Mathematics for Computer

Science, Thomson 2006.
2. Complex analysis for Mathematics & Engineering, , John H Mathews & Russel W Howell, Jones & Barlett Publishers, 2001

Course Outcomes:

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

- 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: DAC216	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

Module - 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.

Module -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.

Module - 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.

Module - 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 .

Module - 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:

- To learn principles and difference between different types of modern operating systems, virtual machines and their structure of implementation
- To understand process management, concurrent processes and threads
- To optimize CPU Scheduling, Page replacement and Disk Scheduling algorithm for developing a System. To Improve their programming skills by implementing various Operating System concepts.
- To apply appropriate hardware architectures and patterns to carry out high level design of a operating system
- To write test cases and can develop a simple test report by performing various tests at module level as well as at system level.
- To learn various management policies to predict the complexity of the application developed and assess the level of risks associated with it

Course No: DAC 221	Course Title: Enterprise JAVA applications	L	P	U
		2	2	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.
- To give practical exposure with programming sessions

Course Content:

Module -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.

Module -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

Module -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

Module -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 streams. Multithreading: Fundamentals, Life Cycle, Thread class, Runnable Interface, Multiple Threads, Thread priorities, Synchronization.

Module -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:

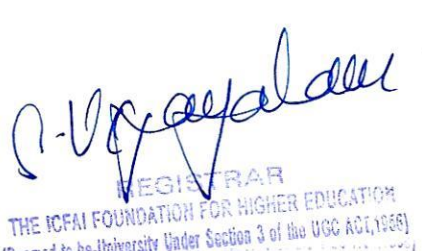
1. Java The Complete Reference, Herbert Schildt, 7th Ed. TataMcGrawHill (2007)
2. Programming with Java A Primer, E. Balaguruswamy,3rd Ed,TataMcGrawHill 2007
3. Object Oriented Programming with Java: Essentials and Applications, Rajkumar Buyya, Thamarai Selvi Somasundaram, Xingchen Chu, 1st Ed. TataMcGrawHill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

List of Enterprise JAVA applicationsLaboratory Experiments:

S.No	Experiments	Duration
1.	Programs on variables and data types in java	
2	Java programs on flow control	
3.	Basic Java programsusing classes and objects	
4.	Java programs on single and multidimensional arrays	
5.	Java programs on inheritance	
6.	Java programs on interfaces	
7.	Java programs on exceptions	
8.	Java programs to work with polymorphism (runtime and compile time)	
9.	Java programs on JDBC	

Course Outcomes

- After successful completion of the course student will be able to
- Understand object-oriented programming concepts and basics of java programming
- Solve real world problems using OOP techniques
- Understand the use of abstract classes, packages and interfaces.
- Expand their knowledge of AWS cloud computing models, services and tools through narrative-based scenarios and short interactive tasks.



Course No: DAC 222	Course Title: Data Operations	L	P	U
		3	0	3

Course Learning Objectives:

1. Understand the DevOps way of organizing work.
2. Be familiar with the range ofDevOps tools.
3. Understand how the tools support the way of work.
4. Become familiar with particular instances of several of the tools

Course Content:

Module -I:

The problem with Data Science: Is there a problem, Reality, Data Value, Technology, Software and Algorithms, Data Scientists, Data Science Processes, Organizational Culture, The Knowledge Gap, Lack of Support.
Data Strategy: Start with Situational Awareness, Identify Analytic Use cases, Benchmark Capabilities of the Data Lifecycle, Deliver the Data Strategy.

Module -II:
Lean Thinking: Lean Thinking and Data Analytics.
Agile Collaboration: Scaling Agile, Agile for DataOps, Agile DataOps practices.

Module -III:
Build Feedback and Measurement: Systems Thinking, Team Health, Service Delivery, Product Health Product Benefit.
Building Trust: Trust People with Data and Systems, People Can Trust Data.

Module -IV
DevOps for DataOps: Development and Operations, Fast Flow from Continuous Delivery, Deployment and Release Processes, DevOps for Data Analytics, MLOps, AIOps.

Organizing for DataOps: Team Structure, The New Skills Matrix, Optimized Teams, Reporting Lines.

Module -V:
DataOps Technology: Choosing Tools Based on DataOps Values and Principles, The DataOps Technology Ecosystem, Build vs Buy, Evolving the Technology Stack.

The DataOps Factory: The First Steps, Minimum Viable DataOps, Expand Across Teams, Extend.

Text Books:

1. Harvinder Atwal "Practical DataOps: Delivering Agile Data Science at Scale" Apress.

Reference Books:

1.John Schmidt, Kirit Basu "DataOps: The Authoritative Edition" Kindle Edition.

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Course Outcomes:

- Be able to Build Feedback and Measurement other tools
- Be able to describe how DevOps relates to Lean and Agile methodologies
- Be able to understand and implement DevOps principles

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Course No: MATH223	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:

Module -I:

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

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

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

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

Module -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.

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Course No: DAC224	Course Title: Data Visualization in Data Science	L	P	U
		3	0	3

Course Learning Objectives

- To recall and identify the relevance of data visualization concepts
- To describe, discuss and relate data visualization techniques adopted within a real world data.
- To apply data visualization techniques for meeting current and future challenges faced by the organization
- To compare the visualization theories and models critically and to inspect and question its validity in the real world
- To assess and modify different concepts of data visualization so as to relate it to current data challenges
- To apply concepts of data visualization in order to solve the real world business problems.

Course Contents

Module -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

Module -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**

Module -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**

Module -IV

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

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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**

Module - 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:

- To recall and identify the relevance of data visualization concepts
- To describe, discuss and relate data visualization techniques adopted within a real world data.
- To apply data visualization techniques for meeting current and future challenges faced by the organization
- To compare the visualization theories and models critically and to inspect and question its validity in the real world
- To assess and modify different concepts of data visualization so as to relate it to current data challenges
- To apply concepts of data visualization in order to solve the real world business problems.

Course No: DAC 225	Course Title:Machine Learning and Deep Learning	L	P	U
		2	2	3

Course Learning Objectives

- To be able to formulate machine learning and deep learning problems corresponding to different applications.
- To understand the basic theory underlying machine learning and deep learning.
- Able to apply machine learning and deep learning algorithms to solve problems of moderate complexity.

Module - I

Introduction - Well-posed learning problems, designing a learning system, Perspectives andissues in machine learningConcept 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 theperformance of the Checkers game.

Module - II

Decision Tree learning – Introduction, Decision tree representation, Appropriate problems fordecision tree learning, The basic decision tree learning algorithm, Hypothesis space search indecision tree learning, Inductive bias in decision tree learning, Issues in decision tree learningArtificialNeuralNetworks– Introduction,Neuralnetworkrepresentation,Appropriateproblemsforneuralnetworklearning,Perceptions,Multilayernetworksandthebackpropagation algorithm, Remarks on the back propagation algorithm, An illustrative exampleface recognition, Advanced topics in artificial neural networks

Case Study: Apply the decision tree for identifying the best rated movies from Movie dataset.

Module - III

Evaluation Hypotheses – Motivation, Estimation hypothesis accuracy, Basics of samplingtheory, A general approach for deriving confidence intervals, Difference in error of twohypotheses, Comparing learning algorithms

Bayesianlearning– Introduction,Bayestheorem,Bayestheoremandconceptlearning,Maximum likelihood and least squared error hypotheses, Maximum likelihood hypotheses forpredicting probabilities, Minimum description length principle, Bayes optimal classifier,

Gibsalgorithm,NaïveBayesclassifier,Anexamplelearningtoclassifytext,Bayesianbeliefnetworks The EM algorithm

Case study: Apply the Naive Bayes for predicting the severity of cancer from Cancer Dataset.

Module -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 Neighbor 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.

Module - 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 to Dynamic 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; 2ndEdition, 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, 1stEdition, 1995.
4. Machine Learning South AsiaEdition: The Art And Science Of Algorithms That MakeSense Of Data, Peter Flach, Cambridge University Press, 1st Edition, 2015.

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Course No: DS226	Course Title: DATA WAREHOUSING AND MINING	L	P	U
		3	0	3

Course Learning Objectives

- To understand concepts related to the use of data for making decisions, learning and predicting. To learn about various probability distributions that play a role in statistical analysis and decision making.
- To apply various specific hypothesis testing techniques, to make inferences, to apply various regression techniques, learn and apply simple classification techniques and unsupervised learning techniques
- Suitability of a problem for various statistical techniques. Finding a suitable regression model for the problem
- To be able to identify the suitable approach to use data science to solve real life problems in business, technology or scientific settings
- To be able to evaluate the statistical parameters using samples, to test hypotheses regarding data, to evaluate suitability of regression models

Course Contents

Module -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)

Module -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.

Module -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)

Module -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

Module - 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:

- To understand data mining fundamentals and Data Mining Principles
- To describe, discuss and relate data mining techniques adopted within an organization
- To identify appropriate data mining algorithms to solve real world problems
- To compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining

Course No: AO 311	Course Title: NUMERICAL METHODS	L	P	U
		3	0	3

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:

Module-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.

Module-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

Module-III:

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

Module-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

Module-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: DAC 321	Course Title: SOFTWARE PROJECT MANAGEMENT	L	P	U
		4	0	4

Course Learning Objectives:

- To understand the Software Project Planning and Evaluation techniques.
- To plan and manage projects at each stage of the software development life cycle (SDLC).
- To learn about the activity planning and risk management principles.
- To manage software projects and control software deliverables.
- To develop skills to manage the various phases involved in project management and people management.
- To deliver successful software projects that support organizations strategic goals.

Course Content:

Module-1:

Introduction to Software Engineering: Software, Evolving role of software, Three "R"-Reuse, Reengineering and Retooling, An Overview of IT Project Management: Define project, project management framework, The role of project Manager, Systems View of Project Management, Stakeholder management, Project phases and the project life cycle. Management Principles – Management Control – Project portfolio Management – Cost-benefit evaluation technology – Risk evaluation – Strategic program Management – Stepwise Project Planning.

Module-II:

Project Life Cycle and Effort Estimation: Software process and Process Models – Choice of Process models – Rapid Application development – Agile methods – Dynamic System Development Method – Extreme Programming- Managing interactive processes – Basics of Software estimation – Effort and Cost estimation techniques -COSMIC Full function points – COCOMO II – a Parametric Productivity Model.

Module-III:

Activity Planning and Risk Management

Objectives of Activity planning – Project schedules – Activities – Sequencing and scheduling -Network Planning models – Formulating Network Model – Forward Pass and Backward Pass techniques – Critical path (CRM) method – Risk identification – Assessment – Risk Planning -Risk Management – – PERT technique – Monte Carlo simulation – Resource Allocation – Creation of critical paths – Cost schedules.

Module- IV:

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Framework for Management and control – Collection of data – Visualizing progress – Cost monitoring – Earned Value Analysis – Prioritizing Monitoring – Project tracking – Change control – Software Configuration Management – Managing contracts – Contract Management.

Module-V:

Framework for Management and control – Collection of data – Visualizing progress – Cost monitoring – Earned Value Analysis – Prioritizing Monitoring – Project tracking – Change control – Software Configuration Management – Managing contracts – Contract Management.

Text Books

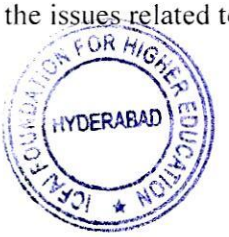
1. Bob Hughes, Mike Cotterell and Rajib Mall: Software Project Management – Fifth Edition, Tata McGraw Hill, New Delhi, 2012

Reference Books

1. Robert K. Wysocki —Effective Software Project Management – Wiley Publication, 2011.
2. Walker Royce: —Software Project Management- Addison-Wesley, 1998.
3. Gopalaswamy Ramesh, —Managing Global Software Projects – McGraw Hill Education (India), Fourteenth Reprint 2013.

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

- Understand Project Management principles while developing software.
- Gain extensive knowledge about the basic project management concepts, framework and the process models.
- Obtain adequate knowledge about software process models and software effort estimation techniques.
- Estimate the risks involved in various project activities.
- Define the checkpoints, project reporting structure, project progress and tracking mechanisms using project management principles.
- Learn staff selection process and the issues related to people management



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ELECTIVES

Course No	Course Title	L	P	U
DAC 312	Natural language processing for ML with Python	3	0	3

Learning Objectives

- To process written text from basic of fundamental knowledge starts with Finite automata, Regular expression and probabilistic model with n-grams.
- Recognizing Speech and parsing with grammar. This course also covers basis of semantic analysis and discourse analysis and drives it to machine translation.
- This NLP course will boost student knowledge to research level where they can conduct new level of research. It really helpful for undergraduate students.

Course Contents:

Module-I

Language Processing and Python : Computing with Language,A Closer Look at Python, Computing with Language: Simple Statistics, Back to Python: Making Decisions and Taking Control Automatic Natural Language Understanding. Accessing Text Corpora and Lexical Resources Accessing Text Corpora, Conditional Frequency Distributions, More Python: Reusing Code, Lexical Resources, WordNet.

Module-II

Processing Raw Text, Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing , Regular Expressions for Tokenizing Text, Segmentation Formatting: From Lists to Strings.

Module-III

Writing Structured Programs, 1 Back to the Basics Sequences, Questions of Style, Functions: The Foundation of Structured Programming, Doing More with Functions Program Development Algorithm Design A Sample of Python Libraries

Module-IV

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Categorizing and Tagging Words Using a Tagger Tagged Corpora Mapping Words to Properties Using Python Dictionaries Automatic Tagging N-Gram Tagging Transformation-Based Tagging How to Determine the Category of a Word

Learning to Classify Text Supervised Classification Further Examples of Supervised Classification Evaluation Decision Trees Naive Bayes Classifiers Maximum Entropy Classifiers Modeling Linguistic Patterns.

Module-V

Extracting information form text, Chunking Developing and Evaluating Chunkers Recursion in Linguistic Structure Named Entity Recognition Relation Extraction

Text Book

1. Natural Language Processing with Python,O'Reilly Steven Bird,Ewan Klein and Edward Loper

Media;1 edition,2009

Reference book(s)

1. Daniel Jurafsky and James H.Martin Speech and Language Processing(2nd Edition),Prentice Hall:2 edition,2008.
2. Machine Learning for Text by Charu C.Aggarwal,Springer,2018 edition
3. Foundations of Statistical Natural Language Processing by Christopher D.Manning and Hinrich Schuetze,MIT press, 1999

Learning Outcomes:

After going through this course, the student will be able to:

- Understand Natural Language Processing
- Probabilistic model of defining language and techniques..
- Applying Hidden Markov model and Speech Recognition.
- Application of context free grammar and language parsing.

Course No	Course Title	L	P	U
DAC 314	PRINCIPLES OF ARTIFICIAL INTELLIGENCE	3	0	3

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.
- To use Artificial Intelligence concepts and algorithms to solve real time problems

Course Contents:

Module-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.

Module-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

Case Study: Apply Forward and backward approaches for obtaining the conclusions on any medical report relevant to Cancer Disease

Module- III

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

Module-IV

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

Case Study: Consider the Uncertainty Knowledge of medical data(Toothache data) and find the way of handling the uncertain knowledge to retrieve the required data.

Module-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.

Case Study: Take any one Machine Learning algorithm. train the system using a taken algorithm and Test the system, then discuss the performance of the algorithm.

Text Book

1. Artificial Intelligence A Modern Approach, by Stuart Russell and Peter Norvig, 3rd Edition, Pearson Education, 2010, ISBN 13:978-0-13-604259-4.Media;1 edition,2009

Reference book(s)

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

Learning Outcomes:

After going through this course, the student will be able to:

- Understand 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
- Demonstrate methods and theories for reactive agents, architectures based on subsumption, and potential fields
- Implement the AI concepts in real time systems

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Course No	Course Title	L	P	U
DAC 322	PREDICTIVE MODELLING AND ANALYTICS	3	0	3

Learning Objectives

- 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.
- Ability to develop and use various quantitative and classification predictive models based on various regression and decision tree methods.
- Learn how to select the appropriate method for predictive analysis, and how to build effective predictive models.
- Learn how to search, identify, gather and pre-process data for the analysis.

Course Contents:

Module-I

Linear Methods for Regression and Classification: Overview of supervised learning, Linear regression models and least squares, Multiple regression, Multiple outputs, Subset selection , Ridge regression, Lasso regression , Linear Discriminant Analysis , Logistic regression , Perceptron learning algorithm.

Module-II

Model Assessment and Selection : Bias, Variance, and model complexity, Bias-variance trade off, Optimism of the training error rate , Estimate of In-sample prediction error, Effective number of parameters, Bayesian approach and BIC, Cross- validation ,Bootstrap methods, conditional or expected test error.

Module-III

Additive Models,Trees,and Boosting: Generalized additive models, Regression and classification trees , Boosting methods-exponential loss and AdaBoost, Numerical Optimization via gradient boosting ,Examples (Spam data, California housing , NewZealand fish, Demographic data)

Module- IV

Neural Networks(NN) , Support Vector Machines(SVM),and K-nearest Neighbor: Fitting neural networks, Back propagation, Issues in training NN, SVM for classification, Reproducing Kernels, SVM for regression, K-nearest –Neighbour classifiers(Image Scene Classification)

Module- V

Unsupervised Learning and Random forests: Association rules, Cluster analysis, Principal Components, Random forests and analysis. Forecasting models, Trend analysis , Cyclical and Seasonal analysis Smoothing; Moving averages; Box-Jenkins, Holt-winters, Auto- orrelation; ARIMA Examples: Applications of Time Series in financial markets.

Text Book

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman , The Elements of Statistical Learning-Data Mining, Inference, and Prediction ,Second Edition , Springer Verlag, 2009

Reference book(s)

1. G.James,D.Witten,T.Hastie,R.Tibshirani-An introduction to statistical learning with applications in R,Springer,2013.
2. C.M.Bishop –Pattern Recognition and Machine Learning,Springer,2006

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Course No	Course Title	L	P	U
DAC 323	Artificial Neural Networks	3	0	3

Learning Objectives

- To understand basics of Neural Networks
- To learn different types of ANN architectures
- To understand different types of learning mechanisms in ANN

Course Contents:

Module-I

Introduction: Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture: Feedforward and Feedback, Convex Sets, Convex Hull and Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks.

Module-II

Learning: Learning Algorithms, Error correction and Gradient Descent Rules, Learning objective of TLNs, Perceptron Learning Algorithm, Perceptron Convergence Theorem. L1, L2.

Supervised Learning: Perceptron learning and Non Separable sets, α-Least Mean Square Learning, MSE Error surface, Steepest Descent Search, μ-LMS approximate to gradient descent, Application of LMS to Noise Cancelling, Multi-layered Network Architecture, Backpropagation Learning Algorithm, Practical consideration of BP algorithm.

Module- III

Support Vector Machines and Radial Basis Function: Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition

Module-IV

support Vector Machines and Radial Basis Function: Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification, Radial Basis Function Regularization theory, Generalized RBF Networks, Learning in RBFNs, RBF application to face recognition.

Module-V

Self-organization Feature Map:Maximal Eigenvector Filtering, Extracting Principal Components, Generalized Learning Laws, Vector Quantization, Self-organization Feature Maps, Application of SOM, Growing Neural Gas. L1, L2, L3

Text Book

1. Introduction to Artificial Neural Systems-J.M. Zurada, Jaico Publications 1994.

Reference book(s)

1. S. Haykin, Neural Networks and Learning Machines , Prentice Hall of India, 2010
2. Satish Kumar, Neural Networks - A Class Room Approach, Second Edition, Tata McGraw-Hill, 2013
3. B. Yegnanarayana, Artificial Neural Networks, Prentice- Hall of India, 1999

Course outcomes:

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

- Understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.
- Understand the concepts and techniques of neural networks through the study of the most important neural network models.
- Evaluate whether neural networks are appropriate to a particular application.
- Apply neural networks to particular applications, and to know what steps to take to improve performance.

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Course No	Course Title	L	P	U
DAC 324	Advanced Deep learning	3	0	3

Learning Objectives

- To understand the theoretical foundations, algorithms and methodologies of Neural Network
- To design and develop an application using specific deep learning models
- To provide the practical knowledge in handling and analysing real world applications.

Course Contents:

Module-I

Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient decent, Curse of Dimensionality

Module-II

Deep Learning Architectures: Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications

Module-III

Convolutional Neural Networks: Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, AlexNet – Applications

Transfer learning: Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet.

Module- IV

Sequence Modelling – Recurrent And Recursive Nets, Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures, BPTT for training RNN, Long Short Term Memory Networks.

Module-V

Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders. Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversial Networks.

Text Book

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, " Deep Learning", MIT Press, 2017.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
3. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.

Reference book(s)

1. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
3. Giancarlo Zaccone, Md. Rezaul Karim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
4. Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.
5. Francois Chollet "Deep Learning with Python", Manning Publications, 2017.

Course outcomes:

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

1. Recognize the characteristics of deep learning models that are useful to solve real-world problems.

2. Understand different methodologies to create application using deep nets.

3. Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.

4. Implement different deep learning algorithms

5. Design the test procedures to assess the efficacy of the developed model

6. Combine several models in to gain better results

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HUMANINY ELECTIVES

Course No	Course Title	L	P	U
HS 315	**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:

Module-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.

Module- 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.

Module-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.

Module-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.

Module-V

Sociology of Religion: Aspects, origin, Hinduism. Social disorganization and delinquency.

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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.

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Course No: HS316	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

Module- 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.

Module- 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.

Module- III

Learning: Concept and theories of learning (behaviourists, gestaltist 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.

Module- 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.

Module-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 OrganisationalBehaviour: 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
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Course No	Course Title	L	P	U
HS317	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:

Module-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.

Module-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.

Module-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.

Module-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.

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Module-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

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Course No	Course Title	L	P	U
HS325	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.

Module- 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.

Module- 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.

Module-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

Module-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.

Module-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.

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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:

Module-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

Module-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.

Module-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.

Module-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.

Module-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: HS327	Course Title: Professional Ethics	L	P	U
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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

Module-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.

Module-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.

Module-III

Engineering as experimentation, engineers as responsible experimenters, codes of ethics, a balanced outlook on law, the challenger case study.

Module-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.

Module- 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.

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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

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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.

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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.

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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.

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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:

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• 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/pieces of 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.

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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.

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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

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(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.

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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.

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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.

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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.

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