NETAJI SUBHAS UNIVERSITY OF TECHNOLOGY

A STATE UNIVERSITY

UNDER DELHI ACT 06 OF 2018, GOVT. OF NCT OF DELHI

Azad Hind Fauj Marg, Sector-3, Dwarka, New Delhi-110078

SCHEME OF COURSES AND EXAMINATION

FOR

BACHELOR OF TECHNOLOGY

INFORMATION TECHNOLOGY

(PART-A: DISCIPLINE SPECIFIC COURSES)

(Effective from the Session: 2019-2020)

APPROVED BY

The Senate in its II to XIII meetings

The Board of Management in its meeting held on ----- --, 20--

Contents

1 INTRODUCTION

NSUT has embarked on its journey towards excellence in academics through the introduction of a novel system of learning that is being followed in many reputed universities globally. The Choice Based Credit System (CBCS) has been proposed by University Grants Commission (UGC) on recommendations of the National Knowledge Commission, to improve the quality of higher education in India. NSUT proposes to adopt CBCS for its Bachelor of Technology courses

CBCS is the mother of student centric educational reforms. A student is provided with an academically rich, highly flexible learning system blended with abundant provision for skill practice and activity orientation that he/she could learn in depth without sacrificing his/her creativity. A student can exercise the option to decide his/her own pace of learning- slow, normal or accelerated plan and sequence his/her choice of paper, learn to face challenges through term work/ project work and may venture out to acquire extra knowledge/ proficiency through add-on facilities. The great advantage of CBCS is that the learning process is made continuous and the evaluation process is not only made continuous but also made learner-centric and is designed to recognize the capability and talent of a student.

2 CURRICULUM STRUCTURE

B.Tech. programme of the University shall be based upon CBCS and shall have well defined Programme Educational Objectives (PEOs). All the courses shall have well-defined Course Outcomes (COs). Courses shall be of three kinds namely Core, Elective and Foundation.

a. Core Course (CC): This is a course which is to be compulsorily studied by a student as a core requirement to complete the requirements of the B.Tech. programme.

b. Elective Course: This is a course which can be chosen from a pool of elective courses. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency and skill. An elective may be of the following types:

- **i.** Discipline Centric Elective (ED): It is an elective course that adds proficiency to the students in the discipline.
- **ii.** Generic Elective (EG): It is an elective course taken from other engineering subjects and enhances the generic proficiency and interdisciplinary perspective of students.
- **iii.** Open Elective (EO): It is an elective course taken from a common pool of non-engineering disciplines that broadens the perspective of an engineering student. These electives shall comprise two groups: Open electives of the Humanities, Social Sciences and Management group and Open electives of the Sciences group.

c. Foundation Course: A Foundation course leads to knowledge enhancement and provides value-based training. Foundation courses may be of two kinds:

- **i.** Compulsory Foundation (FC): It is based upon the content that leads to fundamental knowledge enhancement in Sciences, Humanities, Social Sciences and Basic engineering. They are mandatory for all disciplines.

ii. Elective Foundation (FE): It can be taken from among a common pool of foundation courses which aim at value-based education. They may provide hands-on training to improve competencies, skills or provide education on human, societal, environmental and national values. These shall be mandatory, non-credit courses, which do not carry any credits but a student has to pass in order to be eligible for award of degree.

2.1 EVALUATION AND ASSESSMENT

The performance of a student in a semester shall be evaluated through continuous class assessment, MSE and ESE. Both the MSE and ESE shall be University examinations and will be conducted as notified by the CoE of the University. The marks for continuous assessment (Sessional marks) shall be awarded at the end of the semester. The continuous assessment shall be based on class tests, assignments/tutorials, quizzes/viva-voce and attendance etc. The MSE/ESE shall comprise of written papers, practicals and viva-voce, inspection of certified course work in classes and laboratories, project work, design reports or by means of any combination of these methods.

The weightage of each of these modes of evaluation for the different types of courses shall be as per Table 1. Further, the mechanism for continuous assessment shall be as per Table 2.

Table-1: Evaluation Scheme

S. No.	Type of Course	Continuous Assessment (CA) Theory	Mid-Semester Examination (MSE) Theory	End-Semester Examination (ESE) Theory	Continuous Assessment (CA) Practical	End-Semester Examination (ES) Practical
1	FE courses	Continuous Assessment only (100 marks)				
2	CC/FC/ED/EG/EO Theory with Tutorial	25	25	50	Nil	Nil
3	CC/FC/ED/ EG/EO Theory with Practical	15	15	40	15	15
4	Project I and Project II	Nil	Nil	Nil	40	60
5	Training	Nil	Nil	Nil	40	60
6	Work shop based Course	30	--	20	30	20
7	Audit Courses*	-	-	-	-	-
*The distribution of marks of practical and/or theory components for Audit courses shall be determined by the respective Departments.						

Table 2: Continuous Assessment

S. No.	Type of Course	Continuous Assessment (CA)
1	CC/FC/ED/EG/EO Theory with Tutorial	Two class tests, Assignments, Teachers' assessment (quizzes, viva-voce, attendance)
	CC/FC/ED/EG/EO Theory with Practical	One class test, One Lab test, Assignments/Projects, Teachers' assessment
2	FE courses ***	Two class tests, Assignments, Teachers' assessment

3	Project I /II	Mid-Semester Presentation, Report, Supervisor's Assessment
4	Training	As specified by the Department
5	Audit Courses	As specified by the Department

*** Foundation Elective Courses are value-based courses which may enhance the proficiency /skill. These electives could be communication skills, Spoken English, soft skills, Business and Management courses, entrepreneurship development, Knowledge of an additional Foreign Language, Personality Development through sports, music, theatre, dance, etc.

The University offers the students a pool of Foundation elective courses which may be offered by the following departments of the University:

i) Department of Humanities
ii) Department of Management
iii) Department of Personality Development

Note for students:

i) An Undergraduate student should choose any three foundation elective courses to study from the given list.
ii) He/She can take only one foundation elective course in an ongoing semester.
iii) The study and clearing of foundation elective course is to be done by the end of 2nd year (fourth semester).
iv) For getting a Degree, it is mandatory to clear the entire three chosen foundation elective course.
v) Foundation elective courses are non-cedit mandatory courses and there is no credits awarded to the students.

Note for Course Teacher:

The evaluation of FE courses shall be done through continuous assessment only.

i) Subject having Theory only: The course teacher shall evaluate through TWO class tests (25 marks each), ONE Assignment/Project (40 marks) and internal evaluation [one such component is attendance] (10 marks).
ii) Subject having Theory and Practical: Here, a course teacher evaluate for theory part through TWO class test (20 marks each) and internal evaluation [one such component is attendance] (10 marks). Similarly, for practical part ONE practical test (40 marks) and internal evaluation [one such component is attendance] (10 marks)
iii) Subject having Practical only : The course teacher takes TWO practical test (45 marks each) and internal evaluation [one such component is attendance] (10 marks)

2.2 SEMESTER WISE COURSE/CREDIT DISTRIBUTION

Table 3 : SEMESTER WISE COURSE/CREDIT DISTRIBUTION

Semester	Types of courses as per NSUT Nomenclature						Courses/credits	Credits
	FE (NON-CREDIT)	FC	CC	ED	EG/ EO-Sciences / EO-SS &Mgmt	Training Project etc.		
I	01	05	00	00	00	00	06 courses 20 credits	84 credits
II	00	03	03	00	00	00	06 courses 24 credits	
III	01	00	05	00	00	00	06 courses 20 credits	
IV	01	00	05	00	00	00	06 courses 20 credits	
V	00	00	04	#	#	00	04 –07 courses 16-28 credits	86 credits
VI	00	00	03	#	#	00	03 –07 courses 16-28 credits	
VII	00	00	00	#	#	06	00 – 05 courses 06-26 credits	
VIII	00	00	00	#	#	08	00 – 05 courses 08-28 credits	
TOTAL CREDITS								170

ED : At least 4 courses (16 credits)
EO- Sciences : At least 1 courses (04 credits)
EO-HSS & Management : At least 2 courses (08 credits)
Practical Training of 2 credits shall be undertaken during the summer vacations just after VI semester, and shall add to the credit count of VII semester.

2.3 COURSE CODE NOMENCLATURE

The courses of various B.Tech programmes are assigned a course code.

2.3.1 COURSE/DEPARTMENT/SPECIALIZATION/BRANCH CODING

The courses of various B.Tech programmes are assigned course codes as per the following nomenclature. This nomenclature shall use course/department/specialization/branch coding as defined below.

TABLE 4: TYPE OF COURSE/DEPARTMENT CODES

XX	Course Category Code	FC	Foundation Core
		FE	Foundation Elective
		EO	Open Elective
YY		AR	Architecture
		BT	Biological Sciences and Engineering

	Name of Department Code	CH	Chemistry
		CP	Computer Engineering, East Campus
		CS	Computer Science & Engineering
		CW	Civil Engg, West Campus
		FT	Design
		EE	Electrical Engineering
		EC	Electronics & Communication Engineering
		EP	Electronics & Communication Engineering, East Campus
		HS	Humanities
		IC	Instrumentation & Control Engineering
		IT	Information Technology
		IW	Information Technology, West Campus
		ME	Mechanical Engineering
		MG	Management
		MP	Manufacturing Process & Automation
		MT	Mathematics
		MW	Mechanical Engineering, West Campus
		PD*	Personality Development
		PH	Physics

Note : Second Alphabet P indicates East Campus, and W indicates West Campus.

*PD offers FE courses like music, dance, yoga, sports, NSS, etc.

TABLE 5: B.TECH SPECIALIZATION/BRANCH CODES

ZZ	BT	Bio Technology
	CA	Computer Science & Engineering with Artificial Intelligence
	CB	Computer Science and Engineering (Big Data Analytics), East Campus
	CD	Computer Science and Engineering (Data Science)
	CE	Civil Engineering, West Campus
	CG	Geo informatics, West Campus
	CI	Computer Science and Engineering (IOT), East Campus
	CM	Maths & Computing
	CO	Computer Science & Engineering
	EA	Electronics and Communication Engineering (Artificial Intelligence and Machine Learning) East Campus
	EC	Electronics & Communication Engineering
	EI	Electronics & Communication Engineering (Internet of Things)
	EE	Electrical Engineering
	IC	Instrumentation & Control Engineering
	II	Information Technology (Internet of Things) West Campus
	IN	Information Technology (Network security)
	IT	Information Technology
	ME	Mechanical Engineering
	MP	Manufacturing Process & Automation
	MV	Mechanical Engineering (Electric Vehicles) (MEEV), West Campus

2.3.2 B.TECH COURSE CODE NOMENCLATURE

FOUNDATION CORE AND ELECTIVE COURSES AND OPEN ELECTIVE COURSES:

Course Category		Offering Department Code			Course No.	
X	X	Y	Y	0	*	*

** can take numeric values only

XX and YY maybe chosen as given in Tables 4 and 5 respectively.

OTHER CORE AND ELECTIVE COURSES:

Program Code		Offering Department Code		Course Category	Course No.	
Z	Z	Y	Y	C/E	*	*

** can take numeric values only;

C for Core and E for Elective (Discipline Centric);
YY and ZZ may be chosen as given in Tables 4 and 5 respectively

2.3.3 MOOC (NPTEL BASED) FOUNDATION ELECTIVE COURSES AND OPEN ELECTIVE COURSES:

Course Category		Offering Department (NPTEL) Code		UG/PG	Course No.	
X	X	F	F	G	*	*

** can take numeric only;

XX	Course Category Code	FE	Foundation Elective
		EO	Open Elective
FF	Name of Offering Department Code for NPTEL	NH	Humanities & Social Sciences
		NM	Management
		NP	Personality Development
		NS	Sciences
G	UG/PG	0	B.Tech
		1	M.Tech

2.3.4 STUDENT ROLL NUMBER NOMENCLATURE:

Students shall be assigned roll numbers as per the format given below.

Year of Admission	U	ZZ (FROM TABLE 5)	4 DIGIT NUMBER

3 SEMESTER WISE SCHEME OF COURSES

The Department of IT offers **Discipline Centric Elective** courses in the following two specialization areas of Information Technology.

1. Network Computing and Security
2. Machine Intelligence and Data Analytics

Students who earn credits from at least 4 elective courses from an area of specialization may be offered a degree in "B.Tech (IT), with a minor in Specialization-X". Students can also be awarded the degree with a minor in the area of other B.Tech programmes if he/she earns credits from at least 4 generic elective courses from an area of specialization offered by the other Department.

3.1 SCHEME OF COURSES FOR SEMESTER I

B.Tech -SEMESTER I														
Course Code	Type	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.	Aicte Course Type
							Theory			Practical			
							CA	MS	ES	CA	ES		
FCMT001	FC	Mathematics-I	3	1	0	4	25	25	50	-	-	MATHS	Basic Sciences
FCCS002/ FCHS005	FC	Computer Programming /English	3	0	2	4	15	15	40	15	15	COE/ IT/HSS	Engg Sciences/ Huss
FCEC003	FC	Electronics and Electrical Engineering	3	0	2	4	15	15	40	15	15	ECE/ ICE /EE	Engg Sciences
FCPH004/ FCCH008	FC	Physics/Environment Science and Green Chemistry	3	0	2	4	15	15	40	15	15	PHYSICS /CHEM.	Basic Sciences
FCME006	FC	Basics of Mechanical Engg.	4	0	0	4	25	25	50	-	-	MPAE/ ME	Engg Sciences
FEXXxxx *	FE	Elective Foundation	-	-	-	NIL	-	-	-	-	-	-	Mandatory Course
		28 contact hours *				20							

* The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Part B. The actual weekly load depends upon the Foundation Elective Course.

Students of the Departments of Group I shall be offered courses as follows:

1. Semeter I : Computer Programming, Physics
2. Semeter II : English, Environment Science and Green Chemistry

Students of the Departments of Group II shall be offered courses as follows:

1. Semeter I : English, Environment Science and Green Chemistry
2. Semeter II : Computer Programming, Physics

3.2 SCHEME OF COURSES FOR SEMESTER II

B.Tech. SEMESTER II													
Course No.	Type	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.	AICTE Course Type
							Theory			Practical			
							CA	MS	ES	CA	ES		
FCHS005 /FCCS002	FC	English/Compute r Programming	3	0	2	4	15	15	40	15	15	HSS/IT	Engg Sciences /HUSS
FCMT007	FC	Mathematics-II	3	1	0	4	25	25	50	-	-	MATHS	Basic Sciences
FCCH008/ FCPH004	FC	Environment Science and Green Chem./ Physics	3	0	2	4	15	15	40	15	15	CHEMIS TRY/ PHYSIC S	Basic Sciences
ITECC01	CC	Digital Logic Design	3	0	2	4	15	15	40	15	15	ECE	Program Core/ Engg Sciences
ITITC02	CC	Data Structures	3	0	2	4	15	15	40	15	15	IT	
ITITC03	CC	Discrete Structures	3	1	0	4	25	25	50	-	-	IT	
			24 *			24							
*: The actual weekly load depends upon the Core Courses that are run for IT.													

3.3 SCHEME OF COURSES FOR SEMESTER III

B.Tech. SEMESTER III													
Course No.	Type	Course	L	T	P	Credits	Evaluation Scheme (Percentage weights)					Offering Dept.	AICTE Course Type
							Theory			Practical			
							CA	MS	ES	CA	ES		
ITMTC04	CC	Optimization principles and Techniques	3	1	0	4	25	25	50	-	-	MATHS	Basic Sciences
ITITC05	CC	Data Base Management System	3	0	2	4	15	15	40	15	15	IT	Program Core
ITECC06	CC	Probability and Stochastic Processes	3	1	0	4	25	25	50	-	-	ECE	Engg Sciences
ITITC07	CC	Computer System Organization	3	1	0	4	25	25	50	-	-	IT	Program Core
ITITC08	CC	Computer Graphics	3	0	2	4	15	15	40	15	15	IT	Program Core

FE*****	FE	Foundation Elective	-	-	-	NIL	-	-	-	-	-	-	Mandatory Course
			20*			20							

* The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Part B. The actual weekly load depends upon the Foundation Elective Course.

3.4 SCHEME OF COURSES FOR SEMESTER IV

B.Tech. SEMESTER IV													
Course No.	Type	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.	AICTE Course Type
							Theory			Practical			
							CA	MS	ES	CA	ES		
ITITC09	CC	Operating System	3	0	2	4	15	15	40	15	15	IT	Program Core
ITITC10	CC	Design and Analysis of Algorithm	3	0	2	4	15	15	40	15	15	IT	Program Core
ITITC11	CC	Software Engineering	3	1	0	4	25	25	50	-	-	IT	Program Core
ITITC12	CC	Computer Networks	3	0	2	4	15	15	40	15	15	IT	Program Core
ITECC13	CC	Analog and Digital Communication	3	0	2	4	15	15	40	15	15	ECE	Engg Sciences
FE***** #	FE	Foundation Elective	-	-	-	NIL	-	-	-	-	-	-	Mandatory Course
			20#			20							

#: The course codes, LTP distribution and Evaluation Scheme for Foundation Electives are given in Part B. The actual weekly load depends upon the Foundation Elective Course.

3.5 SCHEME OF COURSES FOR SEMESTER V

B.Tech SEMESTER V												
Course No.	Type	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.
							Theory			Practical		
							CA	MS	ES	CA	ES	
ITITC14	CC	Theory of Computation	3	1	0	4	25	25	50	-	-	IT
ITITC15	CC	Number Theory and Cryptography	3	0	2	4	15	15	40	15	15	IT
ITITC16	CC	Artificial Intelligence	3	0	2	4	15	15	40	15	15	IT
ITITC17	CC	Mobile Computing	3	0	2	4	15	15	40	15	15	IT
1*	**EG/ED/EO**	Elective(s)	2*			3*						

1*: The LTP allocation, Evaluation Scheme and Pre-requisites for Electives are given in Table below. The

course code will depend upon the elective(s) chosen by the student.
2*: The actual weekly load will depend upon the elective(s) chosen by the student.
3*: A student may register for courses leading to a minimum of 16 credits and a maximum of 28 credits. Normally, a student registers for courses leading to 24 credits.

- Students opting for these courses as EG may refer to section 4.3 for information regarding Pre Requisites and Equivalent Courses
- AITCE Course Type : Program Core

The Discipline Centric Elective courses of V semester have been grouped into two minor areas as given in the table below. These are

1. Network Computing and Security
2. Machine Intelligence and Data Analytics

B.Tech. SEMESTER V (Discipline Centric Elective Courses)											
Course Code	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.
						Theory			Practical		
						CA	MS	ES	CA	ES	
MINOR-1: Network Computing and Security											
ITITE01	Intrusion Detection Systems and Firewalls	3	0	2	4	15	15	40	15	15	IT
ITITE02	Advance Computer Networks	3	0	2	4	15	15	40	15	15	IT
ITITE03	Cloud Computing	3	0	2	4	15	15	40	15	15	IT
MINOR-2 : Machine Intelligence and Data Analytics											
ITITE04	Image Analytics	3	0	2	4	15	15	40	15	15	IT
ITITE05	Data Warehouse and Data Mining	3	0	2	4	15	15	40	15	15	IT
ITITE06	Soft Computing	3	0	2	4	15	15	40	15	15	IT

- Students of other Department who opt for these courses as EG may refer to section 4.4 for information regarding Pre Requisites and Equivalent Courses.
- AICTE Course Type: Program Electives

3.6 SCHEME OF COURSES FOR SEMESTER VI

B.Tech SEMESTER VI												
Course Code	Type	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.
							Theory			Practical		
							CA	MS	ES	CA	ES	
ITITC18	CC	Web Technology	3	0	2	4	15	15	40	15	15	IT
ITITC19	CC	Network and networking devices W/S	2	0	4	4	30	-	20	30	20	IT
ITITC20	CC	Compiler and Translator Design	3	0	2	4	15	15	40	15	15	IT
DISCIPLINE CENTRIC ELECTIVE COURSES												
MINOR-1: Network Computing and Security												
ITITE20	ED	Information Security	3	0	2	4	15	15	40	15	15	IT
ITITE21	ED	Digital Forensics	3	0	2	4	15	15	40	15	15	IT
ITITE22	ED	Fog and Edge Computing	3	0	2	4	15	15	40	15	15	IT
ITITE23	ED	Ad Hoc and Delay Tolerant Networks	3	0	2	4	15	15	40	15	15	IT
MINOR -2: Machine Intelligence and Data Analytics												
ITITE24	ED	Machine Learning and Data Analytics	3	0	2	4	15	15	40	15	15	IT
ITITE25	ED	Big Data Science and tools	3	0	2	4	15	15	40	15	15	IT
ITITE26	ED	Artificial Neural Networks	3	0	2	4	15	15	40	15	15	IT

- Students of other Department who opt for these courses as EG may refer to sections 4.3 & 4.4 for information regarding Pre-Requisites and Equivalent Courses
- AICTE Course Type: Program Core & Program Electives

SCHEME OF COURSES FOR SEMESTER VII/VIII

B. Tech (IT) - Semester - VII/VIII													
Course Code	Type	Course	L	T	P	Credits	Evaluation Scheme					Offering Dept.
							Theory			Practical		
							CA	MS	ES	CA	ES	
B. Tech (IT) - Semester - VII												
ITITC21	CC	Training *	0	0	4	2	-	-	-	40	60	IT
ITITC22	CC	Project-I	0	0	8	4	-	-	-	40	60	IT
B. Tech (IT) - Semester - VIII												
ITITC23	CC	Project-II	0	0	16	8	-	-	-	40	60	IT
* Training has to be undertaken during the Summer Vacations just after VI semester												
DISCIPLINE CENTRIC ELECTIVE COURSES												
MINOR-1: Network Computing and Security												
ITITE50	ED	Cyber Security	3	0	2	4	15	15	40	15	15	IT
ITITE51	ED	Internet of Things	3	0	2	4	15	15	40	15	15	IT
ITITE52	ED	Blockchain Technologies	3	0	2	4	15	15	40	15	15	IT
ITITE53	ED	Steganography and Digital Watermarking	3	0	2	4	15	15	40	15	15	IT
ITITE54	ED	Network Security and Risk Management	3	0	2	4	15	15	40	15	15	IT
ITITE55	ED	Wireless Network Security	3	0	2	4	15	15	40	15	15	IT
ITITE56	ED	Wireless Sensor Networks	3	0	2	4	15	15	40	15	15	IT
ITITE57	ED	Cyber Laws	3	1	0	4	25	25	50	-	-	IT
ITITE58	ED	Distributed Systems	3	0	2	4	15	15	40	15	15	IT
ITITE59	ED	Green Computing	3	0	2	4	15	15	40	15	15	IT
MINOR -2: Machine Intelligence and Data Analytics												
ITITE61	ED	Hadoop and Spark	3	0	2	4	15	15	40	15	15	IT
ITITE62	ED	Data Compression and Video Analytics	3	0	2	4	15	15	40	15	15	IT
ITITE63	ED	Deep and Reinforcement Networks	3	0	2	4	15	15	40	15	15	IT
ITITE64	ED	Natural Language Processing	3	0	2	4	15	15	40	15	15	IT
ITITE65	ED	Metaheuristic Algorithms	3	0	2	4	15	15	40	15	15	IT
ITITE66	ED	Machine Vision	3	0	2	4	15	15	40	15	15	IT
ITITE67	ED	Social Network Mining and Analysis	3	0	2	4	15	15	40	15	15	IT
ITITE68	ED	Computational Data Science	3	0	2	4	15	15	40	15	15	IT
ITITE69	ED	Pattern Analysis and Recommender Systems	3	0	2	4	15	15	40	15	15	IT
ITITE70	ED	Multimedia Technology	3	0	2	4	15	15	40	15	15	IT

- Students opting for these courses as EG may refer to sections 4.4 for information regarding Pre-Requisites and Equivalent Courses
- Aicte Course Type: Program Core & Program Electives

4. SYLLABI OF COURSES

4.1 SYLLABI OF FOUNDATION COMPULSORY COURSES

Course No.	Title of the Course	Course Structure	Pre-requisite
FCMT001	Mathematics - I	3L - 1T - 0P	None

COURSE OUTCOMES:

CO 1 : Analyze and test Infinite Series and its convergence,
CO 2 : Successive differentiation and expansion of the function,
CO 3 : Curvature and Radius of Curvature in different coordinate systems,
CO 4 : Applications of definite integral,
CO 5 : Consistency of system of equations, Eigenvalue and Eigenvector.

Unit No.	Topics
Unit-I	Infinite Series: Tests for convergence of series: p-series (with proof), Comparison of ratios, Ratio, Integral, Raabe's, Logarithmic and Cauchy's nth root (all tests without proofs), Alternating series, Absolute convergence, Conditional convergence. Function of Single
Unit-II	Variable: Hyperbolic functions, inverse hyperbolic function, successive differentiation, Leibniz theorem, Taylor's and Maclaurin's theorems (without remainder terms).
Unit-III	Curvature: Polar Curves, Differential coefficients of length of arc, Cartesian, polar and parametric forms, pedal equation, Angle between tangent and radius vector, Curvature and Radius of Curvature in Cartesian, polar and pedal forms.
Unit-IV	Applications of definite integral: Asymptotes (in Cartesian), elementary knowledge of curve tracing, area, length, surface area and volume of revolution (in Cartesian, parametric and polar co-ordinates).
Unit-V	Matrices: Elementary row transformation, Rank of matrix, consistency and inconsistency of system of simultaneous equations, solution of non-homogeneous and homogeneous equations, Eigenvalue and Eigenvector, Characteristic equation, Cayley-Hamilton theorem. Modal matrix

SUGGESTED READINGS:

1. Calculus and Analytic Geometry by G.B. Thomas (Pearson Education)
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Publication)
3. Advanced Engineering Mathematics by Michael Greenberg (Pearson Education)
4. Advanced Engineering Mathematics by R. K. Jain and S.R.K. Iyenger (Narosa Publication)
5. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication)

Course No.	Title of the Course	Course Structure	Pre-requisite
FCCS002	Computer Programming	3L - 0T - 2P	None

COURSE OUTCOMES:

CO 1 : To understand the basic terminology and program structures used in computer programming to solve real worldproblems.
CO 2 : To understand the need for continuing to learn new languages to solve complex problems in differentdomains.
CO 3 : To learn the process of representing problems and writing,compiling and debuggingprograms.
CO 4 : To develop programming skills in using different types of data, decision structures, loops functions, pointers, data files and dynamic memoryallocation/de-allocation.
CO 5 : To be able to code using Procedural and Object-Oriented languages.

Unit No.	TOPICS
Unit-I	Basics of C: Basic features of C Language like Identifier, Keywords, Variable, data types, Operators and Expression, basic screen and keyboard I/O, Control Statements, iteration, nested loops, Enumerated data types, bitwise operators, C Preprocessor statements.
Unit-II	Arrays and Pointers: One and multidimensional dimensional arrays, strings arrays, operations on strings, Array and Pointers, Pointer to Pointer, other aspect of pointers, User Defined Data Types: Structures, Unions.
Unit-III	Functions: Concept of modular programming, Using functions, Scope of data, Recursive functions, Pointers and functions, Command line arguments. Files: Types of files, working with files, usage of file management functions.
Unit-IV	Overview of Object Oriented Programming: Python Programming, Concepts and Terminology. Data Types and Collection Data Types: Identifiers and keyword, Integral types floating point types, operations and formatting, Sequence types, Tuples, named Tuples, lists, set Types, sets, frozen sets, mapping types, Dictionaries, Iterating and Copying collections iterators and interactable operations and functions copying collection. Central Structures and Functions: Conditional branching, looping, Exception handling catching and raising exceptions, custom exceptions custom functions, Names and Docstrings, Argument and Parameter unpacking, Accessing variables in Global scope, lambda functions.
Unit-V	Modules and Packages: Packages, custom modules, overview of python's standard library, string handling, mathematics and Numbers, Times and dates, File formats, Data persistence. File Handling: Writing and Reading binary data, raw binary data, compression, parsing text files, Random Access binary files, generic binary record file class.

SUGGESTED READINGS:

1. B. W. Kernighan and D.M. Ritchie, "The C programming language", Prentice Hall.
2. Herbert Schildt and Tata McGraw Hill, "The Complete Reference".
3. O Reilly Learning Python
4. Programming in Python 3: A Complete Introduction to the Python Language Pearson by Mark Summerfield

Course Ni.	Title of the Course	Credits	Course Structure	Pre-Requisite
FCEC003	Electronics And Electrical Engineering	4	3L-0T-2P	None

Course Outcomes:

CO 1 : To understand the basics of AC and DC circuits, transformers along with DC generator and motor
CO 2 : To analyze series-parallel RLC circuits and
CO 3 : To implement basic circuits using diodes, BJTs and op-amps as circuit elements
CO 4 : To get familiarized with OP-AMP and its applications
CO 5 : To develop circuits using basic electrical and electronic components

Unit No.	Topics

Unit-I	Electric Circuits: Basic Circuit Elements, Nodal and Loop Analysis, Superposition, Thevenin's Theorem & Norton's Theorem and Maximum Power Transfer Theorem;
Unit-II	Steady-state analysis of AC circuits: Sinusoidal and phasor representation of Voltage and current, single phase AC circuit, behavior of R, L and C. Combination of R, L and C in series and parallel, Resonance; Introduction to three-phase circuits, Star-Delta Transformation
Unit-III	Transformers: Principle of operation and construction of single-phase transformer, Introduction to DC Motor. Electronics Devices and Circuits: Junction Diode, Applications: rectifiers, clipping and clamping circuits, LEDs;
Unit-IV	Bipolar-junction Transistor: Physical operation, operating point, load-line, Self-bias circuit, single-stage CE amplifier configuration. Ideal op-amp, inverting, non-inverting and unity gain amplifiers, integrator, differentiator, summer/subtractor.
Unit-V	Digital circuits- Boolean Algebra, logic gates, K-Maps upto 4-variables, Combinational circuits: Adders and subtractors. Flip-Flops: SR, JK, D, T and their characteristic tables. Introduction to Sensors, Introduction to Embedded Computers.

Suggested Reading:

1. M.E. Van Valkenburg, "Network Analysis" Pearson publishers, 3rd Edition
2. Boylestad and Nashelsky, "Electronic Devices and Circuit Theory" Pearson publishers, 10th Edition
3. Edward Hughes, "Electrical and Electronic technology", Pearson publishers, 10th Edition
4. Malvino and Leach, " Digital Principles and Applications", TMH publishers, 8th Edition

Course No.	Title of the Course	Course Structure	Pre-Requisite
FCPH004	Physics	3L-0T-2P	None

COURSE OUTCOMESS :

CO 1 : Knowing important concepts and phenomena linked to relativity

CO 2 : The concept of waves and oscillations are useful for doing analytical and numerical calculations for measurements, observations and gravitational wave communications.

CO 3 : The course is helpful to the students in understanding various optical wave phenomena which are required for optical & electromagnetic wave communications and in opticaldevices.

CO 4 : To develop the basic understanding of laser for gaining advance knowledge in the field of optical communication and opto-electronics.

CO 5 : The Concepts of Optical Fiber for modern developments in physics which are helpful in designing and developing new devices used in optical communications,medicine, environment, Industries and related physics.

Unit No.	Topics
Unit-I	Relativity: Special Relativity, Lorentz Transformations, Velocity addition, Time dilation, Length Contraction, Variation of mass with velocity, Mass and energy, Relativistic momentum and relativistic energy, General theory of relativity, Einstein's theory of Gravitation, Gravitational waves, Gravity and Light.
Unit-II	Oscillations and Waves: Damped and forced oscillations, Sharpness of resonance, Q-factor, Application in resonance, Acoustic waves, Pressure wave equations, Intensity pressure relation, Acoustic impedance, Reflection and transmission of acoustic waves, Impedance matching; Ultrasonics and its applications.

Unit-III	Optics: Interference: Interference due to thin films, Newton's rings, and determination of the wavelength of sodium light, Interference due to wedge shaped film. Diffraction: Fraunhofer diffraction due to single slit and N Slits, Plane transmission grating, Rayleigh criterion of resolution, Resolving power of a grating, Polarization: Polarization in light, Birefringence, Nicol prism, Quarter and half wave plates, Production and analysis of plane, Circularly and elliptically polarized light, Optical rotation, specific rotation,Polarimeter
Unit-IV	Lasers: Absorption and emission of radiation, Main features of a laser, Spatial and temporal coherence, Einstein Coefficients, condition for light amplification, Basic requirement for Laser, Population Inversion - Threshold Condition, Line shape function, Optical Resonators, Three level and four level systems. Classification of Lasers: Solid State Laser-Ruby laser and Gas Laser- He-Ne laser (Principle, Construction and working), Optical properties of semiconductor, Semiconductor laser (Principle, Construction and working), Applications of lasers in the field of medicine, Industry, Environment and Communication.
Unit-V	Fibre Optics: Need for fiber Optic Communication, Physical nature of Optical fiber, Theory of Light propagation in optical fiber, Acceptance angle and numerical aperture, Step index and graded index fibers, Single mode and multimode fibers, Losses in optical fiber, Optical Fiber cables and bundles, Dispersion in optical fibers: Intermodal and Intermodal dispersion

Suggested Readings:

1. Arthur Beiser, Shobhit Mahajan, `` Concepts of Modern Physics," Mc-GrawHill
2. D S Mathur, ``Mechanics," S Chand &co.
3. N. Subramaniam and Brij Lal, ``A Text Book of Optics," S Chand&Co.
4. A K Jha "A Text Book of Applied Physics, Volume-1" I.K. International Publishing House.
5. Indu Prakash, ``A Text Book of Practical Physics, Volume-1," Kitab MahalPublication.
6. Serwey, Moses, Moyer, ``Modern Physics," CengageLearning
7. Jenkins and White, ``Fundamentals of Optics," McGrawHill
8. Ajay Ghatak "Optics" McGrawHill

Course No.	Title of the Course	Course Structure	Prerequisite
FCHS005	Core English	3L 0T 2P	None

Course Outcomes

CO 1: Acquire competence in Basic English grammar. Grammatical accuracy, avoiding inappropriacy and using language naturally and confidently

CO 2: Improve in the four integral skills of language and to be able to use language as a tool for effective communication

CO 3: Enable the learner to express and be understood by others with clarity and precision, in both written and spoken forms, minimizing ambiguity and verbosity.

CO 4: Understand creative use of language through translation, articles and paragraph writing.

CO 5: Reading: Encouraging the habit of reading for different purposes and to analyse, paraphrase and read critically.

CO 6: Develop competence in formal Standard English pronunciation and usage

CO 7: Build confidence to use a standard spoken form of English to face jobinterviews, and workplace interactive situations besides enabling the learner to pursue advancedprofessional courses.

Unit No.	Theory
Unit-I	Vocabulary Enhancement CO 1 Using a standard dictionary- word spellings, meanings, usage, pronunciation, making sentences. Word collocations. Commonly misused words, verbal reasoning. One word substitutions. Abbreviations & foreign phrases
Unit-II	Remedial & Applied Grammar CO1 & CO 2 Tenses & Voice, Subject-Verb Agreement, Narration,Interrogative structures and Question tags, Prepositions, Pronouns and Adverbs, Redundancy, Idiomatic use of language, Identification of errors and editing
Unit-III	3 Techniques of Good Writing CO 5 & CO 2 & 3 3.1Writing self assessment tasks 3.2 Precis writing and note-making. 3.3 Paragraph and Essay writing. 3.4 Article writing and summarizing
Unit-IV	4. Business Communication: CO 4 & CO 3 4.1 Formal and Informal Letter writing 4.2 Statement of Purpose 4.3 Job application & CV (summary statement of academic & professional profiles) 4.4Power point presentations through relevant slides.
Unit-V	5.Written Comprehension CO 3 & 4 5.1 The ability to write after listening to and reading select speeches, news bulletins, presentations and answering questions based on what has been heard. 5.2 Reading the given texts to skim, scan, infer and answer comprehension questions. 5.3 Reading texts like case studies and project reports for critical assessment. 5.4 Book Review

Course No	Title of the Course	Course Structure	Pre-Requisite
FCME006	Basics of Mechanical Engineering	3L-1T-0P	None

COURSE OUTCOMES:

After completion of this course, the students are expected to be able to demonstrate the following knowledge, skills and attitudes:

CO 1 : To know force, its nature and applications.
CO 2 : To know the basic principles of civil and mechanical structures.
CO 3 : To understand the fundamentals of thermodynamics and fluid mechanics.
CO 4 : To know the working principles of IC Engines.
CO 5 : To understand the importance of different engineering materials.
CO 6 : To understand the different manufacturing processes and machining operations.
CO 7 : To know the use of Automation in manufacturing.

Unit Nos	Topics
Unit-I	Introduction to Engineering Mechanics: Rigid and Elastic bodies, Force and its type, Law of parallelogram of forces, Triangle law of forces, Polygon law of forces, Lami's theorem, Laws of motion, Moment, Couple, Varignon's theorem, Conditions of equilibrium, Concept of free body diagram, Coulomb's friction, Plane trusses, Analysis of trusses, Numerical problems
Unit-II	Introduction to Strength of Materials: Simple stresses and strains, Direct, shear, and volumetric stresses and strains, Hooke's law, Tension test, Elastic constants, Poisson's ratio, Factor of safety, Introduction to beam, Types of beams, Types of loads, Shear force and bending moment diagrams (SFD and BMD) for Simple and Cantilever beams under various loading conditions, Numerical problems
Unit-III	Introduction to Manufacturing Engineering: Classification and use of engineering materials, Basic principles and applications of methods of manufacturing such as casting, forming and joining; Working principles and applications of machining operations such as Turning, Thread cutting, Milling, Shaping, Grinding, etc., Use of automation in manufacturing
Unit-IV	Introduction to Thermodynamics: Thermodynamic system, Cycle, Path, Thermodynamic properties, Extensive and intensive properties, Thermodynamic equilibrium, Reversible and irreversible processes, isochoric, Isothermal, Isobaric, Isentropic and Polytropic processes, First law of thermodynamics applied to a cycle and process, Kelvin-Planck and Clausius statements of Second law of thermodynamics, Carnot cycle, Entropy, Clausius inequality, Internal combustion (IC) engines, IC engines terminology, Spark ignition (SI) and Compression ignition (CI) engines, Two and four stroke engines, Air standard cycles such as Otto, Diesel, Dual and Brayton cycles, Numerical problems.
Unit-V	Introduction to Fluid Mechanics: Properties of a fluid, Density, Specific volume, Specific weight, Specific gravity, Kinetic and Kinematic viscosity, Pascal's law and its applications, Laminar and turbulent flow, Use of continuity equation and Bernoulli's equation, Numerical problems.

SUGGESTED READINGS:

1. Engineering Mechanics- Beer and Johnston, Pearson
2. Strength of Materials- D.K. Singh, CRC Press
3. Engineering Thermodynamics- Nag, McGraw-Hill
4. Fluid Mechanics- Cengel, McGraw-Hill
5. Fundamentals of Manufacturing Engineering- D.K. Singh, CRC Press

Course No.	Title of the Course	Course Structure	Pre-Requisite

FCMT007	Mathematics II	3L-1T-0P	None

COURSE OUTCOMES (CO)

CO 1 : Ordinary Differential Equations,
CO 2 : Partial Derivatives, Maxima and Minima for functions of two or more variables,
CO 3 : Evaluation of double and triple integral,
CO 4 : Concept of Numerical Methods and its Applications,
CO 5 : Concept of Probability and Statistics and its Applications.

Unit Nos	Topics
Unit-I	Ordinary Differential Equations: Second & higher order linear differential equation with constant coefficients, general solution of homogenous and non-homogenous equations, Euler-Cauchy equation, Series solution by Frobenius method.
Unit-II	Function of Several Variables: Partial Derivatives, Euler's Theorem, Total differentiations, Change of Variables, Jacobian and its basic properties, Taylor's theorem, Maxima and Minima for functions of two or more variables, Lagrange's method of undetermined multipliers. Multiple Integrals: Evaluation of double integral (in Cartesian and polar co-ordinates), change of order of integration, change of variables. Triple integral (in Cartesian) and its applications. Gamma and beta function.
Unit-III	Numerical Methods: Solution of system of linear equations using Gauss elimination method, LU decomposition method Gauss Seidel iteration method, Solution of polynomial and Transcendental equations by Newton-Raphson method, NumericalIntegration by trapezoidal rule and Simpson's 1/3 and 3/8 rule, NumericalSolutions of first order ordinary differential equations: Euler's method, Runge-Kutta method of fourth order.
Unit-IV	Probability and Statistics: Conditional probability, Random Variables, Probability distributionfunctions-binomial, Poisson, exponential, uniform and normal distributions; Correlation, rank correlation and regression analysis; Sampling Theorem.

SUGGESTED READINGS:

1. Calculus and Analytic Geometry by G.B. Thomas (Pearson Education)
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Publication)
3. Advanced Engineering Mathematics by Michael Greenberg (Pearson Education)
4. Advanced Engineering Mathematics by R. K. Jain and S.R.K. Iyenger (Narosa Publication)
5. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication)
6. Probability and Statistics for Engineers by Anthony J. Hayter (Cengage Learning)
7. Numerical Methods for Scientific and Engg. Computations by M. K. Jain, S. R. K. Iyenger and R. K. Jain, (Wiley Eastern Ltd.)

4.2 FOUNDATION ELECTIVE & OPEN ELECTIVE COURSES

Syllabi of foundation elective & open elective courses are compiled in Part B of the scheme of courses and examination for the Bachelor of Technology Programme

4.3 PROGRAM CORE COURSES

4.3.1 LIST OF PROGRAM CORE COURSES

Pre-requisites/ Equivalent courses information may be used by students opting for the course as EG.

SEM.	Code	Name of Core Course	L T P			Pre-Requisite Courses		Equivqlent Course Codes	Page No
			L	T	P	Course Code	Course Name		
II	ITECC01	Digital Logic Design	3	0	2			COECC03, CAECC03, CDECC03, ECECC08, EEECC08, ICECC08	
	ITITC02	Data Structures	3	0	2			BTITC05, COCSC02, CACSC02, CDCSC02, CMCSC03, ECITC03, EIITC03, EECSC05, ICCSC05	
	ITITC03	Discrete Structures	3	1	0			COCSC01, CACSC01, CDCSC01, CMCSC02	
III	ITMTC04	Optimization principles and Techniques	3	1	0				
	ITITC05	Data Base Management System	3	0	2			COCSC05, CACSC05, CDCSC05, CMCSC05, EECSC09, ICCSC09	
	ITECC06	Probability and Stochastic Processes	3	1	0			CMMTC08, COMTC13, CAMTC13, CDMTC13, ECECC06	
	ITITC07	Computer System Organization	3	1	0	ITITC02	Data Structures	COCSC07, CACSC07, CDCS07, CMCSC07, ECECC12	

	ITITC08	Computer Graphics	3	0	2	ITITC02	Data Structures	---	
IV	ITITC09	Operating System	3	0	2	ITITC02	Data Structures	COCSC09, CACSC09, CDCSC09, CMCSC09	
	ITITC10	Design and Analysis of Algorithm	3	0	2	ITITC02	Data Structures		
	ITITC11	Software Engineering	3	1	0			COCSC11	
	ITITC12	Computer Networks	3	0	2	ITITC02	Data Structures	ECECC19, COECC12, CAECC12, CDECC12	
	ITECC13	Analog and Digital Communication	3	0	2			ECECC13, ECECC14	
V	ITITC14	Theory of Computation	3	1	0	ITITC03	Discrete Structures	COCSC10, CACSC10, CDCSC10,CMCSC10	
	ITITC15	Number Theory and Cryptography	3	0	2				
	ITITC16	Artificial Intelligence	3	0	2	ITITC10	Design and Analysis of Algorithm	CACSC11, ECCSC11	
	ITITC17	Mobile Computing	3	0	2	ITITC12	Computer Networks		
VI	ITITC18	Web Technology	3	0	2	ITITC02	Data Structures	COCSC04, CACSC04, CDCSC04	
	ITITC19	Network and networking devices W/S	2	0	4	ITITC12	Computer Networks		
	ITITC20	Compiler and Translator Design	3	0	2	ITITC14	Theory of Computation	COCSC14, CACSC14	

4.3.2 SYLLABI OF PROGRAM CORE COURSES : II SEMESTER

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC02	Data Structures	4	3L-0T-2P	None

COURSE OUTCOMES:
CO 1: Understand and remember algorithms and its analysis procedure.
CO 2: Illustrate the concept of data structures through ADT including List, Stack, Queues.
CO 3: To design, implement and compare various data structure algorithms.
CO 4: To select appropriate data structure for representation of the data in the real world.
CO 5: To formulate new solutions or improve existing applications using data structure algorithms.

Unit No.	Topics
Unit 1	Introduction to data structure: Arrays, Stacks and Queues: Fundamentals and Representations, Applications of Arrays, Stacks and Queues, Sparse Matrices, Space and time complexity of algorithms.
Unit 2	Linked lists: Singly/Linear Linked lists, Linked list implementation of Stacks and Queues, Doubly and Circular Linked Lists, Applications.
Unit 3	Trees: Binary Trees, B-Trees, N-ary Trees, B+Trees, Tree Traversals, infix to post fix conversion, construction of tree from preorder and inorder notation, Storage of Trees, Threaded trees, AVL trees, Red and Black trees, Application of Trees, Hashing, Heaps: Types of heaps, minheap, maxheap, double heap.
Unit 4	Graphs: Types, Terminology and Representations, Graph Traversals, Applications of Graphs.
Unit 5	Searching and Sorting: Sequential and Binary Searching, Search trees, Sorting Techniques.

Suggested Readings:
1. E. Horowitz and S. Sahani, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein "Introduction to Algorithms", 3rd Edition, The MIT Press Cambridge , Massachusetts London, England McGraw-Hill Book Company.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", Addison-Wesley.
4. Schaum's Outline Series, "Data Structure", TMH, Special Indian Ed., Seventeenth Reprint.
5. Y. Langsam et. al., "Data Structures using C and C++",PHI
6. N. Dale and S.C. Lilly, D.C. Heath and Co., "Data Structures"
7. R. S. Salaria, Khanna, "Data Structure & Algorithms", Book Publishing Co. (P)Ltd..
8. Richard F. Gilberg and Behrouz A. Forouzan, "Data Structure A Pseudocode Approach with C", Cengag Learning, 2nd Ed.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC03	Discrete Structures	4	3L-1T-0P	None

COURSE OUTCOMES:
CO1: Define the notion of mathematical thinking, mathematical proofs and algorithmic thinking.
CO2: Describe an understanding of relations and functions and able to determine their properties.
CO3: Apply counting principles to determine probabilities.
CO4: Evaluate a proof and give examples of each proof technique described.
CO5: Design problems in Computer Science using graphs and trees.

Unit No.	Topics
Unit 1	Set Theory: Introduction, set operations, algebra of sets, duality, Finite sets and multisets, counting principles, power set, partitions, Mathematical Induction, Principle of inclusion and exclusion.
Unit 2	Logic and Propositional Calculus: Propositions and compound statements, basic logical operations, truth tables, propositional functions, normal forms, tautology and contradiction, conditional and bi conditional statements, algebra of propositions, logical equivalence, arguments, quantifiers, predicate logic.
Unit 3	Relations: Introduction, Cartesian product, types of relations, closure, representation and composition of relations, POSETS. Functions: Introduction, types of functions, recursively defined functions, Pigeonhole principle.
Unit 4	Boolean Algebra: binary relations and their representations, binary operations, duality, semi groups, monoid, groups, rings, homomorphism and isomorphism, CNF and DNF, K-Maps.
Unit 5	Hasse diagrams and Lattices. Combinatorics: Permutation, combinations, recurrence relations. Graph Theory: Elementary graph theory, Euclidean and Hamilton paths and circuits, shortest

	path algorithm, Minimum Spanning Trees, coloring graphs, digraphs.

Suggested Readings:

1. C. L. Liu "Elements of Distcrete Mathematics", McGrawHill
2. J.P. Trembley and R. Manohar, Discrete Mathematical Structures with Application to Computer Science, McGraw-Hil
3. S. Lipschutz and M. Lipson (Schaum`s Series) "Discrete Mathematics" McGraw-Hill.
4. Robin J. Wilson, "Introduction to graph theory", 4th edition, Pearson publication.
5. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", PHI.
6. Donglas B. west, "Introduction to graph theory", 2nd Edition.
7. Gary Chartrand and Ping Zhang, "A First Course in Graph Theory", Dover Publications.

4.3.3 SYLLABI OF PROGRAM CORE COURSES : III SEMESTER

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC05	Data Base Management System	4	3L-0T-2P	None

COURSE OUTCOMES:

CO 1 : Identify databases with different types of integrity constraints and use the SQL commands such as DDL, DML to access data from database objects.
CO 2 : Classify subqueries, create indexes and report aggregated data using group functions.
CO 3 : Solve queries and learn to implement SQL Join operations
CO 4 : Implement queries to create and drop views and Simple Triggers using SQL.
CO 5 : Write SQL Query using DCL Statements to GRANT, REVOKE, and TCL statements to COMMIT and ROLLBACK a database structure.

Unit No.	Topics
Unit 1	Introduction to database systems: Overview, File Systems Vs. DBMS, Advantages of DBMS, Levels of Abstraction, Data Independence, Data Models and their comparison (Hierarchical, Network, Relational Model).
Unit 2	Relational Data models: Structure of Relational Database, Integrity Constraints over relations, Enforcing Integrity Constraints, Relational Algebra and Calculus, Introduction to SQL.
Unit 3	Database Design: Top down approach (ER Model), Participation Constraints, Specialization, Generalization and Aggregation, Bottom up approach (Normalization), Normal Forms Based on Primary Keys, (1NF, 2NF, 3NF & BCNF), Transformation of ER Schema to relational tables.
Unit 4	Transactions and File system: Transactions, Typical concurrency problems (The Lost Update Problem, Dirty Read Problem, The Inconsistent Analysis Problem, Non-repeatable Read, Phantom Read), Concurrency Control (Lock based protocols: 2PL, strict 2PL) and Database Recovery, Database Security Introduction to File System, File Organization, File Access Methods, File Storage Devices.
Unit 5	Management Information system: Basic Architecture of MIS, Components of MIS –Reporting styles, frequency, targeted managerial level, software and Hardware. Targeted audience of MIS design and development of MIS for various functional areas: Marketing, finance, purchasing, production, distribution, human resource department, implementation aspects, implementation

	framework, basics, catalysts & change agents.

Suggested Readings:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Tata McGraw Hill.
2. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson / Addision wesley.
3. C.J.Date, A.Kannan, S.Swamynathan, "An Introduction to Database Systems", Pearson Education.
4. Raghu Ramakrishnan, "Database Management Systems", McGraw Hill.
5. S.K.Singh, "Database Systems Concepts, Design and Applications", Pearson Education.
6. James A O'Brien, George M Marakas and Ramesh Behl, Management Information Systems, Tata McGraw Hill Education.
7. Ken Laudon and Jane Laudon and Rajanish Dass, Management Information Systems, Pearson Education.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC07	Computer System Organization	4	3L-0T-2P	None

COURSE OUTCOMES:

CO 1 : Describe the fundamental organization of a computer system.
CO 2 : Explain addressing modes, instruction formats and program control statements.
CO 3 : Understand the basics of hardwired and micro-programmed control of the CPU. Distinguish the organization of various parts of a system memory hierarchy.
CO 4 : Solve elementary problems by assembly language programming. Articulate design issues in the development of processor or other components that satisfy design requirements and objectives.
CO 5 : Compare various I/O devices and the I/O interface. Recognize and perform computations with the functional units of the processor.
CO 6 : Design a computer processor including memory.

Unit No.	Topics
Unit 1	Basic Computer Organization and Design: Register Transfer and Microoperations, Arithmetic Logic Shift Unit, Computer Instructions, Design of Basic Computer, Programming the Basic Computer.
Unit 2	Microprogrammed Control: Address Sequencing, Design of Control Unit, Central Processing Unit, General Register Organization, Stack Organization, Addressing Modes.

Unit 3	Computer Arithmetic: Booth Multiplication Algorithm, Array Multiplier, Division Algorithms, Floating-Point Arithmetic Operations, Decimal Arithmetic Operations.
Unit 4	Input-Output Organization: Asynchronous Data Transfer, Modes of Transfer, Introduction to Interrupts, Priority Interrupt, Direct Memory Access (DMA).
Unit 5	Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management.

Suggested Readings:

1. COMPUTER ARCHITECTURE A QUANTITATIVE APPROACH by HENNESSY, J.L, DAVID A PATTERSON, AND GOLDBERG, PEARSON
2. COMPUTER ORGANIZATION AND ARCHITECTURE-DESIGNING FOR PERFORMANCE by WILLIAM STALLINGS, PRENTICE HALL
3. COMPUTER ARCHITECTURE A QUANTITATIVE APPROACH by HENNESSY, J.L, DAVID A PATTERSON, AND GOLDBERG, PEARSON
4. COMPUTER ORGANIZATION AND ARCHITECTURE-DESIGNING FOR PERFORMANCE by WILLIAM STALLINGS, PRENTICE HALL

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC08	Computer Graphics	4	3L-0T-2P	None

COURSE OUTCOMES:

CO 1 : Explain contemporary graphics hardware; Define computer graphics techniques, focusing on 3D modeling, image synthesis, and Color modeling and rendering.
CO 2 : Classify scan conversion algorithms and use object hierarchy in graphics applications.
CO 3 : Illustrate display systems, image synthesis, shape modeling, and interactive control of 3D computer graphics applications.
CO 4 : Judge their perspective of modern computer system with modeling, analysis and interpretation of 2D and 3D visual information.
CO 5 : Develop interactive graphics applications in C++ using one or more graphics application programming interfaces.

Unit No.	Topics
Unit 1	Introduction to computer graphics: Application areas of computer graphics, Output Devices, Graphical Display Devices, Raster scan Displays, Random scan Displays, Colour Monitors/Displays: mechanism and working principle with concepts like Right handed and left handed coordinate system (RHCS & LHCS), resolution video mode, video memory, video adapter, and display processor, Graphical Printing Devices, Introduction to digital image processing.
Unit 2	Scan Conversion: Point generation: Representation of an image, Line – drawing: symmetric DDA, Simple DDA, Bresenham's line algorithm, Circle Drawing: General methods, symmetric DDA, Bresenham's circle algorithm, Mid-Point Circle Drawing, Ellipse Drawing methods.

Unit 3	Two Dimensional Transformations and Clipping: Geometric Transformation, Coordinate system transformation, Composite transformations and Homogeneous coordinates, Viewing transformations: world coordinate system (WCS), Screen coordinate system (SCS), Window, Viewport, Aspect ratio, Two – Dimensional Clipping, Point clipping and line clipping: Sutherland Cohen algorithm, Mid-point subdivision algorithm, Cyrus-beck algorithm and other methods for clipping line against rectangular and non – rectangular windows, Polygon clipping : Sutherland – Hodgmann algorithm, Curve clipping and text clipping.
Unit 4	Three-Dimensional Object Representation: point, line polygon, curve and surfaces, 3-D Transformations: Translation, Rotation, Scaling, Mirror Reflection etc, Representation of 3 –D object on 2 – D screens, 3-D WCS, Parallel and perspective projection, perspective depth, Need of 3-D screen coordinate system.
Unit 5	Hidden Surface Elimination and Curves & Surfaces: Z-buffer, Scan line algo, Shape description requirements, Parametric curves, Beizer Curves, B- Spline methods. Illumination & Shading: Reflection, Phong & Gourond Models, Color Models: Achromatic light RGB, CMY, YIQ, HSV, and HLS color models, Rendering, Animation Techniques.

Suggested Readings:

1. Foley et. al., “Computer Graphics Principles & practice”, Addison Wesley.
2. D. Hearn and P. Baker, “Computer Graphics”, Prentice Hall.
3. D. Rogers and J. Adams, “Mathematical Elements for Computer Graphics”, McGraw-Hill International Edition.
4. R. Plastock and G. Kalley, “Theory and Problems of Computer Graphics”, Schaum’s Series, McGraw Hill.
5. David F. Rogers, “Procedural Elements for Computer Graphics”, McGraw Hill Book Company.
6. https://www.pearson.com/us/higher-education/program/Gonzalez-Digital-Image-Processing-4th-Edition/PGM241219.html

4.3.4 SYLLABI OF PROGRAM CORE COURSES : IV SEMESTER

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC09	Operating system	4	3L-0T-2P	None

COURSE OUTCOMES:

CO 1 : Describe the general architecture of computers and explain different structures for operating systems.
CO 2 : Summarize the services provided and the design of an operating system.
CO 3 : Relate the different concepts behind processes (scheduling algorithms, inter- process communication, deadlock, synchronization among processes) and correlate the structure and organization of the file system
CO 4 : Appraise the advantages of virtual memory and different approaches to memory management techniques.
CO 5 : Design programs based on operating system services and functionalities.

Unit No.	Topics

Unit 1	Introduction: What is an Operating System, Types of OS: Classification on the basis of Performance, Open Source Operating System and Proprietary Operating System, Mobile, Web, Server and Computer OS, their advantages and disadvantages. Processes: Definition of process, process states, PCB, process scheduling, inter-process communication, threads.
Unit 2	CPU Scheduling: Basic concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling. Deadlocks: System Model, Starvation, deadlock characterization, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.
Unit 3	Process Synchronization: Critical-Section Problem, Solutions to synchronization-software approach, hardware approach, support from OS and complier (Semaphores), Classical Problems of Synchronization.
Unit 4	Memory Management: Logical versus Physical Address space, swapping, Contiguous allocation, Paging, Segmentation. Virtual Memory: Demand paging, page replacement, page replacement algorithms, demand paging, allocation of frames, thrashing.
Unit 5	File - System Interface: File concept, access methods, directory structure, file - system structure, allocation methods. Mass Storage Structure: Disk structure, disk scheduling, RAID structure.

Suggested Readings:

1. Silbersachatz and Galvin, “Operating System Concepts”, John Wiley, 8th Ed.
2. Milan Kovic., “Operating Systems”, Tata McGraw Hill
3. Deitel, Deitel and Choffnes, “Operating Systems”, Pearson ,3rd Edition
4. Tannenbaum, “Operating Systems”, PHI, 4th Ed.
5. Madnick E. and Donovan J., “Operating Systems”, Tata McGraw Hill
6. Flynn McHoes, “Operating System”, Cengage Learning
7. Sibsankar Halder and Alex A. Aravind, “Operating System”, Pearson
8. William Stallings, “Operating Systems Internals & Design Principles”, Pearson Education, 6th Ed

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC10	Design and Analysis of Algorithm	4	3L-0T-2P	Data Structures

COURSE OUTCOMES (COs)

CO1: Understand the complexity of algorithms with regard to their run time and space time.

CO2: Analyze the asymptotic performance of algorithms.

CO3: Write rigorous correctness proofs for design of algorithms.
CO4: Apply suitable algorithmic design paradigms and methods of analysis.
CO5: Synthesize efficient algorithms in engineering applications.

Unit No.	Topics
Unit 1	Introduction: Fundamentals of the Analysis of Algorithmic. Performance Analysis-Space complexity, Time complexity, Efficiency –Asymptotic Notations and their properties. Mathematical analysis for Recursive and Non-recursive algorithms.
Unit 2	Brute Force and Divide & Conquer: Brute Force – Computing. Exhaustive Search. Divide and Conquer Methodology – Binary Search – Merge sort – Quick sort. Multiplication of Large Integers and Matrix Multiplication.
Unit 3	Greedy Technique and Dynamic Programming: Greedy Technique –0/1 Knapsack problem, Optimal Merge pattern – Huffman Trees. Prim's algorithm and Kruskal's Algorithm. Dynamic programming – Principle of optimality. All pair shortest paths, Floyd's algorithm, Matrix chain multiplication, 0/1 knapsack problem and Optimal Binary Search Trees. .
Unit 4	Backtracking and Branch & Bound: Backtracking – n-Queen problem – Hamiltonian Circuit Problem – Subset Sum Problem. Branch and Bound – LIFO Search and FIFO search – Knapsack Problem – Travelling Salesman Problem
Unit 5	NP-Hard and NP-Complete problems: Basic concepts, Non deterministic algorithms, NP – Hard and NP Complete classes, Cook's theorem.

SUGGESTED READINGS:

1. Introduction to Algorithms by Thomas H. Coreman, Charles E. Leiserson and Ronald L. Rivest.
2. Fundamentals of Computer Algorithms by E. Horowitz & S Sahni.
3. The Design and Analysis of Computer Algorithms by Aho, Hopcraft, Ullman.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC11	Software Engineering	4	3L-1T-0P	None

COURSE OUTCOMES:

CO 1 : Define the fundamental concepts of Software engineering.
CO 2 : Compare and Contrast various process models for development of software applications.
CO 3 : Use different conceptual modeling techniques for information system design (including ER Diagrams, DFDs)
CO 4 : Implement logic modeling techniques (decision tree/table, structured English), and illustrate the

managerial issues involved in SA & D

CO 5 : Design test cases using software testing techniques.

Unit No.	Topics
Unit 1	Introduction: Introduction to software Engineering, Need of Software Engineering, Software characteristics, Software development life-cycle models: Build and Fix, Water fall model, V-model, Prototyping model, Incremental model, Iterative enhancement Model, RAD model, Spiral models, Comparison of the models, Introduction to Agile methodology and Design for Software Engineering.
Unit 2	Requirement Engineering: Software Requirement Analysis and Specification: Requirements Elicitation Techniques, Requirements analysis, Models for Requirements analysis, requirements specification, requirements validation, ER diagrams, data flow diagrams, Data Dictionaries, Functional and non-Functional requirements, Software Requirement Specification (SRS).
Unit 3	System Design: Design Principles: Problem partitioning, Software Design: Modularity, Cohesion & Coupling, Classification of Cohesiveness & Coupling, Design Strategies, Function Oriented Design, Object Oriented Design, User Interface Design, structured analysis, extending DFD to structure chart.
Unit 4	Software project Management: Project planning and Project scheduling. Software Metrics: Size Metrics like LOC, Token Count, Function Count. Cost estimation using models like COCOMO, Risk Analysis and Risk Management. Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, software quality metrices, ISO 9000 certification for software industry, SEI CMM.
Unit 5	Software Testing: Software Testing process and Terminologies, Verification and Validation, White box testing, Black box testing, Level of testing: Unit, Integration Testing, System Testing, Acceptance testing, Regression Testing, Mutation testing, Testing Tools and Standards, Introduction to continuous testing and deployment. Software Maintenance: Management of Maintenance, Maintenance Process, Maintenance Models, Reverse Engineering, Software Re-engineering, Configuration Management, Documentation, Introduction to CASE tools and CASE shells, CASE Tool architectures, Introduction to continuous integration and maintenance.

Suggested Readings:

1. K. K. Aggarwal and Yogesh Singh, “Software Engineering”, New Age International.
2. R. S. Pressman, “Software Engineering – A Practitioner’s Approach”, McGraw Hill Int. , 5th Ed.
3. Pankaj Jalote, “An Integrated Approach to Software Engineering”, Narosa, 3rd Ed.
4. Stephen R. Schach, “Classical & Object Oriented Software Engineering”, IRWIN,
5. James Peter, W. Pedrycz, “Software Engineering: An Engineering Approach”, John Wiley & Sons.
6. I. Sommerville, “Software Engineering”, Addison Wesley,8th Ed.
7. Frank Tsui and Orlando Karan, “Essentials of Software Engineering”, Joes and Bartlett,
8. Kassem A. Saleh, “Software Engineering”, Cengage Learning
9. Rajib Mall, “Fundamrntal of Software Engineering”, PHI, 3rd Ed.
10. Carlo Ghizzi , Mehdi Jazayeri and Dino Mandrioli, “ Fundamental of Software Engineering”, PHI.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC12	Computer Networks	4	3L-0T-2P	None

COURSE OUTCOMES:

CO 1 : Describe the basic computer network technology, data communications system and its components.
CO 2 : Classify the different types of network topologies and protocols. Compare and summarize the functioning of the layers of the OSI model and TCP/IP protocol suit.
CO 3 : Discover various types of MAC protocols and their function.
CO 4 : Analyze techniques/algorithms to solve different layers problems and issues in computer networks.
CO 5 : Design the protocols and services for different layers of OSI model.

Unit No.	Topics
Unit 1	Introductory Concepts: Introduction to Computer Networks, Goals and Applications of networks, OSI Reference Model: A Layered Approach, Introduction to TCP/IP Protocol Suite. Connecting Devices: Hubs, Repeaters, Bridges, Two-Layer Switches, Routers, Three-Layer Switches, Gateway. Physical Layer: The Physical Layer, Network structure and architecture, services, networks topology. Transmission Media - Guided and Unguided, Switching- Circuit Switching, Packet Switching- Virtual Circuits and Datagram Approach, Message Switching.
Unit 2	The Data Link Layer: Data Link Layer Design Issues, Framing, Error Detection and Correction Techniques e.g Parity, CRC, Checksum, Hamming Code etc., Flow Control Protocols, Stop-and-wait Flow Control, Sliding – Window Flow Control, Error Control, Stop-and-wait ARQ, Go-back-N, Selective-repeat, Data Link Protocols- HDLC. Medium Access Sub Layer: Channel allocations, ALOHA Protocols (Pure and Slotted), Carrier Sense Multiple Access Protocols (persistent and non-persistent etc.), CSMA with Collision Detection, CSMA/CA, Collision free protocols, IEEE Standards- Ethernet, Token Bus and Token Ring.
Unit 3	Network Layer: Routing algorithms (Link state, Distant Vector etc.), IP addressing (Classful and Classless), subnetting, IPv4 frame format and functions, IPv6, Congestion Control Algorithms, Packet discarding, Choke packets, Congestion prevention policies, Traffic shaping, Leaky bucket algorithm, Token bucket algorithm, Quality Control.
Unit 4	Transport Layer: Design Issue, Connection management, User Datagram Protocol, TCP Services, TCP Features, TCP window management, TCP frame format and functions.
Unit 5	Application Layer: Application Layer Protocols, DNS, Electronic Mail, WWW, FTP, Telnet.Network Security: Introduction to network security, Message Confidentiality, Message Integrity, Message Authentication, Message Non Repudiation, Digital signature, and Entity Authentication.

SUGGESTED READINGS:

1. Forouzan, “Data Communication and Networking”, TMH, 4th Edition.
2. A.S. Tanenbaum, “Computer Networks”, PHI, 4th Edition.
3. W. Stallings, “Data and Computer Communication”, Macmillan Press.
4. Comer, “Computer Networks and Internet”, PHI.
5. Comer, “Internetworking with TCP/IP”, PHI.
6. W. Stallings, “Data and Computer Communication”, McMillan.
7. J. Martin, “Computer Network and Distributed Data Processing”, PHI.
8. W. Stallings, “Local Networks”, McMillan.
9. M. Schwertz, “Computer Communication Network Design and Analysis”, PHI.
10. S. Keshav, “An Engineering Approach to Computer Networking, Pearson”

4.3.5 SYLLABI OF PROGRAM CORE COURSES : V SEMESTER

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC14	Theory of Computation	4	3L-1T-0P	Discrete Structures

COURSE OUTCOMES:

CO 1 : Describe the Finite Automata, their capabilities and limitations.
CO 2 : Classify the different types of grammars, languages and machines.
CO 3 : Discover the equivalence of languages described by finite state machines and regular expressions.
CO 4 : Analyze the problem-solving situations in related areas of theory of computer science.
CO 5 : Design the FA, CFG, Push Down Automata and Turing recognizable languages.

Unit No.	Topics
Unit 1	Finite Automata: Introduction to Automata Theory, Use of Automata, Characteristics of Automaton, Alphabets, Strings & Languages, Finite Automata (FA), Graphical and Tabular Representation FA, Deterministic finite Automata (DFA) & Nondeterministic finite Automata (NDFA), Conversion of NDFA to DFA, Minimization of Finite Automata, NFA with ε (null) Move, Moore and Mealy machine and their equivalence, Limitations of Finite Automata.

Unit 2	Regular expressions and languages: Regular Expressions and Regular Languages, Operations on Regular Expression, Identities of Regular Expression, The Arden's Theorem, Kleen's Theorem, Regular Expression to Finite Automata, Equivalence of Two Regular Expressions, Closure Properties of Regular Languages, Pumping Lemma for regular Languages.
Unit 3	Grammar and Language: Definition of Grammar, Derivations from a Grammar, Types of Grammars, Regular and Linear Grammar, FA to Regular Grammar, Regular Grammar to FA, Context free grammar, Derivation and parse tree, Ambiguity in Context-free Grammar, Simplification of Context Free grammar, Normal forms for CFGs: Chomsky Normal Form & Greibach Normal Form, Pumping Lemma for Context Free languages.
Unit 4	Pushdown Automata: Push Down Automata (PDA), languages of PDA, Graphical Notation for PDA, Acceptance by a PDA: Empty stack, Final state, Deterministic PDA, Non-Deterministic PDA, Construction of PDA from CFG, Construction of CFG Equivalent to PDA.
Unit 5	Turing Machine: Basics of Turing Machine (TM), Instantaneous Description (ID) of TM, Transitional Representation of Turing Machine, Regular Expression to Turing Machine, Nondeterministic Turing Machines, Linear Bounded Automata, Recursive and recursively enumerable languages, Computability and Decidability, Halting problem.

Suggested Readings:

1. Hopcroft, John E.; Motwani, Rajeev; Ullman, Jeffrey D "Introduction to Automata Theory, Languages, and Computation", Third Edition, Pearson.
2. John C. Martin. "Introduction to Languages and Theory of Computations", TMH.
3. K.L.P. Mishra, "Theory of Computer Science. Automata, Languages and Computation. Third Edition", PHI.
4. PETER LINZ, "An Introduction to FORMAL LANGUAGES and AUTOMATA", Fifth Edition, Jones & Bartlett Learning
5. Sudkamp Thomas, "Languages and Machines: An Introduction to the Theory of Computer Science", Peason Addison Wesley
6. Sipser, Michael, "Introduction to the theory of Computation", Third Edition, Cengage.
7. Papadimitrou, C. and Lewis, C.L., "Elements of the Theory of Computation", PHI

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC15	Number Theory and Cryptography	4	3L-0T-2P	None

COURSE OUTCOMES:

CO 1 : To build a solid mathematical basis to understand foundations of cryptography
CO 2 : To understand the traditional and modern symmetric key ciphers
CO 3 : To understand the public key cryptographic algorithms
CO 4 : To understand the notions related to integrity, authentication and privacy

Unit No.	Topics
Unit 1	Elementary Number Theory: Groups, Rings, Finite Fields, Modular Arithmetic, Matrices, Linear Congruence, Efficient Algorithms for Modular Arithmetic, Fermat's Little Theorem, Euler's Criteria, Euler's Totient Function
Unit 2	Advanced Number Theory: Primality Testing, Prime Factorization, Chinese Remainder theorem, Quadratic Congruence, Exponentiation and Logarithm, Legendre and Jacobi Symbols
Unit 3	Classical Symmetric-Key Ciphers: Basic Cryptographic Concept, Caesar Cipher, Affine Cipher, Autokey Cipher, Playfair Cipher, Vigenere Cipher, Hill Cipher, Rotor Cipher, Enigma Cipher, Transposition Ciphers
Unit 4	Modern Symmetric-Key Ciphers: Modern Block ciphers, Structure of a block cipher, Fiestel and Non-Fiestel Ciphers, Modern Stream Cipher, Linear and Differential Cryptanalysis, Blowfish, DES, AES
Unit 5	Public Key Cryptography: RSA, Knapsack, Rabin, ElGamal, Diffie Hellman Key Exchange algorithm, Digital Signatures, Hash Functions and its properties

Suggested Readings:

1. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
2. J.Katz, Y.Lindell, Introduction to Modern Cryptography, Chapman Hall.
3. Wen Bo Mao, Modern cryptography - Theory and practice, Prentice Hall.
4. Douglas Stinson, "Cryptography Theory and Practice", Second Edition, Chapman & Hall/CRC.
5. W. Stallings, "Cryptography and Network Security", Pearson Education

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC16	Artificial Intelligence	4	3L-0T-2P	Design and Analysis of Algorithm

COURSE OUTCOMES:

CO 1 : Distinguish between a conventional system and an intelligent system.
CO 2 : Explain Artificial Intelligence concept and its applications.
CO 3 : Represent knowledge using various different techniques.
CO 4 : Use the appropriate searching techniques in achieving desired goals.
CO 5 : Apply Artificial Intelligent techniques in solving problems of a particular domain

Unit No.	Topics
Unit 1	Foundations in intelligent systems: What is Artificial Intelligence? The AI problems, Underlying assumption, AI technique, Criteria for success, Problems, Problem Spaces and Search Defining problem as a state space search, production systems, problem characteristics, production system characteristics.
Unit 2	AI search techniques: Generate and test, hill climbing, Depth first search, Best first search, best first- A * algorithm, AO* algorithm problem reduction, Tabu search, Simulated annealing, constraint satisfaction, means and ends analysis.
Unit 3	Knowledge Representations: Knowledge representation issues Representations and mappings, Propositional Logic, approaches to knowledge representation, issues in knowledge representation Using Predicate Logic Representing simple facts in logic, representing instance and Isa relationships, computable functions and predicates, resolution, Representing knowledge using rules Procedural vs. declarative knowledge, logic programming, forward vs. backward reasoning, Unification, Forward Chaining-Backward Chaining, Resolution.
Unit 4	Reasoning under un-certainty: Non-monotonic reasoning, Bayesian networks, Fuzzy logic, Introduction to Computing with words, Dempster Shafer theory. Game Playing Overview, Mini-max search procedure, Alpha-beta cutoffs.
Unit 5	Planning and Learning: Planning Overview, blocks world problem, components of planning system, goal stack planning, Inductive learning, decision trees, logical approaches, computational learning theory, Intelligent agents, Natural language understanding.

Suggested Readings:

1. Elain Rich and Kevin Knight- Artificial Intelligence, TMH, 1991.
2. Stuart Russell, Peter Norvig, Artificial intelligence : A Modern Approach, Prentice Hall, Fourth edition, 2020.
3. Nils J. Nilsson, Artificial Intelligence: A New Synthesis, Morgan-Kaufmann, 1998
4. Judea Pearl, Heuristics: Intelligent Search Strategies for Computer Problem Solving, Addison-Wesley Publishing Company, 1984

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC17	Mobile Computing	4	3L-0T-2P	Computer Networks

COURSE OUTCOMES:

CO 1 : To identify and familiarize the basics of wireless and mobile communication and developments towards modern systems.
CO 2 : To classify and extract the propagation characteristics of wireless channels
CO 3 : To provide an overview of 4G LTE and 5G technologies.
CO 4 : To apply and illustrate the concept with the state of art standards used in wireless mobile systems.
CO 5 : To design and evaluate the working of mobile wireless systems.

Unit No.	Topics
Unit 1	Wireless Communication Fundamentals: Introduction, Evolution of Wireless Communication, Applications areas, Switching techniques for Data: Circuit switching, Message Switching and packet Switching in perceptive with mobile communication, Multiplexing in wireless transmission: TDMA, CDMA, SDMA, FDMA, Modulation techniques, Spread spectrum techniques, Cellular systems, Wireless medium access techniques, Hidden terminal problem, Exposed terminal problem, Near and far terminals.
Unit 2	GSM Fundamentals: Introduction, Architecture of GSM, characteristics of GSM standards, services, Radio transmission parameters in GSM System, Applications, Traffic and Logical Channels in GSM, GSM time hierarchy, GSM burst structure, Description of call setup procedure, Handover mechanism in GSM, Security in GSM.
Unit 3	GPRS/ UMTS Fundamentals: GPRS and packet data network, GPRS network architecture, GPRS network operation, data services in GPRS, Applications of GPRS, Billing and charging in GPRS. UTRAN, UMTS core network, UMTS network architecture, UMTS network operation, data services in UMTS, Applications of UMTS.
Unit 4	Recent Mobile Technologies (4G, 5G and above): Overview of LTE: LTE basics, LTE frame structure, LTE Design parameters with Standardization and Architecture of LTE, VOLTE. Overview of 5G Networks: Comparison of 4G and 5G technology, Opportunities and requirements in 5G network, Open Wireless Architecture of 5G network and Disruptive technologies for 5G, Overview of 6G networks.
Unit 5	Communication Protocols for Mobile IP and TCP: IEEE 802.11: System architecture, Protocol architecture, Medium access control layer, MAC management, Bluetooth: Introduction, User Scenario, Architecture, and protocol stack, Mobile IP, TCP protocols for mobile communication, Mobile TCP, Snooping TCP, ITCP.

Suggested Readings:

1. Dr. Jochen H. Schiller, "Mobile communications." Pearson education.
2. Chai K. Toh, "Ad hoc mobile wireless networks: protocols and systems." Pearson Education
3. Asoke K. Talukdar, "Mobile Computing." Tata McGraw-Hill Education.
4. "Wireless Communications & Networks," By William Stallings, Second Edition, Pearson Education
5. Man Young Rhee, "Mobile communication systems and security." John Wiley & Sons.
6. CX Wang, Haider F, Gao X, You XH, Yang Y, Yuan D, Aggoune HM, Haas H, Fletcher S, Hepsaydir E, "Cellular architecture and key technologies for 5G wireless communication networks." IEEE communications magazine 52, no. 2 (2014): 122-130.
7. Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications," Wiley publications.
8. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks," PHI/Pearson Education, 2003.

4.3.6 SYLLABI OF PROGRAM CORE COURSES : VI SEMESTER

Course No	Title of Course	Credits	L-T-P	Pre- Requisites
ITITC18	Web Technology	4	3L-0T-2P	Data Structures

COURSE OUTCOMES:

CO 1 : Familiarize students with the prerequisite primer on the what, how, who & why of the Internet.

CO 2 : Make students comprehend the developments and approaches in the field of Web from three perspectives, namely, Web in Theory, Web in Practice and Web in Research.

CO 3 : To learn multiple concepts, tools and technologies that help developers build a pretty complex yet fascinating dynamic and interactive website.

CO 4 : To help students acquire knowledge and skills for creation and deployment of web sites considering both client and server side programming.

CO 5 : To acquaint students with the recent and dynamic research trends and studies for efficient and effective resource and knowledge discovery on the Web.

Unit No.	Topics
Unit 1	Internet: The Giant WAN; Communicating over the Internet (Protocol Layering, Internet Addressing); Accessing the Internet (Internet Configuration, Web Browser: privacy browser, brave browser, chromium, TOR); Internet Organizations; Cyber Ethics; Internet Services (Electronic Mail, File Transfer, Real-time User Communication (Webrtc), Remote Login, SSH, Usenet
Unit 2	The World Wide Web; The Working of Web; Web Terminology (Web page, Website, Web Apps, Web Service); Web Architecture; World Wide Web Challenges; Evolution of Web (Web 1.0, Web 2.0, Web 3.0); Web Information Retrieval (Web IR); Web IR Tool; Web IR Architecture (Search Engine Architecture); Web IR Performance Metrics.
Unit 3	Hypertext Transfer Protocol (HTTP); HTTP Version; HTTP Connections (Non-Persistent HTTP, Persistent HTTP); HTTP Communication (Handshaking ; Request Message; Response Message); Hypertext Transfer Protocol Secure (HTTPS); HTTP State Retention: Cookies; HTTP Cache (Cache Consistency), Letsencrypt

Unit 4	Elements of Web Development; Client Side and Server-side scripting; Model-View-Controller Architecture; Client-side Technologies(HTML, CSS, JavaScript, JavaScript Frameworks, react.js, vue.js and angular.js, jquery); Server-side Technologies (PHP, Python, python and python based frameworks, node.js, scala, Haskell, Golang); Web Application Frameworks (Django, Flask), Web Databases (RDBMS like MySQL, MongoDB, NoSQL, columnar, neo4j graph database), hosting a web project on public cloud like AWS, GCP, Azure
Unit 5	Research Trends in Web; Web Mining; Social media analytics, Sentiment Analysis, Recommender systems, Information pollution on web (Misinformation-disinformation)

SUGGESTED READINGS:

1. Web Technology: Theory and Practice by Akshi Kumar, CRC Press, Taylor and Francis Group, A Chapman & Hall Book, 2018.
2. Internet and Web Technologies by Raj Kamal, Tata McGraw Hill edition.
3. Web Technologies by Uttam K. Roy, Oxford University Press
4. HTML: A Beginner's Guide by Wendy Willard, Tata McGraw-Hill
5. Programming World Wide Web, Sebesta, Pearson
6. Internet and Worldwide Web Programming, Deitel and Deitel, Pearson

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC19	Network and networking devices Workshop	4	2L-0T-4P	Computer Networks

COURSE OUTCOMES:
CO 1 : To gain conceptual understanding of networks.
CO 2 : To understand the principles and architectures of various networks.
CO 3 : To analyze, design and develop recent network solutions.
CO 4 : To discover various challenges and issues faced in networks.
CO 5 : To model and simulate various types of networks.

Unit No.	Topics
Unit 1	Network Management Techniques & Cisco IOS: Basic commands, Configuring CISCO routers and switches, VLANs, Document a network, Monitor traffic loads, Use diagnostic tools, Set-up a TFTP server to back-up IOS images.
Unit 2	Network Devices: Hub, Repeater, Bridges, Layer-Two Switches, Routers, Layer-Three Switches, Gateway, Network Connectors and cables.
Unit 3	Wireless Network Devices: Wifi Devices, Bluetooth devices, Wimax, Wifi Router, Zigbee.
Unit 4	Recent Trends in Networks: Definition & Characteristics, Applications, Challenges and Issues, Physical Design and Logical Design, Functional Blocks, Security Concerns, performance concerns.
Unit 5	Network Simulators Introduction to Simulators: Cisco Packet tracer, NS3, ONE, OMNET++, MiniNet, Scilab, Octave,

	open source simulators.

Suggested Readings:

1. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri. Internet of Things: Architectures, Protocols and Standards, 1st edition, Wiley Publications, 2019.
2. Arsheep Baga and Vijay Madisetti, Internet of Things: A Hands-On Approach, 1st Edition, Universities press, 2015
3. Donald Norris, The Internet of Things: Do-It-Yourself Projects with Arduino, Raspberry Pi, and BeagleBone Black, 1st edition, McGraw Hill Education, 2015
4. Anshul Verma, Pradeepika Verma, Sanjay Kumar Dhurandher, Isaac Woungang, Opportunistic Networks Fundamentals, Applications and Emerging Trends, CRC Press, 2021, ISBN 9780367677305.
5. Khaleel Ahmad, Nur Izura Udzir, Ganesh Chandra Deka, Opportunistic Networks Mobility Models, Protocols, Security, and Privacy, CRC Press, 2018, ISBN 9780429453434

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITC20	Compiler and Translator Design	4	3L-0T-2P	Theory of Computation

COURSE OUTCOMES:

CO 1 : To explain the compiler architecture and its phases.
CO 2 : To understand patterns, tokens & regular expressions for lexical analysis
CO 3 : To design and implement top down and bottom parsers
CO 4 : To design syntax directed translation schemes for a given context free grammar.
CO 5 : To generate intermediate code for statements in high language
CO 6 : To apply the different optimization techniques to have a better code for code generation

Unit No.	Topics
Unit 1	Introduction, Difference Between a Compiler and an Interpreter, Phases of a Compiler, Lexical Analysis, Languages, Finite Automata, Regular Definitions, Regular Expressions, Thompson's Construction, Converting a NFA to DFA, DFA minimization, Regular Expression to DFA, Lexical Analyzer Generators: LEX
Unit 2	Context Free Grammars, Derivations and Sentential Forms, LL and LR Grammars, Parse Trees, Ambiguous Grammars, Top Down Parsing, Bottom Up parsing, SLR, LR, LALR, Parser Generating tools e.g. YACC

Unit 3	Syntax-Directed Definitions, Evaluation Orders for SDD's, Applications of Syntax-Directed Translation, Syntax-Directed Translation Schemes, Implementing L-Attributed SDD's, Intermediate-Code Generation: Variants of Syntax Trees, Three-Address Code, Types and Declarations, Type Checking, Control Flow, Switch-Statements, Intermediate Code for Procedures
Unit 4	Run-Time Environments: Stack Allocation of Space, Access to Nonlocal Data on the Stack, Heap Management, Code Generation: Issues in the Design of a Code Generator, The Target Language, Basic Blocks and Flow Graphs, Optimization of Basic Blocks, A Simple Code Generator, Peephole Optimization, Register Allocation and Assignment, Dynamic Programming Code-Generation
Unit 5	Machine-Independent Optimization: The Principal Sources of Optimization, Introduction to Data-Flow Analysis, Foundations of Data-Flow Analysis, Constant Propagation, Partial-Redundancy Elimination, Loops in Flow Graphs, overview of GCC compiler and GNU debugger.

Suggested Readings:

1. Alfred Aho, Ravi Sethi, V. Jeffery Ullman D "Compilers Principle, Techniques and Tools" Addison-Wesley.
2. Allen Holub "Compiler Design in C", Prentice Hall of India.
3. Santanu Chattopadhyay "Compiler Design", Prentice Hall of India

4.4 DEPARTMENT ELECTIVE COURSES

4.4.1 LIST OF DEPARTMENT ELECTIVES

B.Tech. SEMESTER V (Discipline Centric Elective Courses)

Course Code	Course	L	T	P	Credits	Pre-Requisites Course		Equivalent Course Codes
						Code	Name	
MINOR-1: Network Computing and Security								
ITITE01	Intrusion Detection Systems and Firewalls	3	0	2	4	ITITC12	Computer Networks	
ITITE02	Advance Computer Networks	3	0	2	4	ITITC12	Computer Networks	
ITITE03	Cloud Computing	3	0	2	4	ITITC12	Computer Networks	
MINOR-2 : Machine Intelligence and Data Analytics								
ITITE04	Image Analytics	3	0	2	4	ITITC08	Computer Graphics	ECECE05

ITITE05	Data Warehouse and Data Mining	3	0	2	4	ITITC05	Data Base Management System	
ITITE06	Soft Computing	3	0	2	4	ITITC10	Design and Analysis of Algorithm	CMCSC16

B.Tech. SEMESTER VI (Discipline Centric Elective Courses)

Course Code	Course	L	T	P	Credits	Pre-Requisites Course		Equivalent Course Codes
						Code	Name	
MINOR-1: Network Computing and Security								
ITITE20	Information Security	3	0	2	4	ITITC15	Number Theory and Cryptography	---
ITITE21	Digital Forensics	3	0	2	4	ITITC15	Number Theory and Cryptography	---
ITITE22	Fog and Edge Computing	3	0	2	4	ITITC17	Mobile Computing	---
ITITE23	Ad Hoc and Delay Tolerant Networks	3	0	2	4	ITITC17	Mobile Computing	---
MINOR-2 : Machine Intelligence and Data Analytics								
ITITE24	Machine Learning and Data Analytics	3	0	2	4	ITITC16	Artificial Intelligence	CACSC11, ECCSC11, CDCSC11, CACSC17
ITITE25	Big Data Science and tools	3	0	2	4	ITITC16	Artificial Intelligence	CDCSC11
ITITE26	Artificial Neural Networks	3	0	2	4	ITITC16	Artificial Intelligence	---

B.Tech. SEMESTER VII/VIII (Discipline Centric Elective Courses)

Course Code	Course	L	T	P	Credits	Pre-Requisites Course		Equivalent Course Codes
						Code	Name	
MINOR-1: Network Computing and Security								
ITITE50	Cyber Security	3	0	2	4	ITITC15	Number Theory and Cryptography	
ITITE51	Internet of Things	3	0	2	4	ITITC12	Computer Networks	COCSC20
ITITE52	Blockchain Technologies	3	0	2	4	ITITC15	Number Theory and Cryptography	
ITITE53	Steganography and Digital Watermarking	3	0	2	4	ITITC15	Number Theory and Cryptography	
ITITE54	Network Security and Risk	3	0	2	4	ITITC15	Number Theory and Cryptography	

	Management							
ITITE55	Wireless Network Security	3	0	2	4	ITITC15	Number Theory and Cryptography	
ITITE56	Wireless Sensor Networks	3	0	2	4	ITITC17	Mobile Computing	
ITITE57	Cyber Laws	3	1	0	4	--	--	
ITITE58	Distributed Systems	3	0	2	4	ITITC09	Operating System	
ITITE59	Green Computing	3	0	2	4	ITITC12	Computer Networks	
MINOR-2 : Machine Intelligence and Data Analytics								
ITITE61	Hadoop and Spark	3	0	2	4	ITITC16	Artificial Intelligence	
ITITE62	Data Compression and Video Analytics	3	0	2	4	ITITC08	Computer Graphics	CDCSE20, COCSE24, CDCSE20
ITITE63	Deep and Reinforcement Networks	3	0	2	4	ITITC10	Design and Analysis of Algorithm	
ITITE64	Natural Language Processing	3	0	2	4	ITITC03	Discrete Structures	CACSE21, COCSE27
ITITE65	Metaheuristic Algorithms	3	0	2	4	ITMTC04	Optimization principles and Techniques	
ITITE66	Machine Vision	3	0	2	4	ITITC16	Artificial Intelligence	COCSE26, CACSE20
ITITE67	Social Network Mining and Analysis	3	0	2	4	ITITC10	Design and Analysis of Algorithm	CDCSE22, COCSE25, CDCSE22
ITITE68	Computational Data Science	3	0	2	4	ITITC16	Artificial Intelligence	
ITITE69	Pattern Analysis and Recommender Systems	3	0	2	4	ITITC16	Artificial Intelligence	CACSE56
ITITE70	Multimedia Technology	3	0	2	4	ITITC08	Computer Graphics	

4.4.2 SYLLABI OF DEPARTMENT ELECTIVES COURSES : V SEMESTER

MINOR-I (NETWORK COMPUTING AND SECURITY)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE01	Intrusion Detection Systems and Firewalls	4	3L-0T-2P	Computer Networks

COURSE OUTCOMES:

CO 1 : To know about intrusion detection
CO 2 : To know about different IDS techniques
CO 3 : To understand the architecture of IDS and IPS
CO 4 : To configure firewalls and IDS

Unit No.	Topics
Unit 1	Introduction: Concept and definition, Internal and external threats to data, Impersonation attack, MITM attack, DDoS Attack, need and types of Intrusion Detection Systems (IDS), information sources for IDS
Unit 2	Intrusion Detection Techniques: Host based IDS, Network based IDS, Information Sources for IDS, Host and Network Vulnerabilities and Countermeasures, Intrusion detection techniques, misuse detection, pattern matching, rule-based and state-based anomaly detection, statistical based, machine learning based, data mining based hybrid detection.
Unit 3	UNIT III: IDS and IPS Architecture: Single-tiered, Multi-tiered, Peer-to-Peer, sensor functions, sensor deployment and security, agent functions, agent deployment and security, manager functions, manager deployment and security, information flow in IDS and IPS, defending IDS/IPS, Case study on commercial and open-source IDS.
Unit 4	Firewall Introduction: Definition and need of firewall, characteristics, types, advantages and disadvantages, location and configuration
Unit 5	Building Firewalls: Firewall architectures, firewall Design, packet Filtering, proxy systems, VPN, pttp, peer-to-peer networking, firewall testing, hosting of firewalls in Linux and Windows

Suggested Readings:

1. Carl Endorf, Eugene Schultz and Jim Mellander, “Intrusion Detection & Prevention”, Tata McGraw-Hill, 2004.
2. Elizabeth D. Zwicky, Simon Cooper & D. Brent Chapman , “Building Internet Firewalls“ O’Reilly
3. Ali A. Ghorbani, Network intrusion detection and prevention concepts and techniques, Springer

Course No	Title of Course	Credits	L-T-P	Pre- Requisites
ITITE02	Advance Computer Networks	4	3L-0T-2P	Computer Networks

COURSE OUTCOMES:

CO 1 : Describe IP addressing for the given network.
CO 2 : Choose relevant routing protocol in the given network situation.
CO 3 : Compare Dynamic Routing and Static Routing on the given aspect.
CO 4 : Analyze techniques/algorithms to solve different layers problems and issues in computer networks.
CO 5 : To understand the evolution of networks and their technologies and analyse the

issues	
Unit No	Topics
Unit 1	Network Layer Services Mobile IP: Addressing, Agents, Inefficiency in Mobile IP. Virtual Private Network: VPN Technology. IPv6 Addressing: Representation, Address Space, Address Space Allocation, Autoconfiguration. Transition from IPv4 to IPv6, IPv6 protocol: Packet Format, Header Extension.
Unit 2	Unicast and Multicast Routing Protocols Introduction: Inter-domain, Intradomain Routing. Routing Algorithms: Distance Vector Routing, Bellman-Ford algorithm, Link State Routing, Path Vector Routing. Unicast Routing Protocols: Internet Structure, Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol Version 4 (BGP) Intradomain Multicast Protocols: Multicast Distance Vector (DVMRP), Multicast Link State (MOSPF).
Unit 3	Local Area Network Technologies (Wired and Wireless LAN): Fast Ethernet, Gigabit Ethernet, IEEE 802.11 WLAN, Need of WLAN, Limitations and challenges of WLAN, WLAN Transmission Mode: Infrared, Radio and Microwave, Topology: BSS and ESS, Hidden and Exposed Station Problems and their solutions, Medium Access Control, Four way handshake protocol, Frame format of IEEE 802.11, WLAN Security, VLANS
Unit 4	Security and QoS Quality of Service Mechanisms, Message Confidentiality: Symmetric-Key Cryptography, Asymmetric-Key Cryptography, Message Integrity, Message Authentication: MAC, Digital Signature, Key Management, Types of attacks.
Unit 5	Evolution of Networks Introduction to Cellular Networks, Ad hoc Networks, Wireless Sensor Networks, Delay Tolerant Networks, Opportunistic Networks, Cognitive Radio Networks, Internet of Things (IoT), Introduction to Cloud Computing (Fog/Edge), Optical networks, Quantum networking, Complex networks.
SUGGESTED READINGS: 1. Natalia Olifer, Victor Olifer, “Computer networks, Principles, Technologies and protocols for network	

Design", Wiley.
2. B.M. Harwani, "Advanced Computer Network", Dreamtech.
3. Forouzan, "Data Communication and Networking", TMH, 5th Edition.
4. A.S. Tanenbaum, "Computer Networks", PHI, 4th Edition.
5. Comer, "Computer Networks and Internet", PHI.
6. Comer, "Internetworking with TCP/IP", PHI.

Course No	Title of Course	Credits	L-T-P	Pre- Requisites
ITITE03	Cloud Computing	4	3L-0T-2P	Computer Networks

COURSE OUTCOMES:

CO 1 : Describe the concept of cloud computing, its quality issues, services, applications, benefits and limitations.
CO 2 : Classify the different types of Deployment and Service models of cloud computing.
CO 3 : Discover the underlying technologies that drive a cloud computing environment.
CO 4 : Analyze various security concern in Cloud computing.
CO5: Evaluate the cloud deployment and service models and their failure considerations.

Unit No.	Topics
Unit 1	Cloud Computing Fundamentals: Need of Cloud Computing, NIST Definition of Cloud Computing, Principles of Cloud computing, Cloud Ecosystem, Requirements for Cloud Services, Cloud Application, Benefits and Drawbacks, Vendors of Cloud Computing, Cloud Architecture, Anatomy of the Cloud, Network Connectivity in Cloud Computing, Managing the Cloud, Migrating Application to Cloud.
Unit 2	Cloud Deployment and Service Models: Private cloud, Public cloud, Community Cloud, Hybrid Cloud, Managed Cloud, Virtual Private Cloud, Cloud Service Models: SaaS, PaaS and IaaS, Comparison of Cloud Service Models their Architecture and Working, Advantages and disadvantage of service models over traditional software and hardware, Cloud Economics, service-level agreements (SLAs): Role and Management of SLA, Types of SLA, SLA Lifecycle.
Unit 3	Virtualization: Introduction to Virtualization, Virtualization Opportunities, Approaches to Virtualization, Hypervisors, Advantages and Downsides of Virtualization, Virtualization Security Threats and Recommendations, Virtualization and Cloud Computing, Introduction to containerization
Unit 4	Cloud Security: Security Concern in Cloud, Security Issues: Threat, Vulnerability and Risk, Threats to Cloud Security, Infrastructure Security, Host level security, Application-Level Security, Information Security, Identity Management and Access Control, Models for Access Control, Cloud Security Design Principles, Security-as-a-Service, Policy Design and Cloud

	security.
Unit 5	Load Balancing: Importance of Load Balancing in Cloud Computing, Goals of Load Balancing, Categories of Load Balancing, Parameters for Load Balancing, Load Balancing Algorithms, The Persistence Issue. Advanced Concepts in Cloud Computing: Mobile cloud computing, Media Cloud, Green Cloud, Introduction to Fog Computing.

SUGGESTED READINGS:

1. K. Chandrasekaran, "Essentials of Cloud Computing," CRC Press.
2. Shailendra Singh, "Cloud Computing", Oxford University Press.
3. Sandeep Bhowmik, "Cloud Computing", Cambridge University Press.
4. U.S. Pandey, Kavita Choudhary, "Cloud Computing", S. Chand.
5. R. Buyya, C. Vecchiola, S.T. Selvi, "Mastering Cloud Computing", Morgan Kaufmann.

MINOR-II (MACHINE INTELLIGENCE AND DATA ANALYTICS)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE04	Image Analytics	4	3L-0T-2P	Computer Graphics

COURSE OUTCOMES:

CO1: A comprehensive understanding of pixel connectivity, digital image and components.
CO2: Explain the concept of different image processing algorithms.
CO3: Represent different techniques for extraction and representation of image features.
CO4: Use the appropriate techniques for object detection and segmentation algorithms.
CO5: Apply image for measurements, recognition and analysis.

Unit No.	Topics
Unit 1	Introduction to Pixel connectivity and Image: Digitization of image, Digital image, image formation, Image formats, Image analysis applications, Relation and connectivity of pixels, Adjacency of pixels, Distance measures, Connected Components, Connected Component Algorithm.
Unit 2	Image enhancement and filtering: Grey level transformation, Contrast stretching, Bit plane slicing and data hiding, Image zooming and shrinking, Histogram equalization, Histogram Specification, Image arithmetic, Image filtering: Smoothing, sharpening filters, Image noise and de-noising.
Unit 3	Extraction of Image features: Image features, Edge Detection and analytics, Representation and Description, Representation Schemes, Boundary Descriptors, Regional Descriptors, Image morphology.
Unit 4	Image analysis and thresholding: Detection and Segmentation, Thresholding in images for segmentation and motion estimation, Image classification, object identification and recognition,

	image search, object detection techniques.
Unit 5	Image Understanding: Template matching by Correlation, stereo vision and depth measurements, evaluate and measure texture information, human action recognition, Visual cryptography, texture analysis, Dimensionality reduction, Data Compression, matching and recognition, Applications

Suggested Readings:

1. Rafael C Gonzalez, Richard E Woods 2nd Edition, Digital Image Processing - Pearson Education 2003.
2. William K Pratt, Digital Image Processing John Willey (2001).
3. A.K. Jain, PHI, New Delhi (1995)-Fundamentals of Digital Image Processing.
4. Richard Szelisk, Computer Vision: Algorithms and Applications
5. Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie, The Elements of Statistical Learning

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE05	Data ware house and data mining	4	3L-0T-2P	DBMS

COURSE OUTCOMES:

CO1: Identify the basic principles, concepts and applications of data warehousing and data mining.
CO2: Choose the task of data mining as an important phase of the knowledge recovery process.
CO3: Compare Conceptual, Logical, and Physical design of Data Warehouses OLAP applications and OLAP deployment and design a data warehouse or data mart to present information needed by management in a form that is usable for management clients.
CO4: Analyze concepts that provide the foundation of data mining.
CO5: Design and develop Data Mining algorithms for classification applications.

Unit No.	Topics
Unit 1	Introduction to Data Warehousing: Overview, Difference between Database System and Data Warehouse, The Compelling Need for data warehousing, Data warehouse – The building Blocks: Defining Features, data warehouses and data marts, overview of the components, Three tier architecture, Metadata in the data warehouse. Data pre-processing: Data cleaning, Data gateway, Synchronization of databases, Data transformation and ETL Process, ETL tools, interoperability of data and applications.
Unit 2	Dimensional Modelling: Defining the business requirements: Dimensional analysis, information packages – a new concept, requirements gathering methods, requirements definition: scope and content. Principles of Dimensional Modelling: Objectives, From Requirements to data design, Multidimensional Data Model, Schemas: the STAR schema, the Snowflake schema, fact

	constellation schema.
Unit 3	OLAP in the Data Warehouse: Demand for Online Analytical Processing, limitations of other analysis methods- OLAP is the answer, OLAP definitions and rules, OLAP characteristics, major features and functions, hyper cubes. OLAP Operations: Drill-down and roll-up, slice-and-dice , pivot or rotation, OLAP models, overview of variations, the MOLAP model, the ROLAP model, the DOLAP model, ROLAP versus MOLAP, OLAP implementation considerations. Query and Reporting, Executive Information Systems (EIS), Data Warehouse and Business Strategy. Advanced Data warehouse Techniques: Document oriented NoSQL Databases- MangoDB, CouchDB; Graph Databases-Neo4J, Infinite Graph.
Unit 4	Introduction to Data Mining Data Mining Basics: What is Data Mining, Data Mining Defined, The knowledge discovery process (KDD Process), Data Mining Applications- The Business Context of Data Mining, Data Mining for Process Improvement, Data Mining as a Research Tool, Data Mining for Marketing, Benefits of data mining, Major Data Mining Techniques: Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, KNN Algorithm.
Unit 5	Data Mining Algorithms: Cluster detection, K- means Algorithm, Outlier Analysis, memory-based reasoning, link analysis, Mining Association Rules in Large Databases: Association Rule Mining, genetic algorithms, neural networks, Data mining tools.

Suggested Readings:

1. Paul Raj Poonia, “Fundamentals of Data Warehousing”, John Wiley & Sons.
2. Kamber and Han, “Data Mining Concepts and Techniques”, Hart Court India P. Ltd. Elsevier Publications Second Edition.
3. W. H. Inmon, “Building the operational data store”, 2nd Ed., John Wiley.
4. “Data Warehousing”, BPB Publications.
5. Pang- Ning Tan, Michael Steinbach, Viach, Vipin Kumar, Introduction to Data Mining, Pearson.
6. Shmueli, “Data Mining for Business Intelligence : Concepts, Techniques and Applications in Microsoft Excel with XLMiner”,Wiley Publications.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE06	Soft Computing	4	3L-0T-2P	Design and Analysis of Algorithms

COURSE OUTCOMES:

CO1: Identify and describe soft computing techniques and their roles in building intelligent machines.
CO2: Choose the feasibility of applying a soft computing methodology for a particular problem.
CO3: Compare solutions by various soft computing approaches for a given problem.
CO4: Analyze existing software tools to solve real problems using a soft computing approach.
CO5: Design and develop certain scientific and commercial applications using computational neural network models, fuzzy models, evolutionary algorithms for optimization, learning, and design of intelligent

systems in specified applications.

Unit No.	Topics
Unit 1	Introduction: Neural networks: definition, advantage of neural networks, Applications scope of neural networks, fuzzy logic, hybrid systems: neuro-fuzzy, Soft computing Artificial neural network: Fundamental concept: ANN, biological NN, brain vs. computer, evolution of neural networks, basic models of ANN: connections, learning, activation functions, important terminologies of ANNs: weights, bias, threshold, learning rate, momentum factor, vigilance parameter, notations, Mc-Culloch –pitts neuron: theory, architecture, linear separability, Introduction to Deep neural network: CNN and RNN.
Unit 2	Supervised and Unsupervised learning network: Introduction, perceptron networks: theory, perceptron learning rule, architecture, flowchart for training process, single output class, multiple output class, network testing algorithm, adaptive linear neuron: theory, delta rule for single output unit, architecture, multiple adaline linear neurons: theory, architecture, back propagation network: theory, architecture, flowchart for training process, training algorithm, learning factors, testing algorithms, Hebb network: theory, flowchart of training algorithm, training algorithm, K-mean clustering.
Unit 3	Fuzzy Logic and Fuzzy Relations: Introduction to Fuzzy sets , Crisp vs Fuzzy Sets, Types of Fuzzy sets, Operations on Fuzzy Sets, Membership functions: Triangular membership function, Trapezoidal membership function, generalized bell membership, Sigmoidal and Gaussian distribution. Fuzzy Relations: Introduction to fuzzy relations, Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods: Center of Sums Method (COS), Center of gravity (COG) / Centroid of Area (COA) Method, Center of Area / Bisector of Area Method (BOA), Weighted Average Method, Maxima Methods- First of Maxima Method (FOM), Last of Maxima Method (LOM), Mean of Maxima Method (MOM), Introduction to Bert techniques and Computing with words.
Unit 4	Introduction to Evolutionary algorithms: Genetic Algorithm: Introduction to Selection, Proportional Selection, Tournament Selection, Rank-based Selection, Boltzmann Selection, A comparison of Selection Mechanisms, Selection pressure, Exploration and exploitation, Introduction to Search Operators, Mutation Operators, Recombination, learning of neural network using genetic algorithm.
Unit 5	Multiobjective Optimization, Introduction to nature inspired metaheuristic algorithms: Swarm Intelligence -Particle Swarm Optimization and its variants, Artificial Bee Colony Optimization algorithm.

Suggested Readings:

1. “Principles of Soft Computing”: Sivanandam and Deepa : Wiley India edition.
2. "Neural Network, Fuzzy Logic, and Genetic Algorithms - Synthesis and Applications", by S. Rajasekaran and G.A. Vijayalaksmi Pai, (2005), Prentice Hall, Chapter 1-15, page 1-435.
3. “Soft Computing and Intelligent Systems - Theory and Application”, by Naresh K. Sinha and Madan M. Gupta (2000), Academic Press, Chapter 1-25, page 1-625.
4. “Genetic algorithms in search, optimization, and machine learning”, by David E. Goldberg, Pearson Education.

4.4.3 SYLLABI OF DEPARTMENT ELECTIVES COURSES : VI SEMESTER

MINOR-I (NETWORK COMPUTING AND SECURITY)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE20	Information Security	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES:

CO1: To understand the message integrity and message authentication
CO2: To explain the concept of ECC
CO3: To discuss some digital signature algorithms
CO4: To design authentication and key management schemes
CO5: To learn the different types of protocols for network security
CO6: To know about the concepts related to system security

Unit No.	Topics
Unit 1	Message Integrity and Message Authentication: Message Integrity, Random Oracle Model, Message Authentication, Hash functions and its properties, MD2, MD5, Whirlpool, SHA-512
Unit 2	ECC and Digital Signatures: Elliptic Curve Operations, Applications, Practical Considerations, Attacks on Digital Signatures, Digital Signatures Schemes, Variations and Applications
Unit 3	Authentication and Key Management: Introduction, One-way Authentication, Mutual Authentication, OAuth 2.0 standard, IAM, Dictionary Attacks, Centralized Authentication, De-centralized Authentication, Zero-Knowledge, Biometrics (GAIT), Digital Certificates, Public Key Infrastructure, Identity-Based Encryption, Kerberos
Unit 4	Network Security: PGP and S/MIME, SSL, TLS, IPSec, Security Association, Security Policy, Internet Key Exchange
Unit 5	System Security: Description of the System, Buffer Overflow and Malicious Software, Malicious Programs, Worms, Viruses, Intrusion Detection System, Firewall, Types of Firewalls, Firewall Configuration, Virtual Private Networks, Standards of the information security

Suggested Readings:

1. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
2. B. Menezes, “Network Security and Cryptography”, Cengage Learning
3. Wen Bo Mao, “Modern cryptography - Theory and practice”, Prentice Hall.
4. Douglas Stinson, "Cryptography Theory and Practice", Second Edition, Chapman & Hall/CRC.
5. W. Stallings, "Cryptography and Network Security", Pearson Education

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE21	Digital Forensics	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES:

CO1: To understand the fundamentals of digital forensics and different kinds of cyber-crimes. .
CO2: To identify the emerging Cybercrime & Cyber security trends and its impact in cyberspace.
CO3: To analyze and understand the digital evidence to support Investigation.
CO4: Apply the evidence to track offenders.
CO5: To examine digital evidences through data acquisition and identification.

Unit No.	Topics
Unit 1	Computer forensics fundamentals, computer crimes, Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery workstation and software, conducting and investigations, Syslog and various log formats.
Unit 2	Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions.
Unit 3	Collecting and analysing network-based evidence, reconstructing web browsing, email activity, and windows registry changes, intrusion detection, tracking offenders. E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics.
Unit 4	Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.
Unit 5	Current computer forensics tools- software, hardware tools, validating and testing, forensic software, addressing data-hiding techniques, performing remote acquisitions. remote network acquisition tools, other forensics acquisitions tools.

Suggested Readings:

1. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., "Guide to Computer Forensics and Investigations", 2nd edition, Thomson Course Technology, 2006, ISBN: 0-619-21706-5.
3. John R. Vacca, Computer Forensics, "Computer Crime Scene Investigation",2ndEd, Charles River Media, 2005.
4. Anthony T. S. Ho and Shujun Li, "Handbook of Digital Forensics of Multimedia

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE22	Fog and Edge Computing	4	3L-0T-2P	Computer Networks

COURSE OUTCOMES:

CO1: Describe the concept of Fog and Edge computing, their services, applications, benefits and limitations.
CO2: Classify the different types of issues and challenges of cloud computing.
CO3: Discover the Optimization problems in Fog and Edge Computing.
CO4: Analyze various security concerns in Fog and Edge computing.
CO5: Design software using standard open-source fog and edge computing tools for data analytics.

Unit No.	Topics
Unit 1	Fog Computing Fundamentals: Introduction to Fog Computing, Limitation of Cloud Computing, Differences between Cloud and Fog Computing, Need and Architecture of Fog Computing, Characteristics and working of Fog Computing, Advantages and Disadvantages of Fog, Applications of Fog Computing.
Unit 2	Issues and challenges of Fog Computing: Open challenges and current research trends in Fog Computing, Privacy and Security issues in Fog Computing, Trust and Reputation Model in Fog Computing, Authentication and Access Control, Data Management and storage challenges, Data Pre-Processing and Analytics, Data Storage and Data Placement.
Unit 3	Edge Computing Fundamentals: Introduction to Edge Computing, Origins of Edge, Edge Helping Low-End IoT Nodes, Edge computing architecture, Edge Helping Higher-Capability Mobile Devices: Mobile Offloading, Edge Helping the Cloud, Data Processing on the Edge, Edge vs Fog Computing, Dispersed Learning with Edge/Fog Computing, Edge Computing Applications.
Unit 4	Optimization Problems in Fog and Edge Computing: Preliminaries, The Case for Optimization in Fog Computing, Formal Modeling Framework for Fog Computing, Metrics, Further Quality Attributes, Optimization Opportunities along the Fog Architecture, Optimization Opportunities along the Service Life Cycle, Taxonomy of Optimization Problems in Fog

	Computing.
Unit 5	Middleware for Fog and Edge Computing: Need for Fog and Edge Computing Middleware, Middleware-Design Goals, State-of-the-Art Middleware Infrastructures, System Model, Architecture, Case Study Example, Clusters for Lightweight Edge Clouds.

SUGGESTED READINGS:

1. Fog Computing: Theory and Practice by Assad Abbas, Samee U. Khan, Albert Y. Zomaya.
2. Fog and Edge Computing: Principles and Paradigms (Wiley Series on Parallel and Distributed Computing) by Rajkumar Buyya and Satish Narayana Srirama
3. Amir Vahid Dastjerdi and Rajkumar Buyya, ―Fog Computing: Helping the Internet of Things Realize its Potential‖, University of Melbourne.
4. Sensors, Cloud, and Fog: The Enabling Technologies for the Internet of Things Paperback by Sudip Misra, Subhadeep Sarkar, Subarna Chatterjee.
5. Wei Change and Jie Wu, Fog/Edge Computing for Security, Privacy and Applications, Springer, 2021.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE23	Adhoc and Delay Tolerant Networks	4	3L-0T-2P	Mobile Computing

COURSE OUTCOMES:

CO1: To identify and familiarize the basics of Adhoc and Delay Tolerant Networks.
CO2: To classify and summarize the protocols used at the MAC layer and scheduling mechanisms.
CO3: To compare and analyze the types of routing protocols used for unicast, multicast, geo-cast.
CO4: To apply and illustrate the concept with the state of art standards used in these networks.
CO5: To design and evaluate the working of these networks.

Unit No.	Topics
Unit 1	Adhoc Networks and DTNs: Introduction and evolution of Cellular networks, overview of ad hoc networks, applications areas, Issues and challenges. DTNs/Opportunistic networks: Introduction, applications, Issues and challenges.
Unit 2	MAC Layer Protocols: Design goals of a MAC protocol, Issues with traditional MAC protocols, Contention based protocols; Contention based protocols with reservation mechanisms, MAC protocols using directional antennas.
Unit 3	Routing Protocols: Adhoc Networks: Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing, Location-based routing, Geocasting. DTNs/Opportunistic networks: Store-carry-forward paradigm, routing in infrastructure-based and infrastructure-less environment. .
Unit 4	Securing Adhoc Networks and DTNs

	Network security requirements: Issues and challenges, network attacks, key management, secure techniques for these networks.
Unit 5	Quality of service in Adhoc Networks and DTNs Adhoc Networks: Energy management schemes, transmission power management, system power management schemes, QoS solutions, and performance metrics. DTNs/Opportunistic networks: Quality of service solutions, performance evaluation parameters for these networks.

Suggested Readings:

1. C. Cordeiro and D. P. Agrawal, "Ad Hoc & Sensor Networks: Theory and Applications," 2nd Edition, World Scientific, Singapore, 2011.
2. C. E. Perkins, "Ad Hoc Networking." Pearson education
3. C. K. Toh, "Ad hoc mobile wireless networks: protocols and systems." Pearson Education
4. Longxiang Gao, Shui Yu, Tom H. Luan, Wanlei Zhou, "Delay Tolerant Networks," Springer, June 2015
5. Jochen H. Schiller, "Mobile communications." Pearson education
6. A. Verma, P. Verma, S. K. Dhurandher, I. Woungang, "Opportunistic Networks: Fundamentals, Applications and Emerging Trends," CRC Press, 2021
7. I. Woungang, S. K. Dhurandher, A. Anpalagan, A. V. Vasilakos, "Routing in Opportunistic Networks," Springer, 2013.

MINOR-II (MACHINE INTELLIGENCE AND DATA ANALYTICS)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE24	Machine Learning and Data Analytics	4	3L-0T-2P	Artificial Intelligence

COURSE OUTCOMES:

CO1: Understand the Data and Model for Machine Learning
CO2: Analyze the role of Learning in supervised and Unsupervised
CO3: Write and generate strategies to learn and classify.
CO4: Apply the Learning to provide predictions related to specific domains.
CO5: Synthesize knowledge on data to learn and predict.

Unit No.	Topics
Unit 1	Introduction to Machine Learning, Machine Learning and it's Types. Applications of ML, Design Perspective and Issues in ML, Basic Data types, Exploring numerical and Categorical data, Data issues and pre-processing, Supervised, Unsupervised, Semi-supervised learning with applications and issues.
Unit 2	Modelling and Evaluation: Selecting a Model, Training Model-Holdout, k-Fold cross validation, bootstrap sampling. Model representation and interpretability-under-fitting, overfitting, bias-variance trade-off, Model Performance evaluation.

Unit 3	Feature construction, Feature extraction, Feature selection Probability concepts in Learning: Bayes theorem-prior and posterior probability, Learning rules from Data, Probabilistic classifier, Nearest Neighbor, K- Nearest Neighbor, Different issues of Nearest Neighbor.
Unit 4	Regression analysis, Gradient descent, Multiple Linear Regression, Polynomial Regression Model, Logistic Regression, Regularization Clustering: Unsupervised Learning technique, Learning from unclassified data, Similarity and Distance Measures, k-means and k-medoids algorithm.. Hierarchical Agglomerative Clustering, k-means partitional clustering.
Unit 5	Dimensionality reduction, feature selection and visualization. Principal Component Analysis, Linear Discriminant analysis, Support Vector Machine.

Suggested Readings:

1. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
2. Introduction to Information Retrieval, Christopher D. Manning and Prabhakar Raghavan and Hinrich Schütze, Cambridge University Press, 2008.
3. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017
4. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
5. Information Storage and Retrieval Systems: Theory and Implementation, Kowalski, Gerald, Mark T Maybury, Springer.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE25	Big Data Science and Tools	4	3L-0T-2P	Artificial Intelligence

COURSE OUTCOMES:

CO1: To Understand the basic concepts of big data
CO2: To Illustrate different terminologies and applications in big data environment
CO3: To design the architecture of Hadoop and process data using Map reduce framework
CO4: To compare different big data database, NoSQL, MongoDB and Cassandra
CO5: To implement and program practical problems using Spark

Unit No.	Topics
Unit 1	Introduction to big data: Characteristics of data, evolution of big data, definition of big data, challenges with big data, Vs of big data, big data types, why big data
Unit 2	Big data analytics: What is big data analytics, big data analytics applications, terminologies used in big data environment (in memory analytics, in database processing, symmetric multiprocessor system, massively parallel processing).
Unit 3	Introduction to Hadoop: Why Hadoop, why not RDBMS, key aspects of Hadoop, Hadoop components, high-level architecture of Hadoop, HDFS, Processing data with Hadoop, Mapreduce framework and programming model, Hadoop Yarn
Unit 4	Big data Management: NoSQL data store, Schema-less models, NoSQL data architecture and patterns (key-value store, document store, tabular store, graph database: neo4j), Using NoSQL to manage big data, MongoDB database, Columnar database, Cassandra, graphql

Unit 5	Introduction to Big data tool- Spark and Apache beam: what is Spark, downloading Spark, Spark SQL, using python features with Spark SQL, programming using RDDs, machine learning with MLib, composing Spark program steps for ETL (Extract, Transform and Load) process, comparative analysis of big data tools, stream and batch processing

Suggested Readings:

1. Big Data in Practice By Bernard Marr
2. Analytics In A Big Data World: The Essential Guide To Data Science And Its Applications By Bart Baesens
3. Big Data and Analytics By Seema Acharya and Subhashini Chellappan

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE26	Artificial Neural Networks	4	3L-0T-2P	Design and Analysis of Algorithms

COURSE OUTCOMES:

CO1: Understand the concept of the neural networks
CO2: Analyze the working of activation functions in networks
CO3: Outline different learning rules with respect to the layers of the neural networks
CO4: Evaluate architectures of neural networks
CO5: Apply the model in different domains of daily applications.

Unit No.	Topics
Unit 1	Introduction to Neural Networks Introduction, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Artificial Neuron Model, Types of ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics - Activation and Synaptic, Learning Rules- Supervised, Unsupervised and Reinforced
Unit 2	Single Layer Feed Forward Neural Networks- Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.
Unit 3	Multilayer Feed forward Neural Networks and associative memories, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Mathematics of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements
Unit 4	Paradigms of Associative Memory, Architecture of Hopfield Network: Discrete and Continuous versions.
Unit 5	Neural network applications: Process identification, control, fault diagnosis and load forecasting.

Suggested Readings:

1. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH, 2006.
2. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
3. Neural Networks – Simon Hakins , Pearson Education
4. Neural Engineering by C.Eliasmith and CH.Anderson, PHI

4.4.4 SYLLABI OF DEPARTMENT ELECTIVES COURSES : VII & VIII SEMESTERS

MINOR-I (NETWORK COMPUTING AND SECURITY)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE50	Cyber Security	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES:

CO1: To understand technical and social aspects of cyber security.
CO2: To learn about cyber-attacks, cyber threats and organizational implications of cyber security
CO3: To learn about cyber securities vulnerabilities their prevention techniques
CO4: To understand how to secure web applications and services
CO5: To learn the different cyber security tools, techniques and their applications and securities policies of different countries

Unit No.	Topics
Unit 1	Introduction to Cyber Security and its Trends Introduction to Cyber Security and its problem, cyber threats, cyberspace, cyber terrorism, Importance and challenges in cyber security, Organizational Implications of Cyber Security, Intervention Strategies, Internet security and its goals.
Unit 2	Cyber Security Vulnerabilities and Attacks Prevention Techniques Types of Hackers, Concept of Ethical hacking and cracking, Cyber attacks and Vulnerabilities: Malwares, viruses, worms and trojan horses, sniffing- Scanning, gaining access and executing the applications, Prevention techniques: Access control, Authentication, Authorization, Biometrics, Cryptography, Denial of Service Filters, Firewalls and its types.
Unit 3	Securing Web Application and Services Securing web applications using HTTPS and SOAP Protocol, Web services use and security considerations, Authorization Schemes and IAM, OAuth 2.0 and OAuth 2.1 issues and Challenges, Password less Web Applications, using VPC for securing web applications
Unit 4	Security tools, Social Engineering attacks and their preventions Cyber security tools like firewalls, antivirus, vulnerability assessment and penetration testing, PKI services, Social engineering attacks- Insider Attacks, Phishing attacks and their prevention, targets and defense strategies, block chain revolution, Challenges in IoT
Unit 5	Cyber Security Strategies and Case Studies Indian Cyber security strategies, Indian National Cyber Security Policy-2013, UK National Cyber Security Strategy 2016 to 2021, US Cyber Security Policy, Hardware based Cyber Security Strategies.

SUGGESTED READINGS:

1. Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives by Sunit Belapure Nina Godbole, 2011, Wiley India Pvt Ltd
2. Firewalls and Internet Security: Repelling the Wily Hacker by William R. Cheswick and Steve Bellovin
3. Metasploit - The Penetration Tester's Guide by David Kennedy, Jim O'gorman , Devon Kearns and Mati Aharoni.
4. Cyber Security: What Everyone Needs to Know by P.W. Singer, A. Friedman
5. Cyber Security for Industry 4.0 by L. Thames, D. Schaefer
6. https://aws.amazon.com/vpc/
7. https://github.com/aws-samples/ec2-classic-resource-finder/
8. https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/vpc-migrate.html
9. https://docs.aws.amazon.com/elasticloadbalancing/latest/userguide/migrate-classic-load-balancer.html#migrate-step-by-step-classiclink
10. https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/USER_VPC.html#USER_VPC.VPC2VPC

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE51	Internet of Things	4	3L-0T-2P	Computer Networks

COURSE OUTCOMES:

CO1: Describe various concepts and terminologies of IoT systems.
CO2: Understand and apply various protocols for design of IoT systems.
CO3: Use sensors and actuators for design of IoT.
CO4: Understand various applications of IoT.

Unit No.	Topics
Unit 1	Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things and Identifiers in IoT, IoT frameworks, IoT and M2M. Development.
Unit 2	IoT Protocols: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus. IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols.
Unit 3	IoT Hardware and programming: Sensors, Types of sensors, Actuators, Radio Frequency Identification (RFID) technology, Wireless Sensor Networks, Participatory Sensing Technology. Embedded Platforms for IoT: Embedded computing basics, Overview of IOT supported Hardware platforms such as Arduino, NetArduino, Raspberry pi, Beagle Bone, Intel Galileo boards and ARM cortex.
Unit 4	Security in IoT: Security requirements of IoT implementations, Device security, Authentication and Authorization, IoT attacks and case studies, IoT security protocols.
Unit 5	Applications of IoT: Smart Meters, Home Automation, Smart Cities, Logistics, Agriculture,

	Health and Lifestyle, Industrial IoT, VANET, IoT in Environmental Protection.

Suggested Readings:

1. Michael Miller “The Internet of Things” by Pearson
2. Hakima Chaouchi, — “The Internet of Things Connecting Objects to the Web”, Wiley Publications.
3. Olivier Hersent, David Boswarthick, and Omar Elloumi, — “The Internet of Things: Key Applications and Protocols”, Wiley Publications.
4. Vijay Madisetti and ArshdeepBahga, — “Internet of Things (A Hands-on-Approach)”, 1 st Edition, VPT, 2014.
5. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
6. Keysight Technologies, “The Internet of Things: Enabling Technologies and Solutions for Design and Test”, Application Note, 2016.
7. Adrian McEwen,Hakin Cassimally “Designing the Internet of Things” Wiley India.
8. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press.
9. https://www.dhitechnologies.org/top-5-security-protocols-for-the-internet-of-things/
10. https://www.einfochips.com/blog/iot-protocol-security-everything-you-need-to-know/
11. https://www.ece.nus.edu.sg/stfpage/bsikdar/papers/net_mag_20.pdf (case study)
12. https://arxiv.org/pdf/1805.05853.pdf
13. https://cyber.uk/areas-of-cyber-security/physical-cyber-security/internet-of-things-case-study/
14. http://ceur-ws.org/Vol-2597/paper-17.pdf

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE52	Blockchain Technology	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES:

CO1: Describe the concept of Blockchain Technology and its advantages and limitations.
CO2: Identify different types of issues and challenges of Blockchain Technology.
CO3: Understand different blockchain algorithms, techniques and their utilization in cryptocurrency eco-system.
CO4: Design and test Blockchain Applications using Ethereum, hyper ledger, Neo and Distributed Ledger Technology platform.

Unit No.	Topics
Unit 1	Blockchain Fundamentals: Introduction to Blockchain, Smart Contracts and decentralized Eco-systems, Economy, Key Characteristics, Applications of Blockchain, Elements of Blockchain, Block structure, Consensus Algorithm and its types, Types of Blockchain (public, private, hybrid and sidechains), Blockchain interoperability, energy consumption concerns, Cryptography: Hash function, Digital Signature, Merkel tree.
Unit 2	Bitcoin and Cryptocurrency: Introduction to cryptocurrency, Creation of Coin, Payments and double spending, Bitcoin Scripts, Bitcoin Network, Transactions in Bitcoin Network, Block Mining, Propagation and Relay, Consensus in a Bitcoin Network, Privacy and fungibility, Bitcoin wallets (software, hardware, paper, cold wallets).

Unit 3	Ethereum Blockchain: Ethereum Virtual Machine (EVM), Wallets for Ethereum, Smart Contracts, Ethereum applications (Contract source code, ERC-20 tokens, Non-fungible tokens (NFTs), Decentralized finance Enterprise software, Enterprise software, Permissioned ledgers), Smart Contracts in Solidity, Ether, Ethereum Governance, Security in Ethereum, comparison to Bitcoin.
Unit 4	Distributed Consensus: Byzantine general problem and Agreement protocol, Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.
Unit 5	Permissioned and Public Blockchains: Design goals, Consensus protocols for Permissioned Blockchains, Decomposing the consensus process, Hyperledger frameworks (fabric, sawtooth, besu), Chain code design, Hybrid models (PoS and PoW), Hyperledger tools (Hyperledger Caliper, Hyperledger Cello, Hyperledger Composer, Hyperledger Explorer, Hyperledger Quilt).

Suggested Readings:

1. "Blockchain: The blockchain for beginners guide to blockchain technology and leveraging blockchain programming", by Josh Thompsons.
2. "Blockchain: Blueprint for a new Economy", by Melanie Swan.
3. Blockchain Revolution: How the technology Behind Bitcoin is Changing Money, Business and the World", by Don Tapscott, Alex Tapscott.
4. "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder.
5. "Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations", by Henning Diedrich.
6. https://www.geeksforgeeks.org/consensus-algorithms-in-blockchain/
7. https://analyticsindiamag.com/blockchain-consensus-algorithms/

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE53	Steganography and Digital Watermarking	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES

CO1: To know about the different digital watermarking techniques
CO2: To classify the digital watermarking techniques
CO3: To apply the digital watermarking techniques
CO4: To know about the steganography and steganalysis techniques
CO5: To learn about the latest steganography and watermarking techniques

Unit No.	Topics
Unit 1	Digital watermarking: Introduction to watermarking techniques. a survey of current watermarking techniques, watermark detection and analysis, application of cryptography in digital watermarking. ,
Unit 2	Classification of watermarking techniques: Robust and fragile watermarking, techniques for protection of multimedia data and databases, security analysis of watermarking techniques.
Unit 3	Applications of digital watermarking: Copyright protection, intellectual property issues, digital signatures, authentication.

Unit 4	Steganography: History of steganography, principles of steganography, steganography in computer file systems, steganalysis techniques, application of cryptography in steganography, steganography algorithms, various applications of steganography
Unit 5	Emerging trends: Advance steganography and watermarking techniques, forensic watermarking and steganography

Suggested Readings:

1. Katzenbeisser and Petitcolas, "Information Hiding: Techniques for steganography and digital watermarking", Artech House.
2. Johnson, Duric, and Jajodia, "Information Hiding – Steganography and Watermarking – Attacks and Countermeasures", Kluwer Academics publishers.
3. Cox, Miller, and Bloom, "Digital Watermarking", Academic Press.
4. Jeng-Shyang Pan, Hsiang-Cheh Huang, Lakhmi C. Jain, "Information Hiding and Applications", Springer.
5. Michael Konrad Arnold, Martin Schmucker, Stephen D. Wolthusen, "Techniques and applications of Digital watermarking and content protection", Artech House.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE54	Network Security and Risk Management	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES

CO1: To understand the basic concept of network security and its importance
CO2: To learn about the security protocols at application layer and transport layer
CO3: To understand the security protocols at application layer and the concepts related to system security
CO4: To learn about wireless network security
CO5: To analyze the risk in the network

Unit No.	Topics
Unit 1	Introduction: Introduction to Security in Networks, Characteristics of Networks, Intrusion, Kinds of security breaches, Plan of attack, Points of Vulnerability, Methods of Defense, Control Measures, Effectiveness of Controls ,
Unit 2	Security at Application Layer and Transport Layer: Email, PGP, S/MIME, SSL Architecture, Handshake, Change Cipher Space, Alert and Record Protocols, SSL Message Formats, Transport Layer Security
Unit 3	Security at Network Layer and System Security: Modes, Two Security Protocols, Security Association, Security Policy, Internet Key Exchange, System Security, Description, Buffer Overflow and Malicious Software, Malicious Programs, Intrusion Detection System, Firewall, Types of Firewall, Firewall Configuration, Virtual Private Networks
Unit 4	Wireless Network Security: Wireless Security, Mobile Device Security, Wireless LAN Overview, Wireless LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP End-To-End Security

Unit 5	Risk Management: Define, Identify and Measure Risk, Risk analysis and Management, Approaches and Considerations in Risk Analysis, Risk Assessment Techniques, Managing Risk, Steps for Risk management, Auding Perspective on Risk Analysis

Suggested Readings:

1. B. A. Forouzan, Cryptography & Network Security, Tata Mc Graw Hill.
2. J.Katz, Y.Lindell, Introduction to Modern Cryptography, Chapman Hall.
3. Douglas Stinson, "Cryptography Theory and Practice", Second Edition, Chapman & Hall/CRC.
4. W. Stallings, "Cryptography and Network Security", Pearson Education
5. Jyrki T. J. Penttinen , Wireless Communications Security: Solutions for the Internet of Things, John Wiley & Sons
6. Eric Maiwald, Fundamental of Networks Security, MaGraw Hill

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE55	Wireless Network Security	4	3L-0T-2P	Number Theory and Cryptography

COURSE OUTCOMES

CO1: To understand and learn about basic concepts of Wireless Network Security.
CO2: To identify security threats in Wireless Networks and learn about wireless Transport Layer security
CO3: To learn about security in Mobile/Cellular Networks.
CO4: To Analyze various Bluetooth security aspects..
CO5: To get familiar about security and privacy issues in IoT Networks and Blockchain networks.

Unit No.	Topics
Unit 1	Introduction Introduction to Security in Networks, Wireless Security, Overview of Cryptography, Encryption in Networks using High level Elliptic Curve Cryptography, Security Threats in Wireless Network, Web and DNS Security
Unit 2	Wireless LAN Security Wireless Lan Infrastructure, Mobility Adaptive Authentication, Authentication for Wireless LAN, Security Protocol in Wireless LANs, Wireless Application Protocol, Wireless Transport Layer Security, Wireless Application Environment Security, WML Scripts
Unit 3	Security in Mobile/Cellular Networks Security issues in GSM, 3G and 4G Networks, Security services offered in GSM, Access control, Confidentiality, anonymity, Authentication Algorithm -A3, Encryption Algorithm -A5, Subscriber Authentication, Data Encryption in GSM, Encryption in UMTS Network, Security in 5G and 6G
Unit 4	Bluetooth Security Bluetooth Security components and protocol, Authentication, Encryption and Ciphering process in Bluetooth, Service Discovery Protocol, Security levels in IEEE 802.15.4, Bluetooth 5.0, Case

	studies in Bluetooth security.
Unit 5	Security in IoT Networks and Blockchain Security and Privacy Issues in IoT, Identity and Access Management, Authentication in IoT Networks, Case studies in IoT implementations from a security perspective, Blockchain applications in wireless platforms and devices, blockchain Security issues and their solutions

SUGGESTED READINGS:

1. Y. Xiao, X. Shen, D. Z.Du, Wireless Network Security, Springer International Edition.
2. Lei Chen, JiahuangJi, Zihong Zhang, Wireless Network Security, Springer Science & Business Media
3. W. Stallings. Cryptography & Network Security: Principles and Practice, Prentice Hall
4. Noureddine Boudriga, Security of Mobile Communications, CRC Press
5. James Kempf, Wireless Internet Security: Architectures and Protocols, Cambridge University Press
6. Levente Buttyán and Jean-Pierre Hubaux, Security and Cooperation in Wireless Networks, Cambridge University Press

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE56	Wireless Sensor Networks	4	3L-0T-2P	Mobile Computing

COURSE OUTCOMES:

CO 1 : Describe the characteristics, basic concepts, and systems issues in sensor networks.
CO 2 : Classify the various types of MAC protocols for sensor networks.
CO 3 : Discover the techniques for deployment and configuration of sensor networks.
CO 4 : Analyze the power management issues and illustrate the suitable OS for sensor networks.
CO 5 : To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Unit No.	Topics
Unit 1	Introduction to Wireless Sensor Networks: Overview of Wireless Transmission Technology and Systems, Introduction to Wireless Sensor Technology - Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WSN Operating Environment, Applications of Wireless Sensor Networks, WSN Standards, IEEE 802.15.4, Zigbee, Network architectures for WSN, classification of WSN, Protocol stack for WSN.
Unit 2	Medium Access Control Protocols for Wireless Sensor Networks: Fundamentals of MAC Protocols, MAC Protocols for WSNs, Contention-Based protocols: Power Aware Multi-Access with Signaling - Data-Gathering MAC, Contention-Free Protocols: Low Energy. Adaptive Clustering Hierarchy, B-MAC, S-MAC. Dissemination Protocol for Large Sensor Network.
Unit 3	Deployment and Configuration: Target tracking, Localization and Positioning, Coverage and Connectivity, Routing Protocols and Data Management for Wireless Sensor Networks - Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks, Routing protocols: table-driven, on-demand, hybrid, flooding, hierarchical,

	and power aware routing protocols, Issues and Challenges in providing QoS, QoS frameworks.
Unit 4	Energy Efficiency and Power control: Need for energy efficiency and power control in WSN, passive power conservation mechanisms, active power conservation mechanisms. Operating Systems for Wireless Sensor Networks: Operating System Design Issues, TinyOS, Contiki – Task management, Protothreads, Memory and IO management, Sensor Node Hardware – Tmote, Micaz, Programming Challenges, Node-level Software Platforms, Node-level Simulators, State-centric Programming.
Unit 5	Recent Trends and Future Directions: Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security, Future Directions: Secure embedded systems, programming models and embedded operating systems, management of collaborative groups, lightweight signal processing, networks of high-data-rate sensors, closing the loops with actuators, distributed information architecture.

Suggested Readings:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks, Technology, Protocols and Applications”, Wiley, 2007.
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.
3. Jun Zheng, Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, Wiley, 2009.
4. Ian F. Akyildiz, Mehmet Can Vuran, “Wireless Sensor Networks”, Wiley, 2010
5. Ibrahiem M. M. El Emary, S. Ramakrishnan, “Wireless Sensor Networks: From Theory to Applications”, CRC Press Taylor & Francis Group, 2013.
6. Feng Zhao and Leonides Guibas, "Wireless sensor networks ", Elsevier publication - 2004.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE57	Cyber Laws	4	3L-1T-0P	None

COURSE OUTCOMES:

CO 1 : To understand the fundamentals of Cyber law and different kinds of cyber-crimes.
CO 2 : To identify the Cybercrime & Cyber security trends and jurisprudence impacting cyberspace in today’s scenario.
CO 3 : To analyse and understand the IT ACT 2000, its applicability with crimes and penalties.
CO 4 : To understand the Indian Evidence ACT for cybercrime related cases.
CO 5 : To understand and analyse about Intellectual Property Right, jurisdiction in Trademark Related laws and dispute resolution with respect to Cyber.

Unit No.	Topics
Unit 1	Fundamentals of Cyber Law and Cyber Crime: Introduction to Cyber Law, Need of Cyber Law, Difference between conventional and cyber crime, Cyber Frauds, Cyber Terrorism, Cyber defamation, Cyber Defacement, Phishing, Cyber Stalking, Cyber Security, Issues in Cyber Security, Types of Cyber Crimes, Social Media, E-

	commerce and its Laws in India
Unit 2	IT Act, Amendments , Jurisdiction and Data Security Evolution of IT Act, genesis and Necessity, features of the IT Act, 2000, Jurisdiction issues under IT Act, 2000, Amendments, Information Technology (Amendment) Act 2008 – Objective, Applicability and Jurisdiction, Data Privacy and Confidentiality, Digital Signature- technical and legal issues, Public key infrastructure, certificate authorities, Electronic record and evidence, E-governance Certifying Authority and Cyber Appellate Tribunal.
Unit 3	Cyber Crimes and their Punishments: Cyber crimes and their penalties under various sections, punishments and fines, Cyber Crimes: Freedom of speech in cyber space & human right issues, Investigation of Cyber Crimes, Investigation of malicious applications, Agencies for investigation in India, their powers and their constitution as per Indian Laws
Unit 4	Criminal Law and Indian Evidence Act: Introduction to Criminal Law, Essentials of criminal law, Constitution and hierarchy of criminal courts. Criminal Procedure Code (CPC). Cognizable and non-cognizable offenses. Bailable and non-bailable offenses. Indian Evidence Act – Evidence and. Expert witness. Cross examination and re-examination of witnesses. Sections 32, 45, 46, 47, 57, 58, 60, 73, 135, 136, 137, 138, 141. Section 293 in the code of criminal procedure. Secondary Evidence- Section 65-B.
Unit 5	Intellectual Property Issues and Cyber Space Copyright and Patent Law in Cyber Space, Trademarks & Domain Names Related issues and laws in cyber space, Jurisdiction in Trademark Disputes, Cybersquatting, Reverse Hijacking, Dispute Resolution Policy, Purpose of UDRP, Procedure of Dispute Resolution in Cyber Space. [7 hrs]

SUGGESTED READINGS:

1. Jonathan Rosenoer; “Cyber Law: The Law of Internet”, Springer- Verlag, New York, 1997.
2. Nina Godbole and Sunit Belapore; “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal
3. Perspectives”, Wiley Publications, 2011.
4. Sreenivasulu N.S; “Law Relating to Intellectual Property”, Patridge Publishing, 2013
5. Pavan Duggal; “Cyber Law – The Indian Perspective”, Saakshar Law Publications.
6. Harish Chander; “Cyber Laws and IT Protection”, PHI Learning Pvt. Ltd, 2012.
7. Vakul Sharma; “Information Technology: Law and Practice”, Universal Law Publishing Co., India, 2011.
8. Justice Yatindra Singh,Cyber Laws, Universal Law Publishing Co, New Delhi, (2012).
9. Verma S, K, Mittal Raman,Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004)
10. SudhirNaib, The Information Technology Act, 2005: A Handbook, OUP, New York,(2011)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE58	Distributed Systems	4	3L-0T-2P	Operating Systems

COURSE OUTCOMES:

CO 1 : To identify and recognize the concepts and fundamentals of Distributed Systems.
CO 2 : To classify and extract the issues evolving in Distributed systems
CO 3 : To apply and illustrate the communication between processes on same/different systems through IPC/RPC.
CO 4 : To design the performance of communicating processes on distributed systems.
CO 5 : To evaluate the performance of processes on distributed systems.

Unit No.	Topics
Unit 1	Introduction to Distributed Systems Introduction, Evolution of Distributed Systems (DS), Distributed OS, Issues in designing DS, Message passing, features of good message-passing system, Inter-process Communication (IPC) by message passing, Synchronization, Buffering, Multi-datagram messages, Encoding and decoding of messages, Process addressing, Failure handling, Group communication, performance metrics for Distributed Systems, Security design and principles of a Distributed System.
Unit 2	Remote Procedure Calls Remote Procedure Call (RPC) Model, Transparency of RPC, Implementing RPC mechanism, Stub generation, RPC messages, Marshalling arguments and results, Server management, Parameter-passing semantics, Call semantics, Communication protocols for RPCs.
Unit 3	Synchronization Introduction, Clock Synchronization: Clock Synchronization Issues, Clock Synchronization algorithms, Event Ordering: Happened-before relation, logical clocks concept, implementation of logical clocks, total ordering of events, Mutual Exclusion: centralized approach, distributed approach, token-passing approach, Deadlocks: necessary conditions for a deadlock, deadlock modeling, handling deadlocks in distributed systems, deadlock avoidance, deadlock, prevention, deadlock detection, deadlock recovery, Election Algorithms: bully algorithm, ring algorithm.
Unit 4	Resource Management Desirable features of a good global scheduling algorithm, Task assignment approach, Finding an optimal assignment, Load balancing approach, Load-balancing algorithms: Static and Dynamic load-balancing, Deterministic and Probabilistic load-balancing, Centralized and Distributed load-balancing, Cooperative and Non-cooperative load-balancing; Issues in designing load-balancing algorithms: Load estimation policy, Process transfer policy, State information exchange policy, Priority assignment policy, Migration limiting policy; Load sharing approach.
Unit 5	Process Management Process migration, Desirable features of a good process migration mechanism, Process migration mechanisms: Freezing and restarting a process, Address space transfer mechanisms, message-forwarding mechanisms, handling co-processes. Immediate and delayed blocking of the process, Fast and slow I/O operations, Information about open files, Reinstating the process on its destination node, Address transfer through Total freezing, Pre-transferring, Transfer on reference.

Suggested Readings:

1. Distributed Operating Systems: Concepts and Design, Pradeep K. Sinha, PHI Ltd.
2. Distributed Operating Systems, Andrew S. Tanenbaum, Pearson Education, India.
3. Distributed Systems 3rd Edition, Maarten V. Steen and Andrew S. Tanenbaum, CreateSpace Independent Publishing Platform.
4. Distributing Computing with Python, Francesco Pierfederici, O'Reilly.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE59	Green Computing	4	3L-0T-2P	Design and Analysis of Algorithm

COURSE OUTCOMES:

CO 1 : To acquire knowledge to adopt green computing practices to minimize negative impacts on the environment.
CO 2 : To enhance the skill in energy saving practices in their use of hardware.
CO 3 : To evaluate technology tools that can reduce paper waste and carbon footprint by the stakeholders.
CO 4 : To understand the ways to minimize equipment disposal requirements.

Unit No.	Topics
Unit 1	FUNDAMENTALS: Green IT Fundamentals: Business, IT, and the Environment –Environmental Impacts of IT, Green IT, Holistic Approach to Greening IT, Greening IT, Applying IT for enhancing. Environmental sustainability, Green IT Standards and Eco-Labelling of IT, Enterprise Green, IT strategy, Green IT: Burden or Opportunity?
Unit 2	Green Devices and Hardware with Green Software Green Devices Hardware/Software: Introduction, Life Cycle of a device or hardware, Reuse, Recycle and Dispose, Energy-saving software techniques, Evaluating and measuring software Impact to platform power.
Unit 3	GREEN ASSETS AND MODELING and GRID FRAMEWORK : Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration –Green Information Systems: Design and Development Models. Virtualization of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework.

Unit 4	GREEN COMPLIANCE and Social: Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies and Future. Introduction, Strategizing Green Initiatives, Implementation of Green IT, Information Assurance, Communication and Social media.
Unit 5	Regulating the Green IT and CASE STUDIES: Introduction, The regulatory environment and IT manufacturers, Non regulatory government initiatives, Industry associations and standards bodies, Green building standards, Green data centers, Social movements and Greenpeace. Case Studies – Applying Green IT Strategies and Applications to a Home, Hospital, Packaging Industry and Telecom Sector.

Suggested Readings:

1. Bhuvan Unhelkar, ―Green IT Strategies and Applications-Using Environmental Intelligence‖, CRC Press, June 2014.
2. Woody Leonhard, Katherine Murray, ―Green Home computing for dummies‖, August 2012.
3. Harnessing Green IT Principles and Practices , San Murugesan, G.R. Gangadharan, Wiley Publication, ISBN:9788126539680.
4. Alin Gales, Michael Schaefer, Mike Ebbers, ―Green Data Center: steps for the Journey‖, Shroff/IBM rebook, 2011.
5. John Lamb, ―The Greening of IT‖, Pearson Education, 2009.
6. Jason Harris, ―Green Computing and Green IT- Best Practices on regulations & industry‖, Lulu.com, 2008
7. Carl speshocky, ―Empowering Green Initiatives with IT‖, John Wiley & Sons, 2010.
8. Wu Chun Feng (editor), ―Green computing: Large Scale energy efficiency‖, CRC Press.

MINOR-II (MACHINE INTELLIGENCE AND DATA ANALYTICS)

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE61	Hadoop and Spark	4	3L-0T-2P	Artificial Intelligence

COURSE OUTCOMES:

CO 1 : Understand the fundamental concepts and need of Hadoop
CO 2 : Acquire fundamental knowledge of HDFS architecture and mapreduce
CO 3 : Illustrate the concept of Apache Spark and its features
CO 4 : Know the importance of Spark streaming
CO 5 : Implement the real world problems using Pig and Hive

Unit No.	Topics
Unit 1	Hadoop Introduction Why Hadoop is at the heart of every Big Data solution, Introduction to the Big Data Hadoop framework, Hadoop architecture and design principles, Hadoop characteristics and data-flow, Components of the Hadoop ecosystem, Hadoop Flavors – Apache, Cloudera, Hortonworks, and more
Unit 2	HDFS and MapReduce HDFS (Hadoop Distributed File System) architecture, HDFS data flow and storage mechanism, Responsibility of HDFS Master – NameNode, Storage mechanism of Hadoop meta-data, Work of HDFS Slaves – DataNodes, Replication of blocks, reliability, and high availability, Rack-awareness, scalability, and other features, What is MapReduce, need for a distributed processing framework, Issues before MapReduce and its evolution, Components of MapReduce – Mapper and Reducer, Hadoop MapReduce execution flow, Execution of Map and Reduce together, Optimization of MapReduce Jobs, Working with map-only jobs
Unit 3	Apache Spark Introduction to Apache Spark, Architecture and design principles of Apache Spark, Spark features and characteristics, Apache Spark Ecosystem components and their insights
Unit 4	Spark Streaming The need for stream analytics, Comparison with Storm and S4, Real-time data processing using streaming, Fault tolerance and checkpointing in Spark, Stateful Stream Processing, DStream and window operations in Spark, Spark Stream execution flow, Connection to various source systems, Performance optimizations in Spark
Unit 5	Data Analysis Tool – Hive and Pig Introduction and architecture of Hadoop Hive, Hive shell and running HQL queries, Hive DDL and DML operations, Hive execution flow, Schema design and other Hive operations, Schema-on-Read vs Schema-on-Write in Hive, need for a high level query language - Apache Pig, How Pig complements Hadoop with a scripting language, Pig execution flow, Different Pig operations like filter and join, Compilation of Pig code into MapReduce, Comparison - Pig vs MapReduce

Suggested Readings:

1. Hadoop: The Definitive Guide: Storage and Analysis at Internet Scale, Tom White, O'Reilly
2. Practical Data Science with Hadoop and Spark: Designing and Building Effective Analytics at Scale (Addison-Wesley Data & Analytics) by Ofer Mendelevitch , Casey Stella, Douglas Eadline
3. Learning Spark: Lightning-Fast Data Analytics, Jules Damji, O'Reilly
4. Hadoop Real-world Solutions, Brian Femiano, Jon Lentz, Jonathan Owens, Packet Publishing
5. Public data sets from Kaggle website https://www.kaggle.com/

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE62	Data Compression and Video Analytics	4	3L-0T-2P	Computer Graphics

COURSE OUTCOMES:

CO 1 : Choose the appropriate compression technique.
CO 2 : Compare various compression techniques for different applications.
CO 3 : Understand the need for video Analytics
CO 4 : Understand the basic configuration and functional block of video analytics system
CO 5 : Design custom made video analytics system for the given target application

Unit No.	Topics
Unit 1	Text Compression: Loss less compression, Lossy Compression, Measures of performance, Modeling and coding, Mathematical Preliminaries for Loss-less compression, Text Compression techniques- Huffman Coding (Static and Dynamic), Arithmetic Coding, LZ-77, LZ-78, LZW.
Unit 2	Image, Audio, Video Compression: zip, gzip, bzip, unix compression, Discrete cosine transform, Image File formats- GIF, JPEG, PNG, JPEG Encoder and Decoder, MPEG motion video compression standard, Video File Format.
Unit 3	Video Analytics Components: Need for Video Analytics, Overview of video Analytics, Foreground extraction, Feature extraction, classifier, Preprocessing, edge detection, smoothening, Feature space-PCA, SIFT, SURF, LBP, variants of LBP.
Unit 4	Foreground Extraction: Background estimation, Averaging, Gaussian Mixture Model, Image Segmentation- Watershed, Region growing, Region splitting, K-means, UNets, Morphological operations- erosion and dilation, Tracking in a multiple camera environment, Motion Estimation, Optical Flow
Unit 5	Applications of Video Analytics: Human behavioral analysis, Human action recognition, crowd analysis and prediction of crowd congestion, Customer behavior analysis, Traffic rule violation detection, traffic congestion identification for route planning, driver assistance and lane change warning

Suggested Readings:

1. Multimedia Communications by Fred Halsall.
2. Introduction to Data Compression, 3rd Edition, Khalid Sayood, Morgan Kauffman
3. Digital Image Processing by Rafael C. Gonzalez.
4. Video-Based Surveillance Systems: Computer Vision and Distributed Processing by Graeme A. Jones, Nikos Paragios, Carlo S. Regazzoni, Kluwer academic publisher.
5. The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video

Analytics Suite, by Zhihao Chen, Ye Yang, Jingyu Xue, Liping Ye, Feng Guo, CreateSpace Independent Publishing Platform.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE63	Deep and Reinforcem-ent Networks	4	3L-0T-2P	Design and Analysis of Algorithms

COURSE OUTCOMES:

CO 1 : Identify the basic idea of Artificial Neural Networks.
CO 2 : Choose the correct model to visualize the problem.
CO 3 : Compare various activation functions over various applications.
CO 4 : Analyze different models of Artificial Neural Networks.
CO 5 : Design various models for different applications of Artificial Neural Networks.

Unit No.	Topics
Unit 1	Overview of Artificial Neural Networks: Biological Neurons, MCP model, Perceptron learning algorithm, multilayer perceptron, Gradient Descent, Backpropagation, regularization.
Unit 2	Deep Neural Networks: Learning with Deep Network, Auto-encoders, Convolutional Neural Network, Building blocks of CNN, Transfer Learning.
Unit 3	Adversarial examples – GANs,Generative Adversarial Nets, Conditional GAN, Super-Resolution GAN, Cycle-GAN
Unit 4	Recurrent Neural Networks: Recurrent Neural network model, Different types of RNNs, vanishing gradients with RNN, LSTM, Gated Recurrent units,BidirectionalLSTM.
Unit 5	Applications and Recent trends: Speech, NLP, Multi-task deep learning, sequence-to-sequence models.

Suggested Readings:

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 Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.
3. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
4. EthemAlpaydin,"Introduction to Machine Learning”, MIT Press, Prentice Hall of India, Third Edition 2014.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE64	Natural Language Processing	4	3L-0T-2P	Discrete Structures

COURSE OUTCOMES:

CO 1 : To get introduced to language processing technologies for processing the text data
CO 2 : To understand the role of Information Retrieval and Information Extraction in Text Analytics.
CO 3 : To analyze the text data at syntactic and semantic level.
CO 4 : To Analyze the text content to provide predictions related to a specific domain using language models.
CO 5 : To acquire knowledge on text data analytics using language models.

Unit No.	Topics
Unit 1	Natural Language Processing Natural Language Processing – Linguistic Background, Mathematical Foundations -Morphological Analysis-Tokenization- Stemming-Lemmatization, Boundary Determination. Reading unstructured data, Representing text data, Part of speech tagging, Syntactic representation, Text similarity - WordNet based similarity- Shallow parsing -Semantic representation, Applications of NLP: conversational interfaces (chat bots), search engines, robotics and social media advertising, Adaptive Healthcare systems, Adaptive Transportation systems, Geographical Information Systems, Adaptive mobile applications, Interoperable Geospatial applications, Large scale e-services, Feature engineering, Multi-lingual knowledge Acquisition, Adaptive Natural Language Processing, Scalability of learning algorithm, ML for Global Information Management, ML for web navigation and mining Mobile data and multimedia mining Cognitive Learning.
Unit 2	Semantic and Pragmatic Interpretation Representation of Meaning, Desirable Properties, Computational Semantics -Word Senses -Relations Between Senses, WordNet, Event Participants-Proposition Bank, Frame Net Metaphor. Computational Lexical Semantics, Word Sense Disambiguation-Supervised Word Sense Disambiguation -Dictionary and Thesaurus Methods-Word Similarity -Minimally Supervised WSD -Hyponymy and Other Word Relations -Semantic Role Labelling -Unsupervised Sense Disambiguation. Computational Discourse, Discourse Segmentation -Unsupervised Discourse -Segmentation..
Unit 3	Phonetics Articulatory Phonetics, Phonological Categories, Acoustic Phonetics and Signals -Speech Synthesis–Text Normalization, Phonetic and Acoustic Analysis, Evaluation-Automatic Speech Recognition Architecture

Unit 4	Language model Language model - Probabilistic Models - n-gram language models- Hidden Markov Model- Topic Modelling - Graph Models -Feature Selection and classifiers -Rule-based Classifiers - Maximum entropy classifier – Clustering-Word and Phrase-based Clustering
Unit 5	Tools Tools – Natural Language Tool kit, Apache OpenNLP. Applications of Text Analytics –Applications in Social media - Life science - Legal Text–Visualization -Case studies.

Suggested Readings:

1. Christopher D. Manning and Hinrich Schutze, “Foundations of Statistical Natural Language Processing”, MIT Press, 1999.
2. Jurafsky and Martin, “Speech and Language Processing”, Pearson Prentice Hall, Second Edition, 2008
3. Steven Struhl, “Practical Text Analytics: Interpreting Text and Unstructured Data for Business Intelligence”, Kogan Page, 2015.
4. James Allen, “Natural Language Understanding”, Addison Wesley, Second Edition, 2007.
5. Steven Bird, Ewan Klein and Edward Loper, “Natural Language Processing with Python”, 1st Edition, O'Reilly Media, 2009.
6. https://github.com/keon/awesome-nlp
7. https://www.edx.org/learn/natural-language-processing
8. https://www.edx.org/course/introducing-text-analytics-and-natural-language-processing-with-python
9. https://www.coursera.org/learn/language-processing
10. https://www.mooc-list.com/course/natural-language-processing-nlp-edx
11. https://onlinecourses.nptel.ac.in/noc19_cs56/preview
12. https://onlinecourses.nptel.ac.in/noc20_cs87/preview
13. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-863j-natural-language-and-the-computer-representation-of-knowledge-spring-2003/lecture-notes/
14. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-864-advanced-natural-language-processing-fall-2005/

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE65	Metaheuristic Algorithms	4	3L-0T-2P	Optimization Principles and Techniques

COURSE OUTCOMES:

CO 1 : Understand the basic ideas of metaheuristics algorithms.
CO 2 : Understand the class of problems that benefit from and are amenable to be efficiently solvable by metaheuristics.
CO 3 : Describe the difference between the intensification and diversification in the context of metaheuristics
CO 4 : Know how to use metaheuristics for solving practical problems

CO 5 : Able to implement a metaheuristic algorithm on a given problem	
Unit No.	Topics
Unit 1	Introduction to Optimization and Metaheuristic: Introduction to the concept of Optimization, Type of optimization problems, Strategies to solve NP-hard optimization problem, Combinatorial explosion, Fundamental properties of metaheuristic algorithms, When to use metaheuristics algorithms, Classification of metaheuristic algorithm, Types of solution/search space, Fitness function, Overall structure of metaheuristic algorithms.
Unit 2	Trajectory based algorithms: Local search vs. global search, Hill climbing, Iterated local search, Simulated Annealing (SA)- neighboring solutions, control parameters, Tabu search- Tabu search strategy: forbidding, freeing and short-term, Tabu list, Aspiration criterion, Stopping criterion
Unit 3	Evolutionary Algorithms: Introduction to genetic algorithm; Intensification and Diversification (exploitation and exploration); Population representation: Encoding types- integer encoding, binary encoding, value encoding, permutation encoding; Operators of GA: selection, crossover and mutation, Effect of population size and number of iterations on the performance of GA
Unit 4	Swarm-Intelligence, Population-based and Nature inspired algorithms: : Particle Swarm Optimization (PSO) – inspiration, effect of various parameters on the performance of PSO, Artificial Bee Colony Optimization (ABC)- inspiration, types of bee- employed bee, onlookers and scout, Cat Swarm Optimization algorithm (CSOA)- seeking mode, tracing mode, Seeking Memory Pool (SMP), Seeking Range of the selected Dimension for mutation (SRD), Count of Dimension to Change (CDC), Self Position Consideration (SPC), Lions Optimization algorithm, Frog Leap Optimization algorithm, Elephant Herding Optimization (EHO), Firefly Algorithm (FA), Bat algorithm (BA), Plant Propagation algorithm (PPA), Arithmetic optimization algorithm (AOA) , Water Wave Optimization Algorithm, hybrid metaheuristics
Unit 5	Applications of Metaheuristic Algorithms: Feature selection, Artificial neural networks weight and structure optimization, Parameter tuning in deep learning models, Image processing, Scheduling, Software engineering: test set optimization problem

Suggested Readings:

1. Essentials of Metaheuristics by Sean Luke.
2. Metaheuristics:From Design to Implementation by El-Ghazali Talbi, Wiley
3. Evolutionary Algorithms and Neural Networks: Theory and Applications by Seyedali Mirjalili
4. Nature-Inspired Metaheuristic Algorithms by Xin-She Yang
5. Metaheuristics in Machine Learning: Theory and Applications by Diego Oliva, Essam H. Houssein, Salvador Hinojosa

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite

ITITE66	Machine Vision	4	3L-0T-2P	Artificial Intelligence

COURSE OUTCOMES:

CO 1 : To understand the fundamentals of Computer Vision, understand Low and mid-level processing.
CO 2 : To identify the emerging applications of computer vision in today's scenario.
CO 3 : To analyze and understand the Segmentation and compression, its applicability in real life.
CO 4 : To understand the fundamentals of Convolutional Neural Networks for Computer vision.
CO 5 : To understand and analyze various applications of Computer Vision

Unit No.	Topics
Unit 1	Introduction to Computer Vision: Computer vision Systems, Digital Image Processing, Characteristics of Digital Image, Basic relationship between pixels, Distance Measure, Fundamental operations on image, Digital Watermarking, Image components. Image noise models, Low and Mid-level image processing in Computer vision.
Unit 2	Basic Techniques of Computer Vision: Fundamentals of spatial filtering: spatial correlation and convolution-smoothing blurring, sharpening, Basics of filtering: smoothing-blurring, sharpening, Histograms and basic statistical models of image, Color models.
Unit 3	Segmentation and Compression: Image Segmentation, Image and Video enhancement, Image compression, Principal Component Analysis, Linear Discriminant Analysis
Unit 4	Object detection and Classification: Object detection and recognition in image and video-Texture models Image and Video classification models- Object tracking in Video, Convolutional Neural Networks for Computer Vision
Unit 5	Applications and Case Studies: Implementation of application like face detection, face recognition, eigen faces, surveillance, foreground-background separation, particle filters, Chamfer matching, tracking, and occlusion, human detection, locating roadway, identifying road signs, locating pedestrians; case studies and recent researches in Computer vision

Suggested Readings:

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing, Pearson Education, 4th edition, 2018
2. A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 1995
3. Rick Szelisk, "Computer Vision: Algorithms and Applications", Springer 2011.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite

ITITE67	Social Network Mining and Analysis	4	3L-0T-2P	Design and Analysis of Algorithms

COURSE OUTCOMES:

CO 1 : Describe the current web development and emergence of social web.
CO 2 : Summarize knowledge on extraction and analyzing of social web.
CO 3 : Discover different types of mining algorithms and techniques.
CO 4 : Illustrate the evolution of social networks and Recommendation Systems.
CO 5 : Design modeling, aggregating and knowledge representation of semantic web.

Unit No.	Topics
Unit 1	Introduction: Introduction to Semantic Web: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web. Social Network analysis: Development of Social Network Analysis, Key concepts and measures in network analysis.
Unit 2	Modelling, Aggregating and Knowledge Representation: Ontology and their role in the Semantic Web: Ontology-based knowledge Representation – Ontology languages for the Semantic Web: Resource Description Framework – Web Ontology Language – Modelling and aggregating social network data: State-of-the-art in network data representation – Ontological representation of social individuals
Unit 3	Mining algorithms and Techniques: Overview, functionalities, The knowledge discovery process, Mining applications and benefits, Association Rule Mining, Supervised Learning, Unsupervised Learning, Semi-supervised Learning, K-Nearest Neighbors, Content-based Recommendation, Collaborative Filtering Recommendation, Social Network Analysis, Detecting Community Structure in Networks
Unit 4	Extracting and Analyzing Web Social Networks: Extracting Evolution of Web Community from a Series of Web Archive, Temporal Analysis on Semantic Graph using Three-Way Tensor, Decomposition, Analysis of Communities and Their Evolutions in Dynamic.
Unit 5	Web Mining and Recommendation Systems: User-based and Item-based Collaborative Filtering Recommender Systems, Hybrid User-based and Item-based Web Recommendation System, User Profiling for Web Recommendation based on PLSA and LDA Model, Combing Long-Term Web Achieves and logs for Web Query Recommendation

Suggested Readings:

1. Peter Mika, “Social networks and the Semantic Web”, Springer, 2007.
2. Guandong Xu,Yanchun Zhang, and Lin Li, “Web Mining and Social Networking Techniques and Applications”, Springer.
3. Borko Furht, “Handbook of Social Network Technologies and Applications”, 1st Edition, Springer, 2010.
4. Guandong Xu ,Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, First Edition Springer, 2011.
5. Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, “Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling”, IGI Global Snippet, 2009.
6. Charu C. Aggarwal, “Social Network Data Analytics”, Springer; 2011.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE68	Computational Data Science	4	3L-0T-2P	Artificial Intelligence

COURSE OUTCOMES:

CO 1 : Understand the fundamental concepts of data science
CO 2 : Acquire fundamental knowledge of learning theory
CO 3 : Illustrate the concept of regression techniques and ensemble learning
CO 4 : Select appropriate statistical test for a given machine learning problem
CO 5 : Formulate new solutions by applying data science applications in various fields

Unit No.	Topics
Unit 1	Introduction What is Data Science, importance of data science, Big data and data Science, The current Scenario, Industry Perspective Types of Data: Structured vs. Unstructured Data, Quantitative vs. Categorical Data, Big Data vs. Little Data, Data science process, Role Data Scientist
Unit 2	Learning Theory Introduction-Population and samples, Data Preparation, Exploratory Data Analysis-Summarizing Data, Data Distribution , Feature Extraction, Feature Construction and Transformation, Feature Selection, Dimensionality Reduction: Subset Selection and its types, feature ranking, consistency based feature selection, correlation feature selection , the Curse of dimensionality, Principle Components analysis, Independent Component analysis, Factor analysis, Multidimensional scaling, Linear discriminant analysis, Bias/Variance tradeoff
Unit 3	Regression and ensemble Modeling Introduction, Linear regression, logistic regression, Univariate and multivariate regression, regression coefficients, Parameter estimation, likelihood, heterogenous and homogenous ensemble methods, (bagging, boosting, stacking, grading), their examples and algorithms
Unit 4	Statistical test Hypothesis testing and its types, p-values, and confidence intervals, statistical assumptions, normal distribution, parametric test, non normal distribution and its types (Beta Distribution, Exponential Distribution, Gamma Distribution, Log-Normal Distribution, Logistic Distribution, Maxwell-Boltzmann Distribution, Poisson Distribution), non parametric tests, choosing the right statistical test
Unit 5	Applications with case studies Data science applications in various fields in marketing, healthcare, banking, finance, etc. Case Studies: Credit card Fraud Analysis, Sentiment Analysis, Recommendation Systems and Collaborative filtering, Uber Alternative Routing , Fake News Detection, Chatbot, Credit Card Fraud Detection, Driver Drowsiness Detection, Speech Emotion Recognition, Breast Cancer Classification, Movie Recommendation System, Sentiment Analysis, Project Customer Segmentation Gender and Age Detection, Uber Data Analysis, Handwritten Digit Recognition, Project Image Caption Generator, Traffic Sign Recognition.

Suggested Readings:

1. Cathy O'Neil, Rachel Schutt, Doing Data Science, Straight Talk from The Frontline. O'Reilly, 2013.
2. Introducing Data Science, Davy Cielen, Arno D. B. Meysman, Mohamed Ali, Manning Publications Co., 1st edition, 2016
3. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten,

Trevor Hastie, Robert Tibshirani, Springer, 1st edition, 2013
4. Jure Leskovek, Anand Rajaraman, Jeffrey Ullman, Mining of Massive Datasets. v2.1, Cambridge University Press, 2014.
5. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 1st edition, 2015.
6. https://www.jigsawacademy.com/blogs/data-science/data-science-project-ideas
7. https://github.com/academic/awesome-datascience

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE69	Pattern Recognition and Recommender Systems	4	3L-0T-2P	Artificial Intelligence

COURSE OUTCOMES:

CO 1 : Describe the concept of Pattern recognition and Recommender systems, analysis and applications.
CO 2 : Classify the different types of issues and challenges of patterns.
CO 3 : Synthesize knowledge on data to learn and predict.
CO 4 : Analyze various models in predicting patterns.
CO 5 : Apply the Recommender Systems to provide recommendations related to specific domains.

Unit No.	Topics
Unit 1	Introduction to Pattern Recognition: Pattern recognition systems, features and feature extraction, learning, feature selection and visualization. Supervised and Unsupervised Learning, Bayes Decision Theory: Introduction to Bayesian decision theory-The continuous case. Two category classification, Estimation of Posteriori Probabilities, Generalized Bayes theorem, Conditional risk or expected loss, Minimum risk classifier, Minimum error rate classification, classifiers, Discriminant Functions, Error probability.
Unit 2	Regression and Dimensionality Reduction: Feature Normalization, Regression analysis, Gradient descent, Multiple Linear Regression, Polynomial Regression Model, Logistic Regression, Regularization, Dimensionality reduction, Principal Component Analysis, Linear Discriminant analysis, Clustering.
Unit 3	Recommender Systems: Recommender systems, discovering features of documents, obtaining item features from tags, representing item profiles, Methods for learning user profiles, Similarity based retrieval, Classification algorithms., content based and collaborative filtering methods, Evaluation of recommenders, Validation of recommender system, Content based: similarity of item attributes, collaborative: similarity from interactions.
Unit 4	Evaluating Recommender System: interaction matrix, rating matrix, explicit rating of items. predicts utility of items Matrix factorization, k — nearest neighbors, stochastic gradient descent, Association rules Mining General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.
Unit 5	Recommender Systems and communities: Pattern Analysis, Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group Recommender Systems.

Suggested Readings:

1. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006..

2. An Introduction to Statistical Learning with Applications, Gareth James, Daniela Witten, Trevor Hastie, Robert Toshigami, Springer
3. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press.
4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer.

Course No.	Title of the Course	Credits	Course Structure	Pre-Requisite
ITITE70	Multimedia Technology	4	3L-0T-2P	Computer Graphics

COURSE OUTCOMES:

CO 1 : Identify the basic principles, concepts and applications of Multimedia.
CO 2 : Choose the appropriate element of multimedia to deliver messages and content in meaningful ways.
CO 3 : Compare various compression techniques and file types for different applications.
CO 4 : Analyze concepts that provide the foundation of Multimedia.
CO 5 : Design and develop multimedia projects of all kinds and avoiding technical and legal pitfalls along the way.

Unit No.	Topics
Unit 1	Introduction to Multimedia: Framework for multimedia systems, Multimedia devices; CD- Audio, CD-ROM, CD-I, presentation devices and the user interface, characteristics of Multimedia, elements of Multimedia, Multimedia presentation and authoring tools.
Unit 2	Types of text, Unicode Standard, Text Compression techniques- Huffman Coding (Static and Dynamic), Arithmetic Coding, LZ-77, LZ-78, LZW. Text file formats.
Unit 3	Image types, Basic steps for Image processing, Scanner, Digital camera, Interface Standards, Image processing software, Image File formats File formats- GIF, JPEG, PNG, DICOM in radiology applications, DICOM Viewer, Conquest PACS server, Introduction to Orthanc PACS server, PyDICOM library.
Unit 4	Introduction, Fundamentals Characteristics of sound, Elements of Audio systems, Musical Instrument Digital Interface (MIDI), MIDI messages, MIDI connections, MPEG motion video compression standard, Video File Format, Compression standards and techniques.
Unit 5	Introduction, uses of animation, key frames and Tweening, Types of animation, Animation on the web, 3D Animation, Special Effects, Creating Animation, Multimedia Conferencing, video-on-demand broadcasting issues, case studies using blender, inkscape, gimp, turtle blocks, turtle music and d3.js, webgl.

Suggested Readings:

1. Ranjan Parekh, “Principles of Multimedia”.
2. Fred Halsall, “Multimedia Communications”.
3. www.sugarlabs.org