Proposed Syllabus

Of

B.Tech

Computer Science and Engineering (Internet of Things, Cyber Security including Block Chain Technology)

Semester – I (FirstYear)							
MandatoryInductionProgram-3 weeksduration							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	BasicScience course	BS-PH101/BS-CH101	Physics-I(Gr-A)/Chemistry-I(Gr-B)	3	1	0	4
2	BasicScience course	BS-M101/BS-	Mathematics–IA*/Mathematics–	3	1	0	4
3	EngineeringScienceCourses	ES-EE101	BasicElectrical Engineering	3	1	0	4
	Total Theory			**9**	**3**	**0**	**12**
Practical							
1	BasicScience course	BS-PH191/BS-CH191	Physics-ILaboratory(Gr-A)/Chemistry-	0	0	3	1.5
2	EngineeringScienceCourses	ES-EE191	BasicElectricalEngineeringLaboratory	0	0	2	1
3	EngineeringScienceCourses	ES-ME191/ES-ME192	EngineeringGraphics &Design(Gr-B)/Workshop/ManufacturingPractices(Gr-A)	1	0	4	3
	Total Practical			**1**	0	**9**	**5.5**
	Total of First Semester			**10**	**3**	**9**	**17.5**

Semester – II (FirstYear)							
Sl No.	**Category**	**Subject Code**	**SubjectName**	**TotalNumberofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	BasicSciencecourses	BS-PH201/BS-CH201	Physics-I(Gr-B)/Chemistry-I(Gr-A)	3	1	0	4
2	BasicSciencecourses	BS-M201/BS-	Mathematics–IIA#/Mathematics#	3	1	0	4
3	EngineeringScience Courses	ES-CS201	Programmingfor ProblemSolving	3	0	0	3
4	HumanitiesandSocialSciencesincludingManagementcourses	HM-HU201	English	2	0	0	2
	Total Theory			**11**	**2**	**0**	**13**
Practical							
1	BasicSciencecourses	BS-PH291/BS-CH291	Physics-ILaboratory(Gr-B)/Chemistry-	0	0	3	1.5
2	EngineeringScience Courses	ES-CS291	Programmingfor ProblemSolving	0	0	4	2
3	EngineeringScience Courses	ES-ME291/ES-ME292	EngineeringGraphics &Design(Gr-A)/Workshop/ManufacturingPractices(Gr-B)	1	0	4	3
4	HumanitiesandSocialSciencesincludingManagementcourses	HM-HU291	LanguageLaboratory	0	0	2	1
	Total Practical			**1**	**0**	**13**	**7.5**
	Total of Second Semester			**12**	**2**	**13**	**20.5**

First year syllabus is common

to all

for B Tech Courses

Semester III (SecondYear)							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	Engineering Science Course	*	Mathematics - III	2	0	0	2
2	Humanities & Social Sciences including Management courses	*	Economics for Engineers (Humanities-II)	3	0	0	3
3	Professional Core Courses	*	Data Structures and Algorithm	3	0	0	3
4	Professional Core Courses	*	Analog and Digital Electronics	3	1	0	4
5	Professional Core Courses	*	Computer Organization	3	0	0	3
6	Professional Core Courses	*	Object Oriented Programming	3	0	0	3
	Total Theory			**17**	**1**	**0**	**18**
Practical							
1	Professional Core Courses	*	Analog and Digital Electronics Laboratory	0	0	3	1
2	Professional Core Courses	*	Data Structures Laboratory	0	0	3	1
3	Professional Core Courses	*	Object Oriented Programming Lab	0	0	4	2
	Total Practical			**0**	**0**	**10**	**4**
	Totalof ThirdSemester			**17**	**1**	**10**	**22**

* **Subject Code to be decided by University**

Semester IV (SecondYear)							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	Engineering Science Course	*	Mathematics -IV	3	1	0	4
2	Professional Core Courses	*	Design and Analysis of Algorithms	3	1	0	4
3	Professional Core Courses	*	Operating Systems	3	1	0	4
4	Professional Core Courses	*	Software Engineering & Testing Methodologies	3	0	0	4
5	Professional Core Courses	*	Data Communications and Networks	3	0	0	3
6	Professional Core Courses	*	Environmental Science	1	0	0	1
	Total Theory			**16**	**3**	**0**	**20**
Practical							
1	Professional Core Courses	*	Design and Analysis of Algorithm Lab.	0	0	3	1
2	Professional Core Courses	*****	Operating Systems Lab.	0	0	3	1
	Total Practical			**0**	**0**	**6**	**2**
	Total of Forth Semester			**16**	**3**	**6**	**22**

* **Subject Code to be decided by University**

Semester V (Third Year)							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	Engineering Science Course	*	Operations Research	3	0	0	3
2	Professional Core Courses	*	Formal Language & Automata Theory	3	0	0	3
3	Professional Core Courses	*	Introduction to IOT and its security	3	0	0	3
4	Professional Core Courses	*	Biology	2	1	0	3
5	Professional Core Courses	*	Computer Graphics	3	0	0	3
6	Professional Core Courses	*	Database Systems	3	0	0	3
	Total Theory			**17**	**1**	**0**	**18**
Practical							
1	Professional Core Courses	*	ComputerGraphics Lab.	0	0	3	1
2	Professional Core Courses	*	Database Lab	0	0	3	1
3	Professional Core Courses	*	**Application Oriented Programming using Python Lab**	0	1	3	2
	Total Practical			**0**	**1**	**9**	**4**
	Total of Fifth Semester			**17**	**2**	**9**	**22**

* **Subject Code to be decided by University**

Semester VI (Third Year)							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	Engineering Science Course	*	Introduction to Block Chain Technology	3	0	0	3
2	Professional Core Courses	*	Privacy and Security of IOT	3	0	0	3
3	Professional Core Courses	*	Digital Forensic	3	1	0	4
4	Professional Core Courses	*	Ethical Hacking and Penetration Testing	3	1	0	4
5	Professional Core Courses	*	Compiler Design	3	0	0	3
6	Professional Core Courses	*	Cryptography and Network Security	3	0	0	3
	Total Theory			**18**	**2**	**0**	**20**
Practical							
1	Professional Core Courses	*	Digital Forensic Lab	0	0	3	1
2	Professional Core Courses	*	Compiler Design Lab	0	0	3	1
3	Professional Core Courses	*	Cryptography and Network Security Lab	0	0	3	1
	Total Practical			**0**	**0**	**9**	**3**
	Total of Sixth Semester			**18**	**2**	**9**	**23**

* **Subject Code to be decided by University**

Semester VII (Fourth Year)							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	Professional Core Courses	*	Programming for IoT	3	0	0	3
2	Professional Core Courses	*	Cyber Security in Block Chain Technology	3	0	0	3
3	Professional Core Courses	*	Block Chain using Multi Chain	3	0	0	3
4	Professional Core Courses	*	Program Elective – I (Fundamental of Business Analytics)	3	0	0	3
5	Professional Core Courses	*	Program Elective – II (Implementing Block Chain in Cloud/ Information Security and Audit Monitoring)	3	0	0	3
6	Professional Core Courses	*	Open Elective – I (Multimedia Technology/Introduction to Philosophical Thoughts)	3	0	0	3
	Total Theory			**18**	**0**	**0**	**18**
Practical							
1			IOT Lab	0	0	3	1
2			Ethical Hacking Lab	0	0	3	1
3			Internship				
	Total Practical						
	Total of Seventh Semester			**18**	**0**	**0**	**18**

* **Subject Code to be decided by University**

Semester VIII (Fourth Year)							
Sl No.	**Category**	**SubjectCode**	**SubjectName**	**TotalNumber ofcontacthours**			**Credits**
				L	**T**	**P**	
Theory							
1	Engineering Science Course	*	IndustrialTraining				2
2	Professional Core Courses	*	Projectwork/Practice School				12
	Total Theory						**14**
Practical							
	Total Practical						
	Totalof Eighth Semester						14

* **Subject Code to be decided by University**

SECOND YEAR
THIRD SEMESTER

❖ MATHEMATICS -III [2 0 0 2]

Statistics: Measures of central tendency – mean, median, mode, measures of dispersion – mean deviation, standard deviation, quartile deviation, skewness and kurtosis. Correlation coefficient, regression, least squares principles of curve fitting. Probability: Introduction, finite sample spaces, conditional probability and independence, Bayes' theorem, one dimensional random variable, mean, variance. Two and higher dimensional random variables: mean, variance, correlation coefficient. Distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, simple problems. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. Partial Differential Equations: Numerical solutions of partial differential equations by finite difference methods, five-point formula, Laplace Poisson Equations, Heat equation, Crank Nicolson's method, Wave equation. Application of Finite Difference technique.

References:

1. Meyer P.L. "*Introduction to probability and statistical applications*", 2nd edn., American Publishing Co.
2. Hogg and craig ,*Introduction to mathematical statistics*, 6th Edn,2012, Pearson education, New Delhi.
3. Ross Sheldon M, "*Introduction to Probability and Statistics for Engineers and Scientists*", Elseveir, 2010.
4. William J. Stewart, *Probability, Markov Chains, Queues and Simulation*.
5. S. Narayanan, T. K. Manicavachagom Pillay, G. Ramanaiah, *Advanced mathematics for engineering students*, S. Viswanathan Pvt.. Ltd., 1985.

❖ Economics for Engineers (Humanities-II) [3 0 0 3]

Unit	Content	Hrs/Unit	Marks/Unit
1	1. EconomicDecisionsMaking– Overview,Problems,Role,Decisionmakingprocess. 2. EngineeringCosts&Estimation– Fixed,Variable,Marginal&AverageCosts,SunkCosts,OpportunityCosts,RecurringAnd NonrecurringCosts,IncrementalCosts,CashCostsvsBookCosts,Life-CycleCosts;TypesOfEstimate,EstimatingModels - Per-UnitModel,SegmentingModel,CostIndexes,Power-SizingModel,Improvement&LearningCurve,Benefits.	9	
2	3.CashFlow,InterestandEquivalence:CashFlow– Diagrams,Categories&Computation,TimeValueof Money,Debtrepayment,Nominal&EffectiveInterest. 4.CashFlow&RateofReturnAnalysis– Calculations,TreatmentofSalvageValue,AnnualCashFlowAnalysis,AnalysisPeriods; InternalRateofReturn,CalculatingRateofReturn,IncrementalAnalysis;BestAlternativeChoosinganAnalysis Method,Future WorthAnalysis,Benefit-CostRatioAnalysis,SensitivityandBreakevenAnalysis.EconomicAnalysisInThePublicSector-QuantifyingAndValuingBenefits& drawbacks.	9	

3	5. InflationandPriceChange– Definition,Effects,Causes,PriceChangewithIndexes,TypesofIndex,CompositevsCommodity Indexes,UseofPriceIndexesInEngineeringEconomicAnalysis, CashFlowsthatinflateatdifferent Rates. 6. PresentWorthAnalysis:End-Of-YearConvention,ViewpointOfEconomicAnalysisStudies,BorrowedMoneyViewpoint,Effect OfInflation&Deflation,Taxes,EconomicCriteria,ApplyingPresentWorthTechniques,MultipleAlternatives. 7. UncertaintyInFutureEvents-EstimatesandTheir UseinEconomicAnalysis, Range OfEstimates,Probability,JointProbability Distributions,ExpectedValue,EconomicDecisionTrees,Risk, RiskvsReturn,Simulation,RealOptions.	9	
4.	8. Depreciation- BasicAspects,Deterioration&Obsolescence,DepreciationAndExpenses,TypesOfProperty,DepreciationCalculationFundamentals,DepreciationAndCapitalAllowanceMethods,Straight-LineDepreciationDecliningBalanceDepreciation,CommonElementsOf TaxRegulationsFor DepreciationAndCapitalAllowances. 9. ReplacementAnalysis-ReplacementAnalysisDecisionMap,MinimumCostLifeofaNewAsset,MarginalCost,MinimumCost LifeProblems. 10. Accounting– Function,BalanceSheet,IncomeStatement,FinancialRatiosCapitalTransactions,CostAccounting,DirectandIndirectCosts,IndirectCostAllocation.	9	

Textbook andReferencebooks:

1. JamesL.Riggs,DavidD.Bedworth,SabahU.Randhawa:EconomicsforEngineers4e,TataMcGraw-Hill
2. DonaldNewnan,TedEschembach,JeromeLavelle:EngineeringEconomicsAnalysis,OUP
3. JohnA. White,KennethE. Case,DavidB.Pratt: PrincipleofEngineeringEconomicAnalysis, JohnWiley
4. Sullivan and Wicks: EngineeringEconomy,Pearson
5. R.PaneerSeelvan: EngineeringEconomics,PHI
6. MichaelR Lindeburg: EngineeringEconomicsAnalysis,ProfessionalPub
7. PremvirKapoor, Sociology&Economicsfor Engineers,KhannaPublishingHouse(AICTERecommendedTextbook –2018)

- **DataStructure &Algorithm [3 0 0 3]**

Unit	Content	Hrs/Unit	Marks/Unit
1	Introduction:BasicTerminologies:ElementaryDataOrganizations,DataStructureOperations:insertion,deletion,traversaletc.;AnalysisofanAlgorithm,AsymptoticNotations,Time-Spacetradeoff.Searching:LinearSearchandBinarySearchTechnique sandtheircomplexityanalysis.	10	
2	StacksandQueues:ADTStackanditsoperations:Algorithmsandtheircomplexityanalysis,ApplicationsofStacks:ExpressionConversionandevaluation–correspondingalgorithmsandcomplexityanalysis.ADTqueue,TypesofQueue:SimpleQueue,CircularQueue,PriorityQueue;OperationsoneachtypesofQueues:Algorithmsand their analysis.	9	
3	LinkedLists:Singlylinkedlists:Representationinmemory,Algorithmsofseveraloperations:Traversing,Searching,Insertionito,DeletionfromlinkedlistLinkedrepresentationofStackandQueue,Headernodes,Doublylinkedlist:operationsonitandalgorithmicanalysis;CircularLinkedLists:all operationstheiralgorithmsand thecomplexityanalysis. Trees:BasicTreeTerminologies,Differenttypes ofTrees:BinaryTree,Threaded BinaryTree,BinarySearchTree,AVLTree; Treeoperations oneachofthetrees andtheiralgorithms withcomplexityanalysis.Applications ofBinaryTrees.BTree,B+Tree:definitions,algorithmsandanalysis	10	
4.	SortingandHashing:Objective and propertiesofdifferentsortingalgorithms: SelectionSort, BubbleSort,InsertionSort,QuickSort,MergeSort,HeapSort; Performance andComparisonamong all themethods,Hashing.Graph:BasicTerminologiesandRepresentations,Graphsearch and traversalalgorithms and complexityanalysis.	9	

Textbook andReferencebooks:

1. "Data Structures andProgramDesign In C",2/Eby RobertL.Kruse,BruceP.Leung.
2. "Data Structure&AlgorithmsUsing C",5th Ed.,Khanna PublishingHouse(AICTERecommended–2018)
3. "FundamentalsofDataStructuresofC"byEllisHorowitz,SartajSahni,SusanAnderson-freed.
4. "Data Structures inC"byAaron M.Tenenbaum.
5. "Data Structures"byS. Lipschutz.
6. "Data Structures UsingC"byReemaThareja.
7. "Data StructureUsingC",2/eby A.K.Rath, A. K. Jagadev.
8. "Introduction toAlgorithms" byThomasH.Cormen,CharlesE. Leiserson,RonaldL.Rivest,CliffordStein

9. “Data Structures throughC” byYashwantKanetkar, BPBPublications.
10. “Expert DataStructureswith C++” by R.B Patel,KhannaPublishingHouse

❖ **Analog and Digital Electronics [3 1 0 4]**

Unit	Content	Hrs/Unit	Marks/Unit
1	DifferentClassesofAmplifiers-(Class-A,B,ABandC-basic concepts,power,efficiency;Recapitulationofbasicconcepts ofFeedbackandOscillation,PhaseShift,WeinBridgeoscillat orsAstable&MonostableMultivibrators; Schimtt Triggercircuits, 555Timer.	9	
2	BinaryNumberSystem&BooleanAlgebra(recapitulation);B CD,ASCII,EBDIC,Graycodesandtheirconversions;Signed binarynumberrepresentationwith1’sand2’scomplementmet hods,Binaryarithmetic,Venndiagram,Booleanalgebra(reca pitulation);RepresentationinSOP and POSforms;Minimizationoflogic expressionsbyalgebraicmethod.	11	
3	Sequential Circuits - BasicFlip-flop& Latch, Flip-flops-SR,JK,D,TandJKMaster-slaveFlipFlops,Registers(SISO,SIPO,PIPO,PISO)Ringco unter,Johnsoncounter BasicconceptofSynchronousandAsynchronouscounters (detaildesignofcircuits excluded),DesignofMod N Counter	10	
4.	A/D and D/Aconversiontechniques– Basicconcepts(D/A :R-2-Ronly [2L] A/D:successive approximation [2L]) Logicfamilies-TTL,ECL,MOS andCMOS - basicconcepts.(2L)	6	

Textbook andReferencebooks:

1. Microelectronics Engineering–Sedra&Smith-Oxford.
2. AnalogElectronics,A.K.Maini,Khanna Publishing House(AICTERecommended-2018)
3. AnalogElectronics,L.K. Maheswari,LaxmiPublications(AICTERecommended -2018)
4. Principles ofElectronicDevices & circuits—B LThereja&Sedha—SChand
5. DigitalElectronics – Kharate– Oxford
6. DigitalElectronics – Logic& Systems by J.Bigmell&R.Donovan;CambridgeLearning.
7. Digital Logic andStateMachineDesign(3rd Edition) – D.J.Comer, OUP
8. ElectronicDevices & CircuitTheory – Boyelstad&Nashelsky- PHI
9. Bell-LinearIC&OP AMP—Oxford
10. P.Raja- DigitalElectronics-ScitechPublications
11. MorriesMano-DigitalLogicDesign-PHI
12. R.P.Jain—Modern DigitalElectronics,2/e,McGrawHill

13. H.Taub&D.Shilling,DigitalIntegratedElectronics-McGrawHill.
14. D.RayChaudhuri- DigitalCircuits-Vol-I&II, 2/e- PlatinumPublishers
15. Tocci,Widmer, Moss- DigitalSystems,9/e-Pearson
16. J.Bignell&R.Donovan-Digital Electronics-5/e-CenageLearning.
17. Leach&Malvino—DigitalPrinciples & Application,5/e,McGrawHill
18. Floyed&Jain-DigitalFundamentals-Pearson.

- **Computer Organization [3 0 0 3]**

Unit	Content	Hrs/Unit	Marks/Unit
1	Basicorganizationofthestoredprogramcomputerandoperation sequenceforexecutionofa program.Roleofoperatingsystemsandcompiler/assembler.Fetch,decodeandexecutecycle,Conceptofoperator,operand,registersandstorage,Instructionformat.Instructionsetsandaddressingmodes.[7L] Commonlyusednumbersystems.Fixedandfloating pointrepresentationof numbers.[1L]	8	
2	Overflow and underflow.Designofadders - ripplecarryandcarrylook aheadprinciples.[3L] Design ofALU.[1L] Fixedpoint multiplication-Booth's algorithm.[1L]Fixedpoint division - Restoring and non-restoringalgorithms.[2L] Floatingpoint- IEEE 754standard.[1L]	8	
3	Memoryunitdesignwithspecialemphasis on implementation ofCPU-memoryinterfacing.[2L]Memoryorganization,static anddynamicmemory,memoryhierarchy,associativememory. [3L] Cachememory,Virtualmemory.Data path designforread/writeaccess.[5L]	10	
4	Designofcontrolunit-hardwiredandmicroprogrammedcontrol.[3L]Introduction to instructionpipelining. [2L] Introduction to RISC architectures.RISC vs CISCarchitectures.[2L] I/Ooperations - ConceptofhandshakingPolledI/O,interruptandDMA. [3L]	10	

Textbook andReferencebooks:

1. Mano,M.M.,"Computer SystemArchitecture",PHI.
2. BehroozParhami "Computer Architecture",Oxford UniversityPress
3. Hayes J.P.,"Computer Architecture&Organisation",McGrawHill,
4. Hamacher,"ComputerOrganisation",McGrawHill,
5. N.senthilKumar,M.Saravanan,S. Jeevananthan,"MicroprocessorsandMicrocontrollers" OUP
6. ChaudhuriP.Pal,"Computer Organisation&Design",PHI,
7. P NBasu-"Computer Organization& Architecture",VikasPub
8. Rajaraman – "ComputerOrganization& Architecture",PHI
9. B.Ram–"Computer Organization&Architecture",NewagePublications

❖ OBJECT-ORIENTED PROGRAMMING [3 1 0 4]

Introduction: Object-oriented Paradigm and Pillars such as Abstraction, Encapsulation, Inheritance and Polymorphism; Java Basics: Compilation and Execution of a Java Program, Access Modifiers; Class and Objects: Class Definition, Creating Objects, Role of Constructors, Method Overloading, Argument Passing, Objects as Parameters, Access Control; I/O Basics: Reading Console Input, Writing Console Output; Array and Strings: Arrays in Java, 1-D, 2-D and Dynamic Arrays, String Basics, String Comparison and Manipulation; Inheritance: Inheritance and its Types, Abstract Class, Inner and Outer Class, Super, Final, Static Keywords; Package and Interface: In-Built Packages and User Define Packages, Role of Interface, Polymorphism via Inheritance; Collection Framework & Generics: List, Set, Map, Generic Classes; Exception Handling: Errors and Exceptions, Types of Exceptions, Handling Exceptions, Multithreading: Thread Class, Runnable, Thread Life Cycle, Synchronization, Thread Priority; Event Handling and GUI Programming: Events, Action Listener, Important Swing Package Classes.

References:

1. Schildt H, Java: *The Complete Reference, (10e*), Tata McGraw-Hill Education Group, 2017.
2. Balagurusamy E, *Programming with Java*, (5e), Tata McGraw Hill, 2017.
3. Daniel Liang Y, *Introduction to Java Programming*, (10e), Pearson Education, 2018.
4. Horstmann CS, *Big Java: Early Objects*, (5e), Wiley's Interactive Edition, 2015.

❖ Analog and Digital Electronics Laboratory [0 0 3 1]

Laboratory Experiments:	
AnalogElectronics	
1	Design a Class A amplifier
2	Design a Phase-ShiftOscillator
3	Design of aSchmittTrigger using 555timer
DigitalElectronics	
4	DesignaFullAdderusingbasicgatesandverifyitsoutput/DesignaFullSubtractorcircuitusingbasic gatesand verifyits output.
5	ConstructionofsimpleDecoder&Multiplexer circuitsusinglogicgates.
6	Realizationof RS / JK /D flipflops usinglogic gates
7	DesignofShiftRegisterusingJ-K / D FlipFlop
8	RealizationofSynchronousUp/Downcounter
9	DesignofMOD- N Counter
10	Studyof DAC

Anyexperimentspeciallydesigned bythe college

(Detailed instructions for LaboratoryManual to be followed forfurtherguidance)

- **Data Structures Laboratory [0 0 3 1]**

Laboratory Experiments:	
LinearDataStructure	
1	Implementationofarrayoperations
2	StacksandQueues:adding,deletingelementsCircularQueue:Adding&deletingelements
3	MergingProblem:Evaluationofexpressionsoperations onMultiplestacks&queues:
4	Implementationoflinkedlists: inserting,deleting,invertinga linkedlist.Implementationofstacks & queues usinglinkedlists
5	Polynomialaddition,Polynomialmultiplication
Non LinearDataStructure	
6	Recursive and Non-recursivetraversalofTrees
7	Threaded binarytreetraversal.AVL tree implementation
8	ApplicationofTrees.Applicationofsorting and searchingalgorithms
9	Hashtablesimplementation:searching,insertingand deleting,searching&sortingtechniques.

Anyexperimentspeciallydesigned bythe college
(Detailed instructions for LaboratoryManual to be followed forfurtherguidance)

- **Object Oriented Programming Lab [0 0 4 2]**

LaboratoryExperiments:
1. Assignments on class,constructor,overloading,inheritance,overriding 2. Assignments on wrapperclass,arrays 3. Assignments on developinginterfaces-multiple inheritance,extendinginterfaces **4.** Assignments on creatingandaccessingpackages 5. Assignments on multithreadedprogramming 6. Assignments on appletprogramming **Note: UseJava forprogramming**

Anyexperiment speciallydesignedbythe college
(Detailedinstructions forLaboratoryManualto befollowed for furtherguidance)

SECOND YEAR
FORTH SEMESTER

- **Mathematics –IV (Discrete Mathematics) [3 1 0 4]**

Unit	Content	Hrs/Unit	Marks/Unit

1	Sets,RelationandFunction:OperationsandLawsofSets,CartesianProducts,BinaryRelation,PartialOrderingRelation,EquivalenceRelation,ImageofaSet,SumandProductofFunctions,Bijectivefunctions,InverseandCompositeFunction,SizeofaSet,FiniteandinfiniteSets,CountableanduncountableSets,Cantor'sdiagonalargumentandThePowerSettheorem,Schroeder-Bernsteintheorem. PrinciplesofMathematicalInduction:TheWell-OrderingPrinciple,Recursivedefinition,TheDivisionalgorithm:PrimeNumbers,TheGreatestCommonDivisor:EuclideanAlgorithm,TheFundamentalTheoremofArithmetic.	8	
2	Basiccountingtechniques-inclusionandexclusion,pigeon-holeprinciple,permutationandcombination	5	
3	PropositionalLogic: Syntax,Semantics,Validity andSatisfiability, BasicConnectivesandTruthTables, LogicalEquivalence: TheLaws ofLogic,LogicalImplication,Rules ofInference,TheuseofQuantifiers.ProofTechniques: SomeTerminology,ProofMethodsandStrategies,Forward Proof,ProofbyContradiction,ProofbyContraposition,Proofof NecessityandSufficiency.	8	
4.	AlgebraicStructuresandMorphism:AlgebraicStructureswithoneBinaryOperation,SemiGroups,Monoids,Groups,CongruenceRelationandQuotientStructures,FreeandCyclicMonoidsandGroups,PermutationGroups,Substructures,NormalSubgroups,AlgebraicStructureswithtwoBinaryOperation,Rings,IntegralDomainandFields.BooleanAlgebraandBooleanRing,IdentitiesofBooleanAlgebra,Duality,RepresentationofBooleanFunction,Disjunctiveand ConjunctiveNormal Form	7	
5	GraphsandTrees:Graphsandtheirproperties,Degree,Connectivity,Path,Cycle,SubGraph,Isomorphism,EulerianandHamiltonianWalks,GraphColouring,ColouringmapsandPlanarGraphs,ColouringVertices,ColouringEdges,ListColouring,PerfectGraph,definitionpropertiesandExample,rootedtrees,treesandsorting,weightedtreesandprefixcodes,Bi-connectedcomponentand ArticulationPoints,Shortestdistances.	8	

Textbook andReferencebooks:

1. RussellMerris,Combinatorics,Wiley-InterscienceseriesinDiscreteMathematicsandOptimisation
2. N.ChandrasekaranandM.Umaparvathi,DiscreteMathematics,PHI
3. GaryHaggard,JohnSchlipfandSueWhitesides,DiscreteMathematicsforComputerScience,CENGAGELearning
4. GaryChartrandandPingZhang– Introduction to GraphTheory,TMH
5. J.K.Sharma,DiscreteMathematics,Macmillan
6. WinfriedKarlGrassmannand Jean-Paul Tremblay,Logicand DiscreteMathematics,PEARSON.
7. S.K.ChakrabortyandB. K.Sarkar,DiscreteMathematics,OXFORD UniversityPress.
8. Douglas B.West,Introduction to graphTheory,PHI
9. C. L.Liu,ElementsofDiscreteMathematics,2ndEd.,TataMcGraw-Hill,2000.
10. R.C.Penner,DiscreteMathematics: ProofTechniques and MathematicalStructures,WorldScientific,1999.
11. R.L.Graham,D. E.Knuth, andO. Patashnik,ConcreteMathematics,2ndEd.,Addison-Wesley,1994.
12. N.Deo,GraphTheory,Prentice Hall ofIndia,1974.
13. S.LipschutzandM.L.Lipson,Schaum's OutlineofTheoryandProblems ofDiscrete Mathematics,2ndEd.,TataMcGraw-Hill, 1999.
14. J.P.TremblayandR. P.Manohar,DiscreteMathematics withApplications toComputer Science, TataMcGraw-Hill, 1997.
15. RussellMerris,Combinatorics,Wiley-InterscienceseriesinDiscreteMathematicsandOptimisation
16. N.ChandrasekaranandM.Umaparvathi,DiscreteMathematics,PHI
17. GaryHaggard,JohnSchlipfandSueWhitesides,DiscreteMathematicsforComputerScience,CENGAGELearning
18. GaryChartrand andPingZhang – IntroductiontoGraphTheory,TMH
19. S.B. Singh,DiscreteStructures– Khanna PublishingHouse(AICTERecommendedTextbook–2018)
20. S.B. Singh,Combinatoricsand GraphTheory,KhannaPublishingHouse(AICTERecommendedTextbook–2018)

❖ DESIGN & ANALYSIS OF ALGORITHMS [3 1 0 4]

Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Nonrecursive and Recursive Algorithms. Brute force Techniques, Divide and Conquer, Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting. Transform and Conquer: Presorting, BST, Heapsort. Space and Time tradeoffs: Input Enhancement in String Matching. Dynamic Programming: Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees. Coping with limitations of algorithmic power, P, NP and NP-complete Problems, Backtracking: n–Queens problem, Hamiltonian Circuit Problem, Subset–Sum Problem. Branch and Bound: Assignment Problem, Knapsack Problem, TSP.

References:

1. Anany Levitin, *Introduction to the Design and Analysis of Algorithms*, (3e), Pearson Education, 2011

2. Ellis Horowitz and SartajSahni, *Computer Algorithms/C++*, (2e), University Press, 2007.
3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, *Introduction to Algorithms*, (2e), PHI, 2006

❖ OPERATING SYSTEMS [3 1 0 4]

Operating System Structure and Operations, Process Management, Memory Management, Storage Management, Operating System Services, User Operating System Interfaces, Types of System Calls, System Programs, Operating System Structure, System Boot ,Overview, Process Scheduling, Operations on Processes, Inter-process Communication, Multithreaded Models, Thread Libraries, Scheduling Algorithms, Thread Scheduling, Linux scheduling, Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Logical Versus Physical Address Space, Segmentation, Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation, Demand Paging, Copy-On-Write, Page Replacement, Allocation of Frames, Thrashing, Disk Scheduling, Swap-Space Management, System Model, Deadlock: Deadlock prevention, Avoidance, Detection, Recovery, File Concept, Protection.

References:

1. Silberschatz, P. B. Galvin and G. Gagne, *Operating System Concepts*, (9e), Wiley and Sons (Asia) Pvt Ltd, 2013.
2. Milan Milenkovic, *Operating systems: Concepts and Design*, McGraw Hill, New York, 1987
3. H. M. Dietel, *An Introduction to Operating Systems*, Addison Wesley, 1990.
4. Andrew S. Tannebaum, *Operating System: Design and Implementation*, (3e), Prentice Hall of India, 2008
5. Maurice J Bach, *Design of UNIX Operating System*, Prentice Hall of India, 1988.

❖ Software Engineering & Testing Methodologies [3 0 0 3]

Unit-1: Introduction to Software Engineering **9 hours**
Software Components, Software Characteristics, Software Crisis, Software Engineering Processes, Similarity and Differences from Conventional Engineering Processes, Software Quality Attributes. Software Development Life Cycle (SDLC) Models: Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models.
Unit II: Software Requirement Specifications (SRS) and Design 9 hours
Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Information Modelling, Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design Data Flow Diagrams, Entity Relationship Diagrams.
Unit III : Software Testing Methods and Selection 9 Hours
Testing Objectives ,Faults, Errors, and Failures, Basics of software testing, Testing objectives, Principles of testing, Requirements, behavior and correctness, Testing and debugging, Test metrics and measurements, Verification, Validation and Testing, Types of testing, Software Quality and Reliability, Software defect tracking.
Unit IV : Software Testing Methods and Selection 9 Hours
Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Integration Testing, , Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom-Up,

Acceptance Testing ,Alpha and Beta Testing of Products. Static Testing Strategies: Formal Technical Reviews (Peer Reviews), Walk Through, Regression testing, Regression test process, Initial Smoke or Sanity test, Tools for regression testing, Ad hoc Testing: Pair testing, Exploratory testing, Iterative testing, Defect seeding.
Unit V : Software Project and Test Management 9 Hours
Software as an Evolutionary Entity, Need for Maintenance, Categories of maintenance: Preventive, Corrective and Perfective Maintenance, Cost of Maintenance, Software Re-Engineering, Reverse Engineering. Software Configuration Management Activities, Constructive Cost Models (COCOMO). Test Planning, Management, Execution and Reporting, Software Test Automation: Testing in Object Oriented Systems.

References:

1. Software Engineering: A practitioner's Approach, Roger S Pressman, Sixth Edition. McGraw-Hill International Edition, 2005.
2. Software Engineering: Ian Summerville, Seventh Edition, Pearson Education, 2004.
3. Fundamentals of Software Engineering: Rajib Mall, PHI, 2005.
4. Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India,2010.
5. Software Engineering: A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008.

❖ DATA COMMUNICATION AND NETWORKS [3 0 0 3]

Basic concepts of computer networks, Layered architecture and comparison between ISO/OSI, TCP/IP layered models. Significance of Datalink layer and protocols. Network layer functionalities, classful, classless IP addressing, address allocation and role of forwarding module in forwarding the packet using routing table. Roles played by IP, ARP, RARP, ICMP& IGMP protocols in network layer. Inter-domain and intra-domain routing algorithms for routing tables. Importance of transport layer in achieving process-to-process communication. Insight of connection oriented protocol TCP and connectionless protocol UDP. Features of TCP in achieving flow control, error control and congestion control. Requirement of different timers in TCP. Drawbacks of IPv4 addressing and new IP addressing scheme IPv6. Migrating from IPv4 to IPv6. Introduction to application layer, a client/server application program and a case study. Client-server application program-Dynamic Host Configuration Protocol (DHCP).

References:

1. Behrouz A. Forouzan, *TCP/IP Protocol Suite*, 4th Edition, Tata McGraw Hill, 2010.
2. Tannenbaum, A.S, *Computer Networks, 5th Edition*, Prentice Hall of India EE Edition, 2011.
3. Behrouz A. Forouzan, *Data Communications and Networking*, 5th Edition, Tata McGraw Hill, 2013.
4. Leon Garcia and Widjala, *Communication Networks*, 5th Edition, Tata McGraw Hill, 2017.

❖ Environmental Science [1 0 0 1]

Unit	Content	Hrs/Unit

1	Basicideas ofenvironment,basicconcepts,man,society &environment,their interrelationship(1L) Mathematicsofpopulationgrowthandassociatedproblems,Importanceofpopulationstudyinenvironmental engineering,definitionofresource,typesofresource,renewable,non-renewable,potentiallyrenewable,effectofexcessiveusevis-à-vispopulationgrowth,Sustainable Development.(2L) Materialsbalance:Steadystateconservationsystem,steadystatesystemwithnon-conservativepollutants,stepfunction. (1L) Environmentaldegradation:NaturalenvironmentalHazardslikeFlood,earthquake,Landslide-causes,effectsand control/management;Anthropogenic degradationlikeAcidrain-cause,effectsandcontrol.NatureandscopeofEnvironmentalScienceandEngineering.(2L)	6
2	Elementsofecology:System,opensystem,closedsystem,definitionofecology,species,population,community,definitionofecosystem-componentstypesandfunction. (1L) Structureandfunctionofthefollowingecosystem:Forestecosystem,Grasslandecosystem,Desertecosystem,Aquaticecosystems,Mangroveecosystem(specialreferencetoSundarban);Food chain[definitionandoneexampleofeachfoodchain],Foodweb.(2L) BiogeochemicalCycle-definition,significance,flowchartofdifferentcycleswithonlyelementaryreaction[Oxygen, carbon,Nitrogen,Phosphate,Sulphur].(1L) Biodiversity-types,importance,Endemicspecies,BiodiversityHot-spot,Threatstobiodiversity,Conservationofbiodiversity.(2L)	6

3	AtmosphericComposition:Troposphere,Stratosphere,Mesosphere,Thermosphere,TropopauseandMesopause.(1L) Energybalance:ConductiveandConvectiveheattransfer,radiationheattransfer,simpleglobaltemperaturemodel[Earthasablackbody,earthasalbedo],Problems.(1L) Greenhouseeffects:Definition,impactofgreenhousegasesontheglobalclimateandconsequentlyonseawaterlevel,agricultureandmarinefood.Globalwarminganditsconsequence,Controlof Globalwarming.Earth's heat budget.(1L) Lapserate:AmbientlapserateAdiabaticlapserate,atmosphericstability,temperatureinversion(radiationinversion).(2L) Atmosphericdispersion:Maximummixingdepth,ventilationcoefficient,effectivestackheight, smokestack plumes andGaussian plume model.(2L) Definitionofpollutantsandcontaminants,Primaryandsecondarypollutants: emissionstandard,criteria pollutant.Sourcesandeffectofdifferentairpollutants- Suspendedparticulatematter,oxidesofcarbon,oxidesof nitrogen,oxides ofsulphur,particulate,PAN.(2L)Smog, Photochemical smog and London smog.DepletionOzonelayer:CFC,destructionofozonelayerby CFC,impact ofothergreen-housegases,effectofozonemodification. (1L) Standardsandcontrolmeasures:Industrial,commercialandresidentialairqualitystandard,controlmeasure(ESP.cycloneseparator,baghouse,catalyticconverter,scrubber(ventury),Statementwithbriefreference).(1L)	11

4.	Hydrosphere,HydrologicalcycleandNaturalwater.Pollutantsofwater,theiroriginandeffects: Oxygendemandingwastes,pathogens,nutrients,Salts,thermalapplication,heavymetals,pesticides,volatileorganiccompounds.(2L) River/Lake/groundwaterpollution:River:DO,5-dayBODtest,SeededBODtest,BODreactionrateconstants,Effectofoxygendemandingwastesonriver[deoxygenation,reaeration],COD,Oil,Greases,pH.(2L) Lake:Eutrophication[Definition,sourceandeffect].(1L) Groundwater:Aquifers,hydraulicgradient,groundwater flow(Definition only)(1L) Standardandcontrol:Wastewaterstandard[BOD,COD,Oil,Grease], WaterTreatmentsystem[coagulationandflocculation,sedimentation and filtration,disinfection,hardness andalkalinity,softening]Wastewatertreatmentsystem,primaryandsecondarytreatments[Tricklingfilters,rotatingbiologicalcontractor,Activatedsludge,sludgetreatment,oxidationponds]tertiarytreatmentdefinition.(2L) Waterpollutionduetothetoxicelementsandtheirbiochemicaleffects:Lead,Mercury,Cadmium, andArsenic (1L)	9
5	Lithosphere;Internalstructureofearth,rockandsoil(1L) SolidWaste:Municipal,industrial,commercial,agricultural,domestic,pathologicalandhazardoussolidwastes; Recoveryanddisposalmethod- Opendumping,Landfilling,incineration,composting,recycling. Solidwastemanagementandcontrol(hazardousandbiomedicalwaste).(2L)	3
6	Definitionofnoise,effectofnoisepollution,noiseclassification[Transportnoise,occupationalnoise,neighbourhoodnoise] (1L) Definitionofnoisefrequency,noisepressure,noiseintensity,noisethresholdlimitvalue,equivalentnoiselevel, *L*10(18hrIndex) ,*nLd*.Noise pollution control.(1L)	3
7	Environmentalimpactassessment,EnvironmentalAudit,Environmentallawsandprotectionact ofIndia,Differentinternationalenvironmentaltreaty/agreement/ protocol.(2L)	2

Textbooks/referencebooks:

1. M.P.Poonia&S.C.Sharma,EnvironmentalStudies,KhannaPublishingHouse(AICTERecommendedTextbook–2018)
2. Masters,G.M.,"IntroductiontoEnvironmentalEngineeringandScience",Prentice-HallofIndiaPvt.Ltd.,1991.
3. De,A.K.,"EnvironmentalChemistry",NewAgeInternational

❖ DESIGN & ANALYSIS OF ALGORITHMS LAB [0 0 2 1]

Exercises to implement doubly linked list & Binary Search Tree, GCD Techniques. Sorting algorithms. String Matching, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

References:

1. Anany Levitin, *Introduction to the Design and Analysis of Algorithms*, (3e), Pearson Education, India, 2011.
2. Ellis Horowitz and SartajSahni, *Computer Algorithms/C++*, (2e), University Press, 2007
3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, *Introduction to Algorithms*, (2e), PHI, 2006.

❖ SOFTWARE ENGINEERING & TESTING METHODOLOGIES LAB. [0 0 3 1]

Sr. No.	Title of Lab Experiments
1.	Demonstration on Manual testing a. Write Programs in „C" Language to demonstrate the working of the following constructs: i)do…while ii) while…do iii)if…else iv)switch v)for b. Write a program in "C" language to demonstrate the working of palindrome using do…while.
2.	Demonstration on Unit testing a. Create a test plan document for any application (e.g. Library Management System). b. Study of any testing tool (e.g. Win runner). c. Create a test plan document for cellular phone.
3.	Demonstration on Integration testing Take a mini project (e.g. University admission, Placement Portal) and execute it. During the life cycle of the mini project create the various testing documents and final test report document.
4.	Demonstration on System testing a. Take any system (e.g. ATM system) and study its system specifications and report the various bugs. b. Write down the test cases for any known applications (e.g. Banking Application).
5.	Demonstration on Blackbox testing

	a. Design a usecase diagram for an ATM system. b. Design a class diagram for an ATM system. c. Design a use case diagram for Library system.
6.	Demonstration on White Box testing a. Create various testing document for robot control system. b.“A Program written in „C‟ Language for Matrix Multiplication fails” Introspect the causes for its failure and write down the possible reasons for its failure. c. Write a Program in „C‟ Language to demonstrate the working of Addition of diagonal elements in a matrix.
7.	Demonstration on Regression testing a. Study of any web-testing tool (eg. Selenium). b. Study of any bug-tracking tool (eg. Bugzilla, bug bit). c. Study of any test management tool (eg. Test Director). d. Compare different testing tools.
8	Demonstration on Mutation testing Write down the test cases for any known applications (e.g. Banking Application).
9	Demonstration on Alpha testing. Make a Case Based study on the experiment
10.	Demonstration on Beta testing. Make a Case Based study on the experiment
11.	Demonstration on User Acceptance testing. Make a Case Based study on the experiment

Reference Book (s)

1. S. Desikan and G. Ramesh, “Software Testing: Principles and Practices”, Pearson Education.
2. Aditya P. Mathur, “Fundamentals of Software Testing”, Pearson Education.
3. Naik and Tripathy, “Software Testing and Quality Assurance”, Wiley
4. K. K. Aggarwal and Yogesh Singh, “Software Engineering”, New Age International Publication.

❖ OPERATING SYSTEMS LAB [0 0 2 1]

Linux basic commands shell concepts and file filters, shell scripting-1,shell scripting-2, linux system calls ,thread programming, inter-process communication, process synchronization, cpu scheduling algorithms, deadlock algorithms, memory management schemes, page replacement algorithms, disk scheduling algorithms.

References:

1. Maurice Bach, *Design of Unix Operating System*, Prentice Hall India Learning Private Limited, 2015.
2. Graham Glass, *Unix for Programmers and Users*- A complete guide, (3e), Prentice Hall India Learning Private Limited , 2003

3. Sumitabha Das, *Unix concepts and applications*, (4e), McGraw Hill Education , 2017.
4. Neil Matthew, Richard Stones, *Beginning Linux Programming*, (4e),Wiley Publication, 2007.
5. A. Silberschatz, P. B. Galvin and G. Gagne, *Operating System Concepts*, (9e), Wiley and Sons (Asia) Pte Ltd, 2013.
6. Rachel Morgan, *Unix System*, McGraw Hill Education, 2007.

THIRD YEAR
FIFTH SEMESTER

❖ OPERATIONS RESEARCH [3 0 0 3]

Introduction: Definition, Phases, Applications, Advantages and Limitations of Operations Research. Linear Programming problems: Assumptions, Formulation of LPP for business and non-business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual, Sensitivity analysis with respect to objective function coefficients and R.H.S. values. Transportation problem: Formulation, North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). Testing the solution by Stepping stone, Modified Distribution (MODI) Method. Maximization, Multiple optimal solutions, Degeneracy and Unbalanced problems. Post optimality analysis. Assignment problem: Solution algorithm for Assignment Problems. Unbalanced, multiple optimal solutions, Maximization and Application problems. Travelling salesman / Job sequencing problem: Solution algorithm for Travelling Salesman Problem, Application to job sequencing problem Game theory: Introduction to game theory, Two person- zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), Simulation of queuing system - Steps in simulation, Application and Limitations, Monte- Carlo technique-Problems involving Waiting line situations and Selection of crew members. Critical Path Method (CPM): General frame work, Introduction to elements of network, conventions adapted in drawing network, analysing the network. Calculation of event and Activity times, Total Float, Free Float, Independent float, Critical path, Determination of project duration, Project Crashing. Applications and Limitations of CPM. Project Evaluation and Review Technique (PERT): Calculation of Probabilistic/Expected event and Activity times, Variance of activity duration, Determination of critical path, probability/expectation of project completion.

References:

1. Taha H. A., *Operations Research*, Pearson Education (7e), 2002.
2. W.L. Winston, *Operations Research*, Thomson Asia, 2003.
3. Vohra N. D., *Quantitative Techniques in Management*, 2007.
4. Sharma S. D., *Operations Research* (14e), KedarNathRamnath Publications, 2005
5. Kanthiswaroop, Gupta and Manmohan, *Operations Research*, Sultan Chand and Sons, 2003.

❖ Formal Language & Automata Theory [3 0 0 3]

Unit	Content	Hrs/Unit	Marks/Unit
1	Introduction:Alphabet,languagesandgrammars,productionsandderivation,Chomskyhierarchyoflanguages.	6	
2	Regularlanguagesandfiniteautomata:Regularexpressionsandlanguages,deterministicfiniteautomata(DFA)andequivalencewithregularexpressions,nondeterministicfiniteautomata(NFA)andequivalencewithDFA,regulargrammarsandequivalencewithfiniteautomata,propertiesofregularlanguages,pumpinglemmaforregularlanguages,minimizationoffiniteautomata)	7	

3	Context-freelanguagesandpushdownautomata:Context-freegrammars(CFG)andlanguages(CFL),Chomskyand Greibachnormalforms, nondeterministicpushdownautomata(PDA)andequivalencewithCFG,parsetrees,ambiguityinCFG,pumpinglemmaforcontext-freelanguages,deterministicpushdownautomata,closurepropertiesofCFLs.	6	
4.	Context-sensitivelanguages:Context-sensitivegrammars(CSG)andlanguages,linearboundedautomata andequivalencewithCSG.	6	
5	Turingmachines:ThebasicmodelforTuringmachines(TM),Turingrecognizable(recursivelyenumerable)andTuring-decidable(recursive)languagesandtheirclosureproperties,variantsofTuringmachines,nondeterministicTMsandequivalencewithdeterministicTMs,unrestrictedgrammarsandequivalencewithTuringmachines,TMsas enumerators	6	
6	Undecidability:Church-Turingthesis,universalTuringmachine,theuniversalanddiagonalizationlanguages,reductionbetweenlanguagesandRicestheorem,undecidableproblems about languages	6	

Introduction to IOT and its security [3 0 0 3]

Outline syllabus	
Unit 1	OVERVIEW
A	IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.
B	M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management,
C	Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management
Unit 2	REFERENCE ARCHITECTURE
A	IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model
B	IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.
C	Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.
Unit 3	Conceptualizing the Secure Internet of Things
A	The BadUSB Thumb Drive, Air-Gap Security, Stuxnet,
B	Designing Safe and Secure Cyber-Physical Systems

C	Constrained Computing and Moore's Law, Trusted IoT Networks and the Network Edge
Unit 4	Base Platform Security Hardware Building Blocks
A	Background and Terminology
B	Identity Crisis, Device Boot Integrity, Data Protection,
C	RunTime Protection, Threat Mitigated
Unit 5	IOT Software Security Building Blocks
A	Operating System, Hypervisors and Virtualization
B	Software separation and containment, Network stack and security management, Device Management
C	System Firmware and Root of Trust Update Services, Application level language Framework, Message Orchestration

Reference Books:

1. Sunil Cheruvu, Anil Kumar, Ned Smith, David M. Wheeler "Demystifying Internet of Things Security"

❖ **Biology [2 1 0 3]**

Unit	Content	Hrs/Unit
1	ToconveythatBiologyis as importanta scientificdisciplineas Mathematics,PhysicsandChemistryBringout the fundamentaldifferences betweenscience and engineering by drawing a comparisonbetweeneye and camera,Bird flyingand aircraft.Mentionthemostexciting aspectofbiology asan independentscientificdiscipline.Whywe need to studybiology? Discusshowbiologicalobservationsof18thCenturyt hat lead to majordiscoveries. ExamplesfromBrownianmotionandtheoriginofthermodyna mics byreferring to the originalobservationofRobertBrownandJuliusMayor.Thesee xamples willhighlightthefundamentalimportanceofobservationsinan yscientificinquiry.	2

2	Theunderlyingcriterion,such as morphological,biochemicalor ecological behighlighted. Hierarchyoflifeformsatphenomenologicallevel.A commonthreadweaves this hierarchyClassification.Discuss classificationbased on(a)cellularity-Unicellularor multicellular(b)ultrastructure-prokaryotes or eucaryotes.(c) energyandCarbonutilisation-Autotrophs,heterotrophs,lithotropes (d)Ammoniaexcretion – aminotelic,uricoteliec,ureotelic(e)Habitata-acquaticor terrestrial(e)Moleculartaxonomy-three major kingdoms oflife. Agivenorganismcancomeunder different categorybasedonclassification.Modelorganismsforthestudyofbiologycomefromdifferentgroups.E.coli, S.cerevisiae,D.Melanogaster, C.elegance, A.Thaliana,M.musculus	3
3	Toconveythat"Genetics is to biologywhatNewton's lawsare to PhysicalSciences"Mendel'slaws,Conceptofsegregation and independentassortment.Conceptofallele.Gene mapping, Geneinteraction,Epistasis.Meiosis andMitosis betaught asa partofgenetics. Emphasis to begivenotto themechanics ofcelldivisionnor thephases but howgeneticmaterialpasses fromparentto offspring. Conceptsofrecessivenessand dominance.Conceptofmapping ofphenotypeto genes.Discuss aboutthesinglegenedisorders inhumans. Discusstheconceptofcomplementationusinghumangenetics.	4
4.	Biomolecules:Toconveythat all formsoflife havethesamebuilding blocksand yetthemanifestations are asdiverse as onecanimagineMolecules oflife. In this contextdiscussmonomeric unitsandpolymericstructures. Discuss aboutsugars,starchandcellulose.Aminoacids and proteins.Nucleotides andDNA/RNA.Twocarbonunits andlipids.	4

5	Enzymes**:**Toconvey that withoutcatalysis lifewould not have existed onearth Enzymology:Howto monitorenzymecatalysedreactions.Howdoesanenzymec atalysereactions?Enzymeclassification.Mechanismofen zymeaction. Discuss atleast two examples.Enzymekineticsandkineticparameters.Whyshoul d weknowtheseparameters to understandbiology? RNA catalysis.	4
6	InformationTransfer:Themolecular basisofcodinganddecoding genetic informationisuniversal Molecular basis ofinformationtransfer.DNA asageneticmaterial.Hierarchyof DNA structure-fromsinglestranded to doublehelixtonucleosomes.Conceptofgeneticcode. Universality and degeneracyofgeneticcode.Definegeneinterms ofcomplementation andrecombination.	4
7	Macromolecularanalysis**:** How to analysebiologicalprocesses atthereductionistlevelProteins-structure andfunction.Hierarchinproteinstructure.Primarysecondary, tertiary andquaternarystructure.Proteins asenzymes,transporters,receptorsandstructuralelements.	5
8	Metabolism**:**Thefundamentalprinciplesofenergytransacti ons arethesameinphysicalandbiologicalworld. Thermodynamics asappliedto biologicalsystems. Exothermic and endothermicversusendergonicandexergoincreactions.C onceptofKeqand its relation tostandardfreeenergy. Spontaneity.ATP asanenergycurrency.Thisshouldinclude thebreakdownofglucosetoCO2 + H2O(GlycolysisandKrebscycle) andsynthesis ofglucose from CO2 and H2O(Photosynthesis).Energyyielding andenergyconsumingreactions.ConceptofEnergychar ge	4
9	MicrobiologyConceptofsinglecelled organisms.Conceptofspecies andstrains.Identificationandclassificationofmicroorganis ms.Microscopy. Ecological aspects ofsinglecelled organisms.Sterilizationandmediacompositions.Growthkin etics	3

Textbooks/referencebooks:

1. Biology:A globalapproach:Campbell, N.A.; Reece,J.B.; Urry,Lisa; Cain,M, L.;Wasserman,S. A.;Minorsky,P.V.; Jackson, R.B.PearsonEducationLtd
2. OutlinesofBiochemistry,Conn,E.E;Stumpf,P.K;Bruening,G;Doi,R.H.JohnWileyandSons
3. PrinciplesofBiochemistry(VEdition),ByNelson,D.L.;andCox,M.M.W.H.FreemanandCompany
4. MolecularGenetics(Secondedition),Stent,G.S.;andCalender,R.W.H.Freemanandcompany,Distributedby Satish Kumar Jainfor CBSPublisher
5. Microbiology,Prescott,L.MJ.P.HarleyandC.A.Klein1995.2ndeditionWm,C.BrownPublishers

❖ **Computer Graphics [3 0 0 3]**

Unit-1 Introduction	9 hours
Types of computer graphics, Graphic Displays- Random scan displays, Raster scan displays, Frame buffer and video controller, Points and lines, Line drawing algorithms, Circle generating algorithms, Midpoint circle generating algorithm, and parallel version of these algorithms.	
Unit-2Transformations	9 hours
Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, Reflections and shearing. Windowing and Clipping: Viewing pipeline, Viewing transformations, 2-D Clipping algorithms-Line clipping algorithms such as Cohen Sutherland line clipping algorithm, Liang Barsky algorithm, Line clipping against non rectangular clip windows; Polygon clipping – Sutherland Hodgeman polygon clipping, Weiler and Atherton polygon clipping, Curve clipping, Text clipping.	
Unit-3Three Dimensional	9 hours
3-D geometric primitives, 3-D Object representation, 3-D Transformation, 3-D viewing, projections, 3-D Clipping.	
Unit-4Curves and Surfaces	9 hours
Quadric surfaces, Spheres, Ellipsoid, Blobby objects, Introductory concepts of Spline, Bspline and Bezier curves and surfaces.	
Unit-5Hidden Lines and Illumination models	9 hours
Hidden Lines and Surfaces: Back Face Detection algorithm, Depth buffer method, A-buffer method, Scan line method, basic illumination models – Ambient light, Diffuse reflection, Specular reflection and Phong model, Combined approach, Warn model, Intensity Attenuation, Color consideration, Transparency and Shadows.	

Text/ReferenceBooks:

1. Donald Hearn and M Pauline Baker, “Computer Graphics C Version”, Pearson Education, India; 2 edition 2002.
2. David Rogers, “Procedural Elements of Computer Graphics”, McGraw Hill Education; 2 edition, 2017.
3. Steven Harrington, “Computer Graphics: A Programming Approach” , McGraw-Hill Inc.,US; 2nd Revised edition, 1983.
4. David Rogers, “Procedural Elements of Computer Graphics”, McGraw Hill Education; 2 edition, 2017.

❖ **DATABASE SYSTEMS [3 1 0 4]**

Introduction: Database System Applications, View of data, Database languages, Database users and Administrator. Introduction to Relational Model: database schema, keys, schema diagrams, Relational Query

Languages, Relational Operations. Introduction to SQL: Data Definition, Basic structure of SQL queries, Basic operations, Set operations, Null values, Aggregate Functions, Nested subqueries, Modification of the database. Intermediate SQL: Join expressions, Views, Transactions, Integrity Constraints, SQL Data types and schemas, Authorization, Advanced SQL-PL/SQL, Cursors, Functions,
Procedures, Triggers, recursive queries, advanced aggregation features. Database Design and Entity-Relationship Model: Design Process, ER Model, Reduction to Relational schema. Relational Database design: Functional dependencies, Normal forms, Closure, Canonical cover, Lossless joins , dependency preserving decomposition, Storage and File structure, Indexing & Hashing. Query Processing, Overview, Measure of query cost, selection, Join operation, sorting, Evaluation of expressions. Query Optimization: Overview, Estimating statistics of expression results, Materialized Views. Transactions: Concepts, Simple transaction model, Transaction atomicity and durability, Transaction Isolation, Serializability, Transaction Isolation Levels. Concurrency Control- Lock based protocols, Deadlock Handling, Multiple granularity, Timestamp-based Protocols, Validation-based Protocols. Recovery System: Failure classification, Storage, Recovery algorithm, Buffer Management. Unstructured database: Introduction to NoSQL, Basics of document-oriented database, MongoDB.

References:

1. Abraham Silberschatz, Henry Korth, S. Sudarshan, *Database System Concepts*, 6th Edition, McGraw Hill, 2010.
2. RamezElmasri, ShamkantNavathe, *Fundamentals of Database System*, 6th Edition, Addison Wesley Publications Co., 2010.
3. Raghu Ramakrishnan, Johannes Gehrke, *Database Management System*, 3rd Edition, WCB/McGraw Hill Publisher, 2014.
4. Ivan Bayross, SQL, PL/SQL-The *Programming Language of Oracle*, 4th Edition, BPB Publications, 2010.
5. Shashank Tiwari, *Professional NoSQL*, Wiley, 2015.

- **Computer Graphics** Lab [0 0 3 1]

1. Write a program to plot a pixel on the screen in a particular color.

2. Write a program for creating a simple two-dimensional shape of any object using lines, circle, etc.

3. Using different graphics functions available for text formatting, write a program for displaying text in different sizes, different colors, font styles.

4. Implement the DDA algorithm for drawing lines (programmers are expected to shift the origin to the center of the screen and divide the screen into required quadrants)

5. Write a program to input the line coordinates from the user to generate a line using Bresenham's method and DDA algorithm. Compare the lines for their values on the plotted line.

6. Write a program to generate a complete moving wheel using Midpoint circle drawing algorithm and DDA line drawing algorithm.

7. Write a program to draw an ellipse using the Midpoint ellipse generation algorithm for both the regions.

8. Write a program to draw any 2-D object and perform the transformations on it according to the input parameters from the user, namely: Translation, Rotation or Scaling.

9. Write a program to rotate a triangle about any one of its end coordinates..

10. Write a program to draw a house like figure and perform the following operations. a.Scaling about the origin followed by translation. b. Scaling with reference to an arbitrary point.

11. Write a program for filling a given rectangle with some particular color using boundary fill

algorithm.

12. Write a program for filling a polygon using Scanline Polygon fill algorithm.

13. Write a program to perform clipping on a line against the clip window using any line clipping algorithm. The output must be twofold showing the before clipping and after clipping images.

14. Write a program to implement the Sutherland Hodgeman Polygon Clipping algorithm for clipping any polygon.

❖ DATABASE LAB [0 0 3 1]

Introduction to SQL, Integrity Constraints in SQL, Simple and complex queries, PL/SQL Basics, Exception Handling, Cursors, Transactions, Procedures, Functions and Packages, Triggers, Exercises on NoSQL MongoDB, MsAccess. Mini Project.

References:

1. Silberschatz, Korth, Sudarshan, *Database System Concepts*, (6e), McGraw-Hill, 2011
2. Ivan Bayross, *SQL, PL/SQL*, (2e/3e), BPB Publications
3. G. Reese, *Database Programming with JDBS* and Java, (2e), O'Reilly, 2000

❖ Application Oriented Programming using Python Lab [0 1 3 2]

List of Experiments
1. Implement Python script to read person's age from keyboard and display whether he is eligible for voting or not.
Implement Python script to find biggest number between two numbers.
Implement Python Script to generate prime numbers series up to n
Implement Python Script to check given number is palindrome or not.
Implement Python script to print factorial of a number.
Implement Python Script to perform various operations on string using string libraries
Implement Python Script to check given string is palindrome or not.
Define a function max_of_three() that takes three numbers as arguments and returns the largest of them.
Write a program which makes use of function to display all such numbers which are divisible by 7 but are not a multiple of 5, between 1000 and 2000.
Define a function which generates Fibonacci series up to n numbers
a) Write a program which accepts a sequence of comma-separated numbers from console and generate a list and a tuple which contains every number. Suppose the following input is supplied to the program:34,67,55,33,12,98. Then, the output should be: ['34', '67', '55', '33', '12', '98'] ('34', '67', '55', '33', '12', '98'). b) With a given tuple (1,2,3,4,5,6,7,8,9,10), write a program to print the first half values in one line and the last half values in one line.
a) Write a python script to perform basic dictionary operations like insert, delete and display. b) Write a python script to find frequency of words in a file using dictionaries.
a) Write Python script to display file contents. b) Write Python script to copy file contents from one file to another.

References

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Shroff/O'Reilly; Second edition, 2016.
2. Tony Gaddis, Starting Out with Python, 3rd edition, Pearson, 2014.
3. Y. Daniel Liang, Introduction to Programming Using Python, Pearson, 2013.
4. Budd T A, Exploring Python , 2011, Tata McGraw Hill Education, 2011.
5. Downey, Allen B., Think Python: How to Think Like a Computer Scientist. O'Reilly, 2012
6. Python Programming: An Introduction to Computer Science (Second Edition) John Zelle, ISBN 978-1-59028-241-0-9, Franklin, Beedle& Associates Inc., 2004.

THIRD YEAR

SIXTH SEMESTER

Introduction to Block Chain Technology [3 0 0 3]

Introduction
The consensus problem - Asynchronous Byzantine Agreement and its analysis
Abstract Models for BLOCKCHAIN - GARAY Model - RLA Model
Proof of Work (PoW) as random oracle - formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS)
Cryptographic Basics For Cryptocurrency
A Short Overview of Hashing
Signature Schemes,
Encryption Schemes
Bitcoin - Wallet
Merkley Tree - Hardness of Mining
Transaction Verifiability - Anonymity - Forks - Double Spending
Mathematical Analysis of Properties Of Bitcoin
Ethereum
Ethereum Virtual Machine (EVM) - Wallets for Ethereum
Smart Contracts - some attacks on smart contracts
Vulnerability, Attacks, Sidechain
Application and future of Blockchain
Zero Knowledge proofs and protocols in Blockchain
Succinct non interactive argument for Knowledge (SNARK)
Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain, Zcash

Reference Books:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.

2. Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015 (article available for free download) { curtain raiser kind of generic article, written by seasoned experts and pioneers}.

3. J.A.Garay et al, The bitcoin backbone protocol - analysis and applications EUROCRYPT 2015 LNCS VOl 9057, (VOLII), pp 281-310. (Also available at eprint.iacr.org/2016/1048) . (serious beginning of discussions related to formal models for bitcoin protocols).

4. R.Pass et al, Analysis of Blockchain protocol in Asynchronous networks, EUROCRYPT 2017, (eprint.iacr.org/2016/454) . A significant progress and consolidation of several principles).
5. R.Pass et al, Fruitchain, a fair blockchain, PODC 2017 (eprint.iacr.org/2016/916).

Privacy and Security in IoT [3 0 0 3]

Unit I: INTRODUCTION: SECURING THE IOT **8 lecture hours**

Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees

Unit II: CRYPTOGRAPHIC FUNDAMENTALS FOR IOT **8 lecture hours**

Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication

Unit III: IDENTITY & ACCESS MANAGEMENT SOLUTIONS FOR IOT 8 lecture hours

Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control

Unit IV: PRIVACY PRESERVATION AND TRUST MODELS FOR IOT 8 lecture hours

Concerns in data dissemination – Lightweight and robust schemes for Privacy protection – Trust and Trust models for IoT – self-organizing

Unit V: CLOUD SECURITY FOR IOT **8 lecture hours**

Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterpriseIoT cloud security architecture – New directions in cloud enabled IoT computing.

Reference Books

1. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations. By Fei Hu, 2016, by CRC Press.

2. The Internet of Things: Privacy and Security in a Connected World, Federal Trade Commission staff reports, United States. Federal Trade Commission, Publisher, DIANE Publishing Company, 2015, 1457867680.

Digital Forensic [3 1 0 4]

INTRODUCTION TO COMPUTER FORENSICS
History of Forensics – Computer Forensic Flaws and Risks
Rules of Computer Forensics – Legal issues – Digital Forensic Principles
Digital Environments – Digital Forensic Methodologies
AN OVERVIEW OF DIGITAL FORENSICS INVESTIGATION
Live forensics and investigation –digital evidence
seizure methodology factors limiting the whole sale seizure of hardware- Demystifying computer/ cyber crime
explosion of networking – explosion of wireless networks – interpersonal communication
DATA FORENSICS
Recovering deleted files and deleted partitions – deleted file recovery tools –

deleted partitioned recovery tools – data acquisition and duplication
data acquisition tools – hardware tools – backing up and duplicating data.
ROUTER FORENSICS AND NETWORK FORENSICS
overview of Routers – Hacking Routers – Investigating Routers
Investigating Wireless Attacks – Basics of wireless -Wireless Penetration Testing
Direct Connections to Wireless Access Point – Wireless Connect to a Wireless Access Point.
E-MAIL FORENSICS AND STEGANOGRAPHY
Forensics Acquisition – Processing Local mail archives –
Processing server level archives – classification of steganography
categories of steganography in Forensics – Types of password cracking.

Reference Books:

1. Anthony Reyes, Jack Wiles, "Cybercrime and Digital Forenscis", Syngress Publishers, Elsevier 2007.
2. John Sammons, "The Basics of Digital Forensics", Elsevier 2012
3. Linda Volonins, ReynaldsAnzaldua, "Computer Forensics for dummies", Wiley Publishing 2008.

- **Ethical Hacking and Penetration Testing [3 1 0 4]**

Unit 1	**Introduction to Ethical Hacking**
A	Security Fundamental, Security testing, Hacker and Cracker, Descriptions
B	Test Plans-keeping It legal, Ethical and Legality
C	The Attacker's Process, The Ethical Hacker's Process, Security and the Stack
Unit 2	**Malware Threats**
A	Viruses and Worms, Trojans, Covert Communication
B	Keystroke Logging and Spyware, Malware Counter measures
C	Sniffers, Session Hijacking, Denial of Service and Distributed, Denial of Service
Unit 3	**Web Server Hacking**
A	Web Server Hacking, Web Application Hacking
B	Database Hacking
C	Wireless Technologies, Mobile Device Operation and Security, Wireless LANs
Unit 4	**Understanding Penetration Testing**
A	Defining penetration testing, proliferation of Viruses and worm, Wireless LANs.
B	Complexity of networks today, frequency of software updates, availability of hacking tools, the nature of open source
C	Unmonitored mobile users and telecommuters, marketing demands, industry regulation, administrator trust, Hacktivism, Attack Stages
Unit 5	**Legal and ethical consideration**
A	Ethics of penetration testing, Laws: US Law, Computer Fraud and abuse act (CFAA), State Laws
B	Regulatory Laws: Health Insurance Portability and Accountability Act (HIPAA), Graham-Leach-Bliley (GLB)
C	Federal Information Security Management Act (FISMA), Sarbanes-Oxley Act (SOX)

❖ **Compiler Design [3 0 0 3]**

Unit	Content	Hrs/Unit
1	**IntroductiontoCompiling**[3L] Compilers,Analysis of thesourceprogram, Thephasesof thecompiler,Cousins of the compiler.	3
2	**Lexical Analysis**[6L] The role of the lexical analyzer,Tokens, Patterns, Lexemes,Input buffering,Specifications ofatoken, Recognition ofa tokens,Finiteautomata,From a regularexpressiontoanNFA,From aregularexpressiontoNFA,From a regular expressiontoDFA,Design ofalexicalanalyzer generator(Lex).	6
3	**Syntax Analysis**[9L] The role ofaparser, Contextfree grammars,Writinga grammar,TopdownParsing, Non-recursive Predictive parsing (LL),Bottomup parsing,Handles,Viable prefixes,Operatorprecedenceparsing,LRparsers(SLR,LALR),Parsergenerators (YACC). Error Recoverystrategiesfordifferent parsingtechniques.	9
4	**Syntax directedtranslation**[5L] Syntaxdirectordefinitions,Construction ofsyntaxtrees,Bottom-upevaluation ofSattributeddefinitions,Lattributeddefinitions,Bottom-upevaluation of inheritedattributes.	5
5	**Typechecking**[4L] Type systems,Specification ofa simpletypechecker,Equivalenceof type expressions,Typeconversions	4
6	**Runtimeenvironments**[5L] Sourcelanguageissues(Activationtrees, Controlstack,scope ofdeclaration,Bindingofnames), Storage organization (Subdivision ofrun-time memory,Activationrecords),Storageallocationstrategies,Parameterpassing(call byvalue,callbyreference,copyrestore,call byname),Symbol tables,dynamicstorageallocationtechniques.	5
7	**Intermediate code generation**[4L] Intermediatelanguages,Graphicalrepresentation,Three-addresscode,Implementation of threeaddressstatements (Quadruples, Triples,Indirect triples).	4

8	**Code optimization**[5L] Introduction,Basicblocks &flowgraphs,Transformation of basicblocks, Dagrepresentationof basicblocks,The principle sourcesofoptimization,Loopsinflowgraph,Peephole optimization.	5
9	**Code generations**[4L] Issuesinthe design ofcode generator, a simplecode generator, Register allocation&assignment.	4

Text book andReference books:

1.Aho, Sethi,Ullman -"CompilerPrinciples,TechniquesandTools"-PearsonEducation.
2. Holub - "CompilerDesigninC"- PHI.

Cryptography and Network Security [3 0 0 3]

Unit 1	**Introduction to Network Security & Ethics**
A	Computer Security Concepts- OSI security Architecture, Security attacks, Services, mechanism, model of network security
B	Classical encryption techniques- Substitution Cipher (Mono-alphabetic, Poly-alphabetic), Transposition cipher, Steganography
C	Block Cipher- Encryption Principles, DES & strength of DES
Unit 2	**Mathematics of Cryptography**
A	Euclidean, Extended Euclidean Algorithm, Euler's Totient Function, Ferment little Theorem, Euler's Theorem
B	Primality Testing-Miller Rabin test, Chinese Remainder Theorem
C	Exponential- square and multiply method, Discrete Logarithm
Unit 3	**Asymmetric Cryptography & Key Exchange**
A	Public Key cryptography-RSA, Cryptanalysis of RSA
B	Key management & distribution: KDC
C	Diffie Hellman key exchange
Unit 4	**Digital Signatures**
A	User Authentication protocol- Kerberos, Digital Signature –RSA, Elgamal
B	DSS, Data integrity algorithms-Hash Functions
C	MD5, SHA-512
Unit 5	**Message Authentication & hash function**
A	Authentication requirement & functions, Message Authentication Code
B	Security of Hash function & MAC
C	Secure HASH & MAC algorithm.

Reference Books:

1. AtulKahate , "Network Security ", Wiley India Pvt Ltd, 2010.
2. Michael T. Simpson, "Hands-on Cryptography& Network Security & Network Defense", Course Technology, 2010.
3. RajatKhare, "Network Seucirytand Cryptography& Network Security ", Luniver Press, 2006.
4. Bruce Schneier, “Applied Cryptography”, John Wiley & Sons Inc, 2001.
5. Behrouz A. Forouzan, “Cryptography And Network Security”- McGraw Hill

Internet as a resource for reference.

Digital Forensic Lab [0 0 3 1]

Unit 1	Introduction to computer forensics
A	Learn to install wine / virtual box or any other equivalent software on the host os
B	Perform an experiment to grab a banner with telnet and perform the task using netcat utility
Unit 2	An overview of digital forensics investigation
A	Perform an experiment for port scanning with nmap, superscan or any other software.
B	Using nmap 1)find open ports on a system 2) find the machines which are active 3)find the version of remote os on other systems 4)find the version of s/w installed on other system
Unit 3	Data forensics
A	Perform an experiment on active and passive finger printing using xprobe2 and nmap.
B	Performa an experiment to demonstrate how to sniff for router traffic by using the tool wireshark
Unit 4	Router forensics and network forensics
A	Perform an experiment how to use dumpsec.
B	Perform an wireless audit of an access point / router and decrypt wep and wpa.
C	Perform an experiment to sniff traffic using arp poisoning.
Unit 5	E-mail forensics and steganography
A	Install ipcop on a linux system and learn all the function available on the software.
B	Install jcrypt tool (or any other equivalent) and demonstrate asymmetric, symmetric crypto algorithm, hash and digital/pki signatures

Reference Books:

1. Anthony Reyes, Jack Wiles, "Cybercrime and Digital Forenscis", Syngress Publishers, Elsevier 2007.
2. John Sammons, "The Basics of Digital Forensics", Elsevier 2012
3. Linda Volonins, ReynaldsAnzaldua, "Computer Forensics for dummies", Wiley Publishing 2008.

❖ **Compiler Design Lab [0 0 3 1]**

LaboratoryExperiments:
1. Implementation ofSymbolTable 2. Develop a lexicalanalyzertorecognizeafewpatternsin C. (Ex. identifiers,constants,comments,operatorsetc.) 3. Implementation of LexicalAnalyzerusing LexTool 4. GenerateYACCspecificationfor afew syntactic categories. a) Programtorecognize a validarithmeticexpressionthat usesoperator +, – , * and/. b) Programtorecognize a validvariable whichstartswithaletterfollowedbyanynumberof lettersor digits. c)Implementation of Calculatorusing LEXand YACC 5. Convert the BNFrulesintoYaccformand writecode togenerateAbstractSyntaxTree. 6. Implementtypechecking 7. Implementcontrol flow analysisandData flowAnalysis 8. Implementanyonestorage allocationstrategies(Heap,Stack,Static) 9. Construction of DAG 10. Implement the back end of the compilerwhichtakesthethree address codeandproduces the8086assemblylanguage instructions thatcan be assembledand run usinga8086 assembler.The target assemblyinstructionscan be simple move,add,sub, jump.Alsosimpleaddressingmodesareused. 11. Implementation ofSimpleCode OptimizationTechniques(Constant Folding.,etc.)

Anyexperiment speciallydesignedbythe college
(Detailedinstructions forLaboratoryManualto befollowed for furtherguidance)

❖ **Cryptography and Network Security Lab [0 0 3 1]**

Unit 1	**Symmetric Encryption – Substitution (Stream Ciphers)**
A	Perform the following implementation 1. Encryption and Decryption with Ceaser cipher 2. Encryption and Decryption with Playfair cipher 3. Encryption and Decryption with Hill cipher 4. Encryption and Decryption with Vigenere cipher
B	
C	
Unit 2	**Symmetric Encryption – Transposition Technique**

	Perform the following implementation 1. Transposition using Rail Fence Cipher 2. Transposition using Columnar Transposition 3. Transposition using Route Cipher 4. Transposition using Scytale Cipher
Unit 3	**Symmetric Encryption – Substitution (Block Ciphers)**
	Perform the following implementation 1. Encryption and Decryption with DES 2. Encryption and Decryption with 3-DES 3. Encryption and Decryption with AES 4. Encryption and Decryption with IDEA
Unit 4	**Asymmetric Encryption**
	Perform the following implementation 1. Encryption and Decryption with RSA 2. Encryption and Decryption with Diffie-Hellman 3. Encryption and Decryption with DSA
Unit 5	**Digital Signature & Hashing & Authentication**
	Perform the following implementation 1. Digital signature of data using RSA 2. Digital signature of data using Diffie-Hellman 3. Hashing function – SHA-1 4. Message Authentication Code (MAC)

Reference Books:

1. Cryptography and Network Security, 4th Edition, William Stallings, Prentice Hall, 2005
2. Cryptography & Network Security by AtulKahate, Tata McGraw-Hill, 2008.
3. Internet as a Resource for Reference.

FOURTH YEAR

SEVENTH SEMESTER

- **Programming for IoT [3 0 0 3]**

UNIT 1: Introduction to Embedded Systems **9 lecture hours**

Introduction, Generic Embedded system architecture, Components, sensors and actuators, analog/digital conversion, hardware and software, integrated circuits, microcontroller properties, microcontroller components, Python vs C/C++, Why networking, WAN structure, internet structure, protocols stack, TCP/IP layer, MANETs

UNIT 2: The Arduino Platform and C Programming **9 lecture hours**

Arduino Platform, board, direct programming, arduino schematics, Install Arduino IDE, Arduino Shields and Libraries, Arduino basic setup, basic C variables and operators, conditions, loops, functions, arduinotoolchian, cross compilation, sketches, pins, input and output, Debugging, debug via serial, UART protocol and synchronization, UART parity and stop.

UNIT 3: Interfacing with Arduino **9 lecture hours**

Introduction, Electrical circuits, properties, Ohm's Law, Electrical Components, Diodes, Switches, Potentiometers, Wiring, Sensors, Resistive Sensors, Resistive Sensor Demo, Actuators, Analog Actuators, making sounds, arduino libraries, EEPROM, Masking, arduino shield, Ethernet shield and library, Ethernet client, server

UNIT 4: The Raspberry Pi Platform and Python Programming for the Raspberry Pi **9 lecture hours**

Raspberry Pi Board, Raspberry Pi Processor, Raspberry Pi vs. Arduino, Raspberry Pi IoT, Raspberry Pi Setup, Raspberry Pi Configuration, Overclocking, Python on Raspberry Pi, Python Programming Environment, Python Expressions, strings, functions, list, control flow, General Purpose IO Pins, Protocol Pins, GPIO Access, Graphic User Interface.

UNIT 5: Interfacing with the Raspberry Pi **9 lecture hours**

Network, Secure Shell, SSH Client/Server, Network Programs, Internet Protocols, IP Addresses, Domain Names, Sockets, Sending Data, Server Code, Live Server, Internet Control, Network Libraries, Web Services, Public APIs, Camera Module, PWM on RPI, Servo Control, Servo Code.

Reference Books:

1. Raspberry Pi with Java: Programming the Internet of Things (IoT) (Oracle Press) Paperback – 16 Nov 2015
2. The Internet of Things DoitYourself at Home Projects for Arduino Raspberry Pi and Beaglebone Black by Donald NorrisISBN: 9780071835206, 2016.
3. Link https://www.analyticsvidhya.com/blog/2016/06/11-read-books-summer-internet-iot/
4. Programming for the Internet of Things: Using Windows 10 IoT Core and Azure IoT Suite (Developer Reference) 1st EditionbyDawidBorycki (Author)

Cyber Security in Block Chain Technology [3 0 0 3]

Privacy, Security issues in Blockchain
Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation
attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - -advent of algorand
Sharding based consensus algorithms to prevent these attacks
Cryptography
Public Key Infrastructure (PKI) and Cryptography
Conventional PKI , Blockchain as a Form of Distributed PKI , Blockchain vs PKI
Blockchain - Public Key Cryptography, Decentralized Public Key Infrastructure (DPKI)
Digital Signature
Digital Signature from Blockchain context
Undeniable signature
Diffie–Hellman, Digital signature scheme for information non-repudiation in blockchain
Blockchain-based time stamping
Time stamping Metadata Using Blockchain
Decentralized Trusted Time stamping Based on Blockchains
Content Time stamping
Use Cases of Blockchain In Cyber security
Decentralized Storage Solutions, How Guardtime uses blockchain technology to safeguard data
IoT Security, Safer DNS, Using blockchains to prevent DDoS attacks
Implementing Security in Private Messaging

Reference Books:

1. Blockchain Technology Basics: Blockchain cryptography and cybersecurity Kindle Edition by Raghava Shankar (Author), Srikanth RC Cherukupalli M.Tech (Author)

2. Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks Kindle Edition by Imran Bashir (Author) Format: Kindle Edition

Block Chain using Multi Chain [3 0 0 3]

Introduction
What is Block chain? Basic ideas behind blockchain, how it is changing the landscape of digitalization, Uses of Blockchain. Abstract Models for BLOCKCHAIN - GARAY model - RLA Model
What is Multichain? Objective of Multichain, Features of Multichain, Uses of Multichain, Process of mining in Multichain technology
AnalyseMultichain platform, why it is better than other open platforms
Privacy and Permissions in Multichain,
Privacy and Permissions in Multichain, compare Multichain Core, and Bitcoin Core, Hand-Shaking Process, Private blockchainsMultichain

Multiple configurable Blockchains using Multichain, Decentralized exchange
Wallets for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts
DECENTRALIZED APPLICATIONS (DAPPS)
Characteristics of Decentralized application, Setting up a Private Blockchain, Multiple configurable Blockchains using Multichain
Deployment scenarios of Multichain, Centralized currency settlement, Bond issuance and peer-to-peer trading
Consumer-facing rewards scheme in Decentralized Applications
Introducing Multichain Feeds
Multichain feed Adapters, MultiChain Feeds for Database Integration, feed file adaptors, MultiChain streams
Purpose of Multichain streams, off chain data vs on chain data, JSON and Unicode text, Streams required to implement database, Streams and the MultiChain roadmap.
Three areas of high-level functionality, create the streams, publish the data into streams, retrieve the data from the streams using the key, and give permission to others to publish the data into the same streams.
Smart contract approaches
Hyperledger Fabric, smart filters, R3 Corda, Transaction rules in Hyperledger Fabric, smart filters, R3 Corda, Multichain , Etherium, Conflict transaction
Hyperledger Fabric vs MultiChain vs Ethereum vs Corda, Multichain Tools: MultiChain Explore, Multichain web demo
Applications of Multi chain: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain

Reference books:

1. Blockchain From Concept to Execution: BitCoin, Ethereum, Quorum, Ripple, R3 Corda, Hyperledger Fabric/SawTooth/Indy, MultiChain, IOTA, CoCo Kindle Edition by DebajaniMohanty (Author)

2. Beginner's Guide to Ontology: The Public Multi-Chain & Distributed Trust Collaboration Platform: (crypto, cryptocurrency, forex, trading, bitcoin, invest, earn money, invest, ethereum, blockchain) Kindle Edition by Juan Jimenez (Author),

3. Mastering Blockchain, Second Edition Paperback – 1 January 2018 by Imran Bashir (Author)

- **FUNDAMENTALS OF BUSINESS ANALYTICS [3 0 0 3]**

Data-Analytic Thinking for Business: The Ubiquity of Data Opportunities, Data Science as a strategic asset, data analytic thinking, Business Enterprise and its functions, Enterprise Applications – ERP, CRM, MIS.

Difference between Business Intelligence and Business Analytics. Database systems for Business: OLTP and OLAP systems for business overview and architecture overview. Business Problems and Data Science Solutions using CRISP-DM Approach: Business Understanding, preparation, modeling, evaluation, deployment. Performance Metrics in Analytics - Key performance
Indicators (KPIs), KPI based balanced score card, KPIs on Dashboards. Project Management - Project Management, phases, tools, techniques and methodologies in project management, Agile Framework and Scrum Approach. Quality Management - quality management philosophy, concepts and tools, Statistical Quality Control methods, Lean and Six Sigma, SERVQUAL model of service quality. Case studies – Human Capital Analytics, IT Analytics, Sales and Marketing Analytics, Analytics in telecom, Retail, healthcare, financial markets, social media, sports and other related business fields.

References:

1. Prasad, R, N. and Acharya, Seema*Fundamentals of Business Analytics*. Wiley India Pvt, Ltd, New Delhi, 2016.
2. Provost and Fawcett ,*Data Science for Business*, O'Reilly,2013.
3. Shmueli, Patel, and Bruce, *Data Mining for Business Intelligence, Concepts, Techniques and Applications.* Wiley, 2009.
4. Clifford F. Gray, Erik W. Larson, Gautam V. Desai - *Project Management* - Tata McGraw Hill, 2014.
5. Schwaber Ken *Agile project management with scrum, WP Publishers and Distributors*, Bangalore, 2004.
6. Sridhar Bhatta, *Total Quality Management, concepts and cases-Himalaya Publishing House,* 2015.

Implementing Block Chain in Cloud [3 0 0 3]

INTRODUCTION
Why Blockchain?, IBM blockchain platform introduction, benefits and differentiators of deploying and using a blockchain environment of LinuxONE
LinuxONE, Kubernetes(K8s), IBM cloud private, Gluster FS, IBM secure service container, IBM blockchain platform,
Secure service container partition, IBM cloud private cluster.
PLANNING FOR INSTALLATION
Why secure service container? Persistant storage provider, setting up file storage system
IBM blockchain platform console, Minimum network , Pilot network, Production network, Component containers, Resource reallocation
Consideration for specific use cases
SECURE SERVICE CONTAINER INSTALLATION AND CONFIGURATION
Secure service container architecture, SSC bootleader overview, download the image
Hardware requirement for SSC partition, Networking, Supported operating system and platform, software requirement, supported docker version, Supported IBM Cloud Private Versions, required ports,
Creating SSC partitions, Installing IBM cloud private cluster, Deploying IBM cloud private, Uninstalling ICP and SSC, Updating cluster resource dynamically
IBM BLOCKCHAIN PLATFORM INSTALLATIONS AND CONFIGURATIONS
Loading Helm chart, setting up role based access control (RBAC) rules, scripted console installation, manual console installation

Creating peer organization, creating a peer, creating the ordering service, Open shift support
Troubleshooting the installation
PERFORMANCE AND CONSIDERATIONS
Application client, Smart contract programming language, Endorsement policy, Orderer block configuration, Peer container resource allocation
Hiper sockets, Hiper socket benefits
Cryptography importance in block chain, CPACF's role in acceleration and protection

Reference Books:

1. Serious Cryptography: A Practical Introduction to Modern Encryption By Jean-Philippe Aumasson
2. Handbook of Research on Blockchain Technology by Saravanan Krishnan, Valentina Emilia Balas, Julie Golden, Y. Harold Robinson, S. Balaji, Raghvendra Kumar

- **Information Security and Audit Monitoring [3 0 0 3]**

Unit 1	**Introduction to Information Security and IS Auditing**
A	Objectives of IS audit and control,
B	The structure of an IS audit and audit reports,
C	IS auditing standards, Computer assisted audit tools
Unit 2	**Organization Security and Controls**
A	Physical security controls: contingency plan, disaster recovery and reconstruction
B	Logical security controls: operating system security and access control, Operating controls: segregation of duties, monitoring and logging controls
C	Personnel security and management practices: user training and incident reporting, third-party access and outsourcing, Application software control: software development control, input, processing and output control
Unit 3	**Basics of Cryptographic Technologies**
A	Symmetric encryption, Asymmetric encryption
B	Basics of message authentication and cryptographic hash functions
C	Digital signatures and digital certificates, Public-key Infrastructure & Web of Trust
Unit 4	**Network Security & Network Defense**
A	**Network Security:** User Authentication, Access Control and Identity Management
B	Network Security – Attack & Defense, Network Attacks: Host based attacks, Network attacks, Web based attacks
C	**Network Defense:** Intrusion detection systems & firewall, IPSec and DNSSec, IPv6, Cloud Computing
Unit 5	**Information System Security Auditing, Computer Forensic and Other Security Technologies**
A	Security auditing and security standards
B	Incident handling and computer forensic
C	Other security technologies including blockchain

Reference Books:

1. William Stallings and Lawrie Brown, Computer Security Principles and Practice, (3rd Edition), Pearson, 2014
2. Bruce Schneier, Applied Cryptography: Protocols, Algorithms and Source Code in C, Wiley, 2015
3. Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, Cryptography Engineering: Design Principles and Practical Applications, John Wiley & Sons, 2010.
4. Julia H. Allen, Sean J. Barnum, Robert J. Ellison, Gary McGraw, Nancy R. Mead, Software Security Engineering: A Guide for Project Managers, Addison-Wesley, 2008.

❖ IOT Lab [0 0 3 1]

List of Experiments:

1. Control an IoT Device using a web service.
2. Conduct an experiment with a temperature sensor connected to Arduino which is connected to Raspberry Pi
3. Demonstrate the capabilityof sending and receiving SMS messages is by creating a SMS application for home automation.
4. Execute a LED operation with different names remotely wireless operation using Respberry Pi
5. Demonstrate a Bluetooth Controlled LED Operation on Sound Detection
6. Demonstrate an operation using interfacing angle rotary sensor with Intel Galileo Gen 2 Controlled Brightness of LED
7. Experiment onInterfacing temperature sensor with Intel Galileo Gen 2 Controlled when temperature above threshold
8. Experiment on Interfacing Ultrasonic sensor with Intel Galileo Gen 2 and send data to mobile phone
9. Experiment on Interfacing light sensor with Intel Galileo Gen 2 and sending data to mobile application via Bluetooth
10. Experiment on Body health condition monitor with Respberry Pi and BP, Glucometer etc. sensors

Reference Books:

1. Raspberry Pi with Java: Programming the Internet of Things (IoT) (Oracle Press) Paperback – 16 Nov 2015

2. The Internet of Things DoitYourself at Home Projects for Arduino Raspberry Pi and Beaglebone Black by Donald NorrisISBN: 9780071835206, 2016.
3. Link https://www.analyticsvidhya.com/blog/2016/06/11-read-books-summer-internet-iot/
4. Programming for the Internet of Things: Using Windows 10 IoT Core and Azure IoT Suite (Developer Reference) 1st Editionby DawidBorycki (Author)

❖ **Ethical Hacking Lab [0 0 3 1]**

Unit 1	Introduction to Ethical Hacking
	To learn about hacking tools and skills.
Unit 2	To study about Fingerprinting.
Unit 3	Malware Threats
	To study about system Hacking.
Unit 4	Web Server Hacking
	To study about Wireless Hacking
Unit 5	IDS, Firewalls and Honeypots
	To learn & study about Sniffing & their tools.

Reference Books:

1. Ec-Council, "Ethical Hacking and Countermeasures: Attack Phases", Delmar Cengage Learning, 2009.
2. Michael T. Simpson, Kent Backman, James E. Corley, "Hands-On Ethical Hacking and Network Defense", Cengage Learning, 2012
3. Patrick Engebretson, "The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy", Syngress Media, Second Revised Edition, 2013.
4. Jon Erickson, "Hacking: The Art of Exploitation", No Starch Press, Second Edition, 2008.

PROGRAMELECTIVES:

Sub.Code	SubjectName	Sub.Code	SubjectName
1	Advanced DataStructuresand Algorithms	2	SoftwareEngineering
3	BlockchainTechnologies	4	Internetof Things
5	QuantumComputing	6	SocialNetworkAnalysis
7	DataForensics	8	InformationRetrieval
9	SoftComputingTechniques	10	EnterpriseDataArchitecture
11	ComputerVision	12	Robotics&Automation
13	Finance& Accounting	14	RiskAnalytics
15	FinancialMarketAnalytics	16	Business&EconomicAnalytics
17	DigitalMarketing	18	SupplyChainManagement
19	HealthInformatics	20	Bioinformatics
21	MedicalImageProcessing	22	Biostatistics
23	AlgorithmicTrading	24	AppliedEconometrics

Open Elective – I

1. Multimedia Technology
2. Introduction to Philosophical Thoughts

PROGRAM ELECTIVES

ADVANCED DATA STRUCTURES [3 0 0 3]

Advanced Search Trees: Review of Binary Search Trees, AVL Tree, R-B Trees and Splay Trees, Advanced Search Data Structures Like- Treaps, Skip Lists, Finger Search Trees, Biased Search Trees; Data Structures For External Storage: Review of 2-3-4 Trees and 2-3 Trees, B-Tree, B+ Trees, Priority Queues and Concatenable Queues Using 2-3 Trees; Advanced Heaps: Review of Heaps, Binomial Trees, Implementing Binomial Heaps and its Operations, Structure of Fibonacci Heaps, Mergeable Heap Operations, Decreasing Key and Deleting a Node, Bounding the Maximum Degree, Amortized Analysis of Fibonacci Heaps; Dictionaries and Hashing: Review of Dictionaries and Implementation, Review of Hashing- The Bucket Approach, Index File Approach, Universal Hashing, Perfect Hashing, Locality-Sensitive Hashing, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing, Synopses, Fingerprints, Fault Tolerant Data Structures; Graph Theory And Sorting Network: Review Of Graph Representation and Basic Algorithms, Algorithms for Connectedness, Finding all Spanning Trees in a Weighted Graph, Bipartite Graphs: Maximum Matching, the Hungarian Algorithm, Maximum Flow in a Transport Network - the Ford–Fulkerson Algorithm; Sorting Network: Comparison Network, Zero-One Principle, Bitonic Sorting and Merging Network Sorter.

References:

1. Cormen, T. H., Leiserson, C. E., Rivest, R.L., and Stein, C. *Introduction to Algorithms*, (3e), MIT Press, 2009.
2. Aho, V., Hopcroft, J. E. and Ullman, J. D. *The Design and Analysis of Computer Algorithms*, (1e), Fourth Impression, Pearson Education, 2009.
3. Horowitz, E., Sahni, S. and Rajasekaran, S, *Computer Algorithms, (2e), University Press*, 2007.
4. Weiss, M. A, *Data Structures and Algorithm Analysis* in C++, (2e), Pearson Education India, 2004.
5. Goodrich, M. T., Tamassia, R., *Algorithm Design*, (1e), John Wiley, 2002.

BLOCK CHAIN TECHNOLOGIES [3 0 0 3]

Introduction, Structure of a Block, The Genesis Block, Linking Blocks in the Blockchain, Merkle Trees, Simplified Payment Verification, Using hash functions to chain blocks, for Proof-of-Work, Digital Signatures to sign transactions, Distributed Ledger, Byzantine Agreement, Eventual Consistency & Bitcoin Consistency-Availability and Partitions, Bitcoin, Smart Contracts, Weak Consistency, Distributed Storage, Consistent Hashing, Hypercubic Networks, Mining and Consensus: Decentralized Consensus, Independent Verification of Transactions Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block Header, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Consensus Attacks, Changing the Consensus Rules, Soft Fork Signaling with Block Version, Consensus Software Development, Ethereum and Bitcoin, block format, mining algorithm, proof-of-stake (PoS) algorithm, account management, contracts and transactions, Solidity language, account management, contracts and transactions, Applications of Blockchain :Case studies

References:

1. Andreas M. Antonopoulos, "*Mastering Bitcoin: unlocking digital cryptocurrencies*", O'Reilly Media, (1e) 2014
2. Roger Wattenhofer, "*Distributed Ledger Technology, The science of the Blockchain*", Inverted Forest Publishing, (2e), 2017.
3. Antonopoulos, Andreas M. and Wood, Gavin. "*Mastering Ethereum*", O'Reilly Media, 2018.
4. George Icahn, "*Blockchain:the complete guide to understanding blockchain technology*", Amazon publishers, 2017.

INTERNET OF THINGS [3 0 0 3]

Introduction to internet of things, IoT in global context, Design Principles, IoT Technology Fundamental- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, IoT reference Architecture, IoT Domain Model, Functional Model. Information Model, Communication Model, Deployment and Operational View, IoT Prototyping- Prototyping Embedded Devices, Electronics, Sensors, Actuator, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, IoT Use Cases - Industrial Automation, Smart Home, Smart City, Commercial Building Automation.

References:

1. McEwen A., *Designing the Internet of Things*, Wiley, 2014
2. Holler J., From *Machine-to-Machine to the Internet of Things: Introduction to a New Age of* Intelligence, Academic Press, 2014.
3. Francis daCosta, *Rethinking the Internet of Things: A Scalable Approach to Connecting* Everything, Apress Publications, 2013
4. Pethuru R., *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, CRC Press, 2017
5. Vijay M., *Internet of Things (A Hands-on-Approach*), Universities Press, 2014
6. Daniel M., *Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications*, Wiley, 2013.

QUANTUM COMPUTING [3 0 0 3]

Introduction, Fundamental concepts. Quantum bits, Quantum computation, Quantum algorithms, Quantum Information, Introduction to Quantum Mechanics, Liner algebra, Postulates of quantum mechanics, Quantum Computation, Quantum circuits, Controlled operations, Measurement, Universal quantum gates, The Quantum Fourier Transform, The quantum Fourier transform, Phase estimation, Applications, Quantum Search Algorithms, Quantum counting, Speeding up the solution of NP-Complete problems, Quantum Information, Classical noise and Markov processes, Quantum Operations, Quantum Error Correction, The Shor code, Theory of quantum error correction, Entropy and Information, Shannon entropy, Basic properties of entropy, Von Neumann entropy, Quantum Information Theory, Distinguishing quantum states and the accessible information, Data compression, Classical information versus noisy quantum channels, Quantum information versus noisy quantum channels, Entanglement as a physical resource, Quantum cryptography.

References:

1. Michael A Nielsen, and Isaac L. Chuang "*Quantum Computation & Quantum Information*", (10e), Cambridge University Press, 2011.
2. F. Benatti, M. Fannes, R. Floreanini, and D. Petritis, "*Quantum Information, Computation and Cryptography"* Springer, 2010.
3. Mika Hirvensalo, "*Quantum Computing*", (2e), Springer-Verlag New York, 2004.
4. JozefGruska, "*Quantum Computing*", McGraw Hill, 1999.
5. Phillip Kaye, Raymond Laflamme and Michele Mosca, "*An Introduction to Quantum Computing"*, Qxford University Press, 2006.

SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction to Social Web, Nodes, Edges and Network Measures, Describing Nodes and Edges, Describing Networks, Layouts, Visualizing network features, The role of Tie strength, Measuring Tie strength and its network structures, network propagation, Link prediction, entity resolution, Case study, Introduction to community discovery, communities in context, quality functions, The Kernighan-Lin algorithm, Agglomerative algorithms, spectral algorithms, multi-level graph partitioning, Markov clustering, Other approaches, Introduction to social influence, Influence related statistics, social similarity and influence, Homophily, Existential Test for social influence, Influence and actions, Influence and interactions, influence maximization in viral marketing.

References:

1. Jennifer Golbeck., *Analysing the Social Web*, Morgan Kaufmann publications, 2013
2. Charu C. Aggarwal, *Social Network Data Analytics*, Springer publications, 2011
3. John Scott, *Social Network Analysis*, (3e), Sage publications limited, 2013
4. Jay Goldman, *Facebook Cookbook*, O'Reilly, 2009
5. Shamanth Kumar, Fred Morstatter, Huan Liu, *Twitter Data Analytics*, Springer publications, 2013

DATA FORENSICS [3 0 0 3]

Introduction, the history of forensics, the objectives of computer forensics, computer forensics flaws and risks, computer forensics- rules, procedures and legal issues, computer forensics lab, essential laboratory tools. Forensics investigation process: Introduction, investigating computer crime, conducting a computer forensics investigation, Recovering Deleted Files and Deleted Partitions, Data
Acquisition and Duplication. Hard disk and file systems: Introduction, file systems and hard disks, digital media devices, image file forensics, boot process-windows, linux and macintosh. Advanced forensics: Operating system forensics, Network forensics, Database forensics, Mobile forensics; cloud forensics, Malware forensics, investigating web and email attacks. Forensics analysis, validation and Report writing: Determine what data to collect and analyze, validating forensics data, addressing data hiding techniques, understanding the importance of reports, guidelines for writing reports, generating report findings with forensics software tools.

References:

1. Nelson, Phillips Enfinger, Steuart, *Computer Forensics and Investigations*, CENGAGE Learning, 2013.
2. Dave Kleiman, *The official CHFI study guide* ,Syngress publishing, 2017
3. Chris Pogue, *Unix and Linux forensic analysis DVD toolkit*, Syngress publishing, 2008.
4. John R. Vacca, Charles, *Computer Forensics, Computer Crime Investigation*, River Media, 2005.
5. Eoghan Casey, *Handbook of digital forensics and investigation*, Elsevier Academic press, 2010.
6. Harlan Cavery, *Windows forensic analysis DVD toolkit*, Syngress Publishing, 2009.
7. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, *Real Digital Forensics*, Addison Wesley Pearson Education, 2005.

INFORMATION RETRIEVAL [3 0 0 3]

Introduction to Information Retrieval: Mathematical Basics, Vector spaces and Similarity, Probabilities and Statistics, Text Analysis; Pre-processing: Document processing, Stemming, String Matching, Basic NLP tasks – POS Tagging Shallow Parsing; Overview of Text Retrieval Systems: System Architecture, Boolean Models, Inverted Indexes, Document Ranking, IR Evaluation; Retrieval Models and Implementation: Vector Space Models, TF-IDF Weighting, Retrieval Axioms, Implementation Issues, Probabilistic Models; Statistical Language Models: Okapi/BM25, Language Models, KL-divergence, Smoothing; Query Expansion and Feedback: Query Reformulation, Relevance feedback, Pseudo-Relevance Feedback, Language Model Based, Feedback; Web Search Engines: Models of the Web, Web Crawling; Static Ranking: Page Rank HITS, Query Log Analysis, Adversarial IR, Information Filtering: Adaptive Filtering, Collaborative Filtering, User Interfaces, Text Classification, Naïve Bayes, K-nearest neighbors, Feature selection, Semi-supervised Learning; Text Clustering: Vector-space Clustering; K-means, EM algorithm, Text shingling; Graph-Based Methods: WordNet, Document and Word Graphs, Network Analysis, Random Walks, Harmonic Functions.

References:

1. Christopher D. Manning, PrabhakarRaghavan and HinrichSchütze, *Introduction to Information Retrieval",* (2e), Cambridge University Press, 2015.
2. B. Croft, D. Metzler, T. Strohman, *Search Engines: Information Retrieval in Practice*, (3e), MIT Press, 2016.

3. ChengxiangZhai, *Statistical Language Models for Information Retrieval* (Synthesis Lecture Series on Human Language Technologies), (2e), Morgan & Claypool Publishers, 2017.

SOFT COMPUTING TECHNIQUES [3 0 0 3]

Introduction to Soft Computing: Concept of Computing Systems, Soft Computing Versus Hard Computing, Characteristics of Soft Computing, Some Applications of Soft Computing Techniques; Fuzzy Logic: Introduction to Fuzzy Logic- Fuzzy Sets and Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Rules, Propositions, Implications and Inferences, Defuzzification Techniques - Fuzzy Logic Controller Design, Some Applications of Fuzzy Logic; Artificial Neural Networks: Biological Neurons and its Working, Simulation of Biological Neurons to Problem Solving, Different ANNs Architectures, Training Techniques for ANNs, Applications of ANNs to Solve Some Real Life Problems; Nature Inspired Algorithms: Genetic Algorithms, Concept of "Genetics" and "Evolution" and its Application to Probabilistic Search Techniques, Basic GA Framework and Different GA Architectures, GA Operators- Encoding, Crossover, Selection, Mutation, etc., Solving Single-Objective Optimization Problems Using GAs, Particle Swarm Optimization- Implementation, Operators, Case Studies, Ant Bee Colony Optimization- Implementation, Operators, Case Studies; Multi-Objective Optimization: Problem Solving Concept of Multi-Objective Optimization Problems (MOOPs) and Issues of Solving Them. Multi-Objective Evolutionary Algorithm (MOEA), Non-Pareto Approaches to Solve MOOPs, Pareto-Based Approaches to Solve MOOPs, Some Applications with MOEAs.

References:

1. Martin, F., Neill, Mc. and Thro, E., *Fuzzy Logic: A Practical approach*, AP Professional, 2000.
2. Ross, T, J., Fuzzy Logic with Engineering Applications, (3e), Willey India, 2010.
3. Kasabov, N. K., *Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering*, MIT Press, 1998.
4. Ibrahim, A. M., *Fuzzy Logic for Embedded Systems Applications*, Elsevier Press, 2004.
5. Mitchell, M., An*Introduction to Genetic Algorithms*, MIT Press, 2000.
6. Goldberg, D. E., *Genetic Algorithms In Search, Optimization And Machine Learning*, Pearson Education India, 2002.
7. Rajasekaran, S. and VijayalakshmiPai, G. A., *Neural Networks, Fuzzy Logic and Genetic Algorithms:* Synthesis, and Applications, Prentice Hall India, 2007.
8. Pratihar, D. K., *Soft Computing*, (1e), Narosa Publishing, 2008.
9. Jang, J.-S. R., Sun, C.-T. andMizutani, E., *Neuro-Fuzzy and Soft Computing*", (1e), PHI Learning, 2009.
10. Haykin, S., *Neural Networks and Learning Machines*, (3e), Prentice Hall India, 2011.

ENTERPRISE DATA ARCHITECTURE [3 0 0 3]

Introduction to Enterprise Architecture , Overview, core elements , analysis and planning approaches, Structure and culture of Enterprises, Enterprise data governance, Value and risk of creating an Enterprise Architecture, Developing an Enterprise Architecture. Implementation methodology, Analysis and Documentation Framework, Components and Artifacts, Developing Current Architect Views, Developing an Enterprise Architecture Management Plan, Investment Planning and Project Management, Role of Security and Privacy, Enterprise Architecture Repository and Support Tools. Data Quality Management – Concepts and Implementation. Service Oriented Architecture (SOA) and Virtualization. Data Warehousing, data modeling for data warehousing and business intelligence. Enterprise Big Data Storage Models. Outsourcing and Vendor Management. Service Level Agreements (SLAs), Performance testing and monitoring; Disaster Recovery strategies. Fault Tolerance and Recovery. Effective Metadata modeling, design and management. Case Studies.

References:

1. Scott A. Bernard ,*An Introduction to Enterprise Architecture*, Third Edition, , AuthorHouse .

2. Paul Clements, Felix Bachmann , Len Bass, David Garlan, James Ivers, Reed Little, Paulo Merson , Robert Nord, Judith Stafford , *Documenting Software Architectures: Views and Beyond* , (2nd Edition) Addison-Wesley Professional.
3. Jeanne W Ross, Peter Weill, David Robertson, Enterprise Architecture *As Strategy: Creating a Foundation for Business Execution*. Harvard Business Review Press, 2006
4. Mario Godinez, Eberhard Hechler, Klaus Koenig, Steve Lockwood, Martin Oberhofer, and Michael Schroeck , *The Art of Enterprise Information Architecture: A Systems-Based Approach* for Unlocking Business Insight, IBM Press, 2010.
5. Stefan Bente, Uwe Bombosch, and ShailendraLangade, *Collaborative Enterprise Architecture: Enriching EA with Lean*, Agile, and Enterprise 2.0 practices, Morgan Kaufmann, 2012.

COMPUTER VISION [3 0 0 3]

Introduction : Image Processing, Components of Image processing system, Image formation and digitization concepts, Neighbours of pixel adjacency connectivity, regions and boundaries, Distance measures, Image processing operations, Arithmetic, Logical, Geometrical, Convolution and Correlation Operations, Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality, Image Formation, Image representations (continuous and discrete) , Image pre-processing Techniques, Feature Extraction-Point, Line and Edge Detection, Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform , Image Segmentation: Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Watershed algorithm, Use of motion in segmentation, Computer Vision: Computer Vision, What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications, Fundamentals of object recognition, Low-level computer vision-Edges, contours, textures, shapes, and colors , Motion, optical flow, and tracking Local features, invariance, bag-of-words models, Fisher vector, Middle-level representations of objects: parts, attributes, embedding.

References:

1. David Aforsyth& Jean ponce "*Computer vision – A modern Approach, Prentice* Hall, Pearson Education India; Edition: Second, ISBN-13: 978-9332550117, 2015.
2. R. C. Gonzalez, R. E. Woods. "*Digital Image Processing"*. Pearson, Inc., Edition-Fourth, ISBN. 978-0131687288, 2017.
3. A. K. Jain. "*Fundamentals of Digital Image Processing*. Prentice-Hall, Pearson; Edition: First, ISBN-13: 978-0133361650, 1994.
4. David A forsyth& Jean ponce , "*Computer vision – A modern Approach*" , Prentice Hall ,2002.
5. Bernd Jahne and Horst HauBecker, "*Computer vision and Applications*" Academic press, 2000.

ROBOTICS AND AUTOMATION [3 0 0 3]

Introduction: Definition, Applications of mobile robotics, History of mobile robotics. Design of system and navigation architecture: Reference control scheme of a mobile robotics environment, Temporal decomposition of architecture, Control decomposition, Hybrid architecture, Mobile architecture, Perception, Representation and the mapping process. Locomotion: Issues for locomotion, Legged mobile robots, Wheeled mobile robots. Kinematics: Kinematics introduction, Forward and reverse kinematics, Wheeled kinematics and its constraints, Mobile system locomotion, Human biped locomotion as a rolling polygon, Representation of robot position through the reference frame. Power
Sources and Sensors: Hydraulic, pneumatic and electric drives, determination of HP of motor and gearing ratio, variable speed arrangements, path determination, micro machines in robotics, machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors. Manipulators, Actuators and Grippers: Construction of manipulators, manipulator dynamics and force control, electronic and pneumatic manipulator control circuits, end effectors, U various types of grippers, design considerations. Navigation: Localization overview,

Path planning. Computational intelligence: Swarm intelligence, Evolutionary computation, Artificial immune system, Ant algorithm. Mobile robot programming.

References:

1. Ronald Siegwart, Illah R. Nourbakhsh, "*Introduction to Autonomous Mobile Robots*", MIT Press,
2. Andries P. Engelbrecht , "*Computational Intelligence: An Introduction*", Wiley 2nd Edition, 2007
3. Ronald C. Arkin , "*Intelligent Robotics and Autonomous Agents*", MIT Press, 1997
4. Ulrich Nehmzow, "*Mobile Robotics: A practical Introduction*", Springer-Verlag London, 2003
5. Robin R. Murphy, "*Introduction to AI Robotics*", MIT Press, 2000
6. Leandro N. de Castro and Jonathan Timmis, "*Artificial Immune system: A new Computational Intelligence Approach*", Springer-Verlag, Germany 2002.

DS4152: FINANCE & ACCOUNTING [3 0 0 3]

Understanding the Financial Data: Financial Statements, Type of Accounting and finance data, Nature and behavior of financial and accounting data. Preparation of financial statements in excel, Calculation, projection of various reports with finance and accounting data, Understanding data in finance, sources of data, cleaning and pre-processing data, Understanding stock price behaviour, Time series analysis in finance . Review of Financial Statements: Sources for Financial Statement Information, Types of financial statements: Income statement, Balance Sheet, Cash flow and funds flow statement, Ratio Analysis, DuPont Analysis, Profitability and Turnover Ratios, Liquidity Ratios, Forecasting of ratios and future financial statements, Preparation financial reports using MS Excel. Valuation of Equity and Firm/Business: Free Cash Flow to Equity (FCFE), Free Cash Flow to the firm (FCFF), Discounted cash flow approach to equity and business valuation, Relative Valuation approach to valuation, non-financial performance metrics affecting company valuations. Investment Analysis: Capital Budgeting Techniques – Pay Back Method, Discounted Pay Back Method, Accounting Rate of Return, Net Present Value Method, Internal Rate of Return and Profitability Index. Risk Analysis in Capital Budgeting – Nature of risk, Statistical Techniques for risk analysis, Conventional techniques of risk analysis and Sensitivity Analysis. Capital Rationing. Capital Structure and Valuation: Meaning. Operating Leverage. Financial Leverage, EBIT-EPS Analysis. Combined Leverage. Meaning of Capital Structure. Capital Structure Theories – Definitions, Net Income Approach, Net Operating Income Approach, Modigliani Miller Approach, and Traditional Approach. Practical Considerations in Determining Capital Structure. Working Capital Analysis: Meaning, Need and Nature of Working Capital [Concept and Definitions]. Determinants of Working Capital. Trade-off between Profitability and Risk. Determining Financing Mix. Computation/Estimation of Working Capital. Cash Management and Receivables and payables management.

References:

1. Prasanna Chandra., *Fundamentals of Financial Management*, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., *Engineering Economics*, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., *Accounting and Financial Management*, Scitech Publications Pvt. Ltd. India, 2001.
4. Eugene F. B. & Joel F. H., *Fundamentals of Financial Management*, 12th ed., Cengage Learning Publisher, 2009.
5. Johnston,J, *Econometric Methods*, McGraw-Hill Book Co., New York.
6. Maddala, G.S, *Econometrics*, McGraw-Hill Book Co., New York, 3rd Rd.
7. Gujarathi, D.N, *Basic Econometrics*, Fourth Edition, Tata McGraw-Hill, New Delhi.

RISK ANALYTICS [3 0 0 3]

Introduction to risk analysis: Nature of risk and uncertainty; Why do a risk analysis?; Management's responsibility with regard to risk; Discuss risk management; Upside and downside risk; Handling big data; Cost and benefits associated with investing in information systems; Recommended techniques for the Boards to manage risks. Quantification of risk: Quantification of risk using expected values, standard deviations and

probability tables; Calculating Beta & Capital Asset Pricing Model; Decision trees; Decision models to deal with uncertainty in decision making-Max-min, Max-max, and Min-max regret criteria; Payoff tables. Probability mathematics and simulation: Types of risks; Types of market risks; Market risk measurement, Value at Risk (VaR); VaR as a key parameter to measure market risk; Elements of VaR system; Stress testing; VaR Methods- An overview of VaR methods; VaR local and full valuation; Delta normal methods; Historical simulation; Monte Carlo simulation; Examples of VaR applications. Financial risk analysis modelling: Introduction to credit risk; Credit risk management; Settlement risk; Measuring credit risk; Measuring Credit VaR; Types of credit derivatives. Forecasting with uncertainty: Properties of a Time Series Forecast; Common Financial Time Series Models; Autoregressive Models; Time Series Projection of Events Occurring Randomly in Time; Time Series Models with Leading Indicators. Hedging Techniques: Hedging-Hedging linear risk; Optimal hedging; Hedge ratio as regression coefficient; Duration hedging; Beta hedging; Non-linear risk hedging; Delta and dynamic hedging.

References:

1. Vose David, *Risk Analysis: A Quantitative Guide*, John Wiley & Sons Inc, 2018.
2. Hull John C., *Risk Management and Financial Institutions*, John Wiley & Sons Inc, 2018.

FINANCIAL MARKET ANALYTICS [3 0 0 3]

Money and Capital market, Fundamental Analysis: Economic analysis, Industry Analysis, Company analysis. Technical Analysis, chart formations, Moving average analysis, Relative strength analysis, Technical indicators. Merits and demerits of technical analysis. Random Walk Hypothesis: Efficient market theory, weak form, semi-strong form, strong form, Implications for investment analysis. Equity valuation: Balance sheet valuation, Dividend discount model, Earnings multiplier approach, Earnings to price ratio, Expected return, and growth. Analysis and Valuation of debt: Bond pricing, Bond yield, Risk in debt. Portfolio Analysis: Risk and Return analysis, Markowitz Theory. Portfolio Theories –CAPM. Markowitz Theory, Single Index Model, Two Factor Model Theory, Arbitrage Pricing Theory.

References:

1. Donald Fischer and Jordan - *Security Analysis and Portfolio Management* - PHI, New Delhi, 2017.
2. William F. Sharpe - *Investments*

BUSINESS & ECONOMIC ANALYTICS [3 0 0 3]

Consumers, producers & production: Consumer Behavior, Production, cost & revenue analysis. Price and Output determination under different market structure: Perfect competition, Price and output determination under Monopoly, monopolistic competition, oligopoly. National Income Accounting: Circular flow of income model; methods and concepts in national income accounting and limitations, Inflation: Types, causes, effects and control measures for Inflation. Macro policies: Meaning, objectives and tools and effects of monetary and fiscal policies. External Sector: Economic openness, Balance of Payments, BoP crisis, exchange rate concepts, foreign capital flow.

References:

1. SoumyenSikdar., *Principles of Macroeconomics*, OXFORD University Press, 2017.
2. Robert Pindycik& Daniel Rubinfeld., *Microeconomic*s, 8TH ed., Pearson India Education services Pvt Ltd.
3. Gujarathi, D.N, *Basic Econometrics*, Fourth Edition, Tata McGraw-Hill, New Delhi, 2017.

DIGITAL MARKETING [3 0 0 3]

Introduction: Online Market space- Opportunities for building Brand, Digital eco system and channels, Market and customer segmentation, Digital Marketing Strategy Components, Combining digital and traditional media. Search Engine Optimization: How Search Engine works, SEM components, PPC

advertising with Google ad words, Display Advertisement. Search Engine Optimization: SEO success factors (On-Page and Off-Page Techniques), Google analytics. Display Advertising: Real time bidding, executing display advertising, E-commerce Models. Social Media Marketing: Social Media Channels. Facebook, Twitter, LinkedIn, Instagram, other Soc. Media channels. Leveraging Social media for brand conversations and buzz, Successful /benchmark Social media campaigns. Social Media Marketing: Promoting/advertising brand in Social media, Social Media Feedback, Measuring Social media impact. E- Mail Marketing: Types of E- Mail Marketing, Email Automation, Lead Generation, Integrating Email with Social Media and Mobile, Digital Marketing for B2B, Measuring and maximizing email campaign effectiveness. Online Reputation Management: Combining digital and traditional media, Power of Social Media, Monitoring SM, Proactive and reactive reputation management. Creating a Digital Marketing Strategy: Elements of strategy, Operational aspects of strategy, Digital Marketing plans .Mobile Marketing: Mobile Inventory/channels, Location based, Context based, Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns ,Profiling and targeting. Web Analytics and Channel Attribution Strategies: Social Media Analytics, Website Analytics, Channel attribution model.

References:

1. Maity, Moutusy, *Internet Marketing: A Practical Approach in the Indian Context,* Oxford University Press, 2017.
2. Richard Gay, Alan Charlesworth and Rita Esen, *Online Marketing- a customer led approach,* Oxford University Press, New York, 2013.
3. Alan Charlesworth, *Digital Marketing: A Practical Approach*, 2014.
4. AvinashKaushik ,*Web Analytics 2.0: The Art of Online Accountability*, 2009.

SUPPLY CHAIN MANAGEMENT [3 0 0 3]

Introduction and objectives of supply chain, Decision phases in a supply chain, Purchasing tools and techniques, Value analysis, Project planning and control techniques, Pricing and revenue management, Costing fundamentals, Types of costing, Managing inventory in a supply chain, Economic order quantity, EOQ determination with instantaneous delivery and without shortages, Effect of quantity discount, safety stock, reorder level & lead time. Facility decisions in supply chain:, Factors influencing network design in supply chain, Models for facility location and capacity allocation, Transportation decisions in a supply chain, Routing and scheduling in transportation, Multistage transportation problems, Truck allocation problem, Travelling salesman problem, Vehicle routing problems, Financial evaluation of supply chain Decisions, The impact of financial factors on supply chain decisions, Discounted cash flow analysis, Evaluating supply chain decisions using decision trees.

References:

1. Chopra and Meindl.,*Supply Chain Management – Strategy, Planning and Operation*, (3e), Pearson Education, New Delhi, 2009.
2. Raghuram and Rangaraj, *Logistics and Supply Chain Management: Cases and Concepts*, Macmillan, New Delhi, 2000.
3. Simchi-Levi and Kaminski, *Designing and Managing the Supply Chain: Concepts, Strategies* and Case Studies , McGraw-Hill, 2003.
4. Shapiro J., *Modelling the Supply Chain,* Duxbury Thomson Learning, U.S.A., 2009.
5. Krajewski Lee J. and Ritzman Larry P., *Operations Management, Pearson Education (Singapore)* Pte. Ltd., Delhi, 2005.

HEALTH INFORMATICS [3 0 0 3]

Introduction to Health care and Information Technology-HealthCare Data – Types of HealthCare Data – HealthCare Databases & Applications – Healthcare Informatics Vs Clinical Informatics-EMR, HER and EPR.

Interoperability Standards in Healthcare – Introduction to healthcare standards-need for such standards-HL7-Digital Image Communication in Medicine (DICOM)- Picture Archival and Communication System (PACS)-Clinical Document Architecture (CDA)- Integrating the Healthcare Enterprise . Imaging Systems in Healthcare – Imaging Modalities- Xray, CT, MRI, US- Radiology Information Systems-PACS. Ethics in Healthcare – Protected Healthcare Information-HIPPA-Mobile in Healthcare. Telehealth-Telemedicine-Tele Radiology-Data Compression Techniques- IT for rural healthcare.

References:

1. Ramona Nelson and Nancy Staggers, *Health Informatics: An Interprofessional Approach*, 2016.
2. WIlliam Hanson, *Healthcare Informatics* , McGraw-Hill Education, 2017.
3. K. Kirk Shung, Michael B. Smith, Benjamin M.W. Tsui*Principles of Medical Imaging*".
4. Oleg S Pianykh, *"Digital Imaging and Communication in Medicine(DICOM)*", Springer.
5. HIMSS, *"HIMSS Dictionary of Healthcare Information Technology Terms, Acronyms and Organizations*", Second Edition, 2016
6. Victor Lyuboslavsky, *"Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients*" .
7. "Erich H. Loewy, M.D. , Roberta Springer Loewy, *Textbook of Healthcare Ethics"* 2nd Edition, Kluwer Academic Publishers New York, 2017.

BIOINFORMATICS [3 0 0 3]

Introduction to Bioinformatics, Central dogma of biology, Digital code of life, database sequence search & Alignment, The evolutionary basis of sequence alignment, The modular nature of proteins, Optimal alignment methods, Substitution scores and gap penalties, Statistical significance of alignments, Structure file formats; Visualizing structural information, Motifs and Pattern, Protein structure prediction, Searching for trees, Rooting trees, Evaluating trees and Data, Phylogenetic software, Phylogenetics on the web, Some simple practical considerations, Genome annotation, Comparative genomics, Genome compression.

References:

1. Arthur M. Lesk. *Introduction to Bioinformatics*. Oxford University Press, 2002
2. Stuart M. Brown. *BIOINFORMATICS: A biologists guide to biocomputing and the internet*. NYU Medical Center, 2000.

MEDICAL IMAGE PROCESSING [3 0 0 3]

Review of signals, systems & transforms; 2D signals & systems; Medical Imaging: Imaging modalities and their applications; Computed tomography (CT): mathematical basis, the Radon transform & the central slice theorem; Image reconstruction from projections: the Direct Fourier Method, convolution back projection (CBP) algorithm, Algebraic Reconstruction Techniques (ART); reconstruction from fan-beam projections; Extension to 3D – cone-beam CT, spiral CT. Tomosynthesis; X-rays: utility, generation and detection; X-ray CT systems. Emission CT: principles, Positron emission tomography (PET); attenuation correction in ECT; Ultrasound in clinic: benefits/risks, Basics of Ultrasound - review, Ultrasound imaging; Contrast enhanced ultrasound imaging; Motion artifacts in ultrasound imaging. Clutter filtering; elastography, plane wave imaging; Magnetic resonance imaging: Principles of data-generation, resolving the tissues, resolving the spatial locations, and extension to 2D. Resolution & Field of View; Data sampling and the concept of bandwidth.

References:

1. R.C Gonzalez and R.E. Woods, *Digital Image Processing*, (4e), Pearson Education Inc., 2017.

2. A.K. Jain, *Fundamentals of Digital Image Processing, Prentice- Hall, Fourth Indian Reprint*, 1989.
3. A.C. Kak and M. Slaney, *Principles of Computerized Tomographic Imaging, SIAM's Classics in Applied Mathematics*, Philadelphia, SIAM, 2001.
4. Kline Jacob, *Handbook of Biomedical Engineering*, Academic Press, 1988.
5. Carol M. Rumack, Deborah Levine, *Diagnostic Ultrasound*, (5e), Elsevier, 2017

BIOSTATISTICS [3 0 0 3]

Introduction, Summarizing Quantitative Data, Summarizing Categorical Data; Prevalence, Incidence, Relative Risk, Risk Difference, Sampling Bias, Confidence Intervals, Study Design, Probability & Screening; Probability distributions: Binomial & Normal Distributions, Sampling Distributions, Confidence Intervals. Introduction to statistical design: Introduction to factorial designs, 2k factorial design, main effects, interaction effects Screening designs: Fractional factorial designs, Plackett-Burmann screening designs. Model reduction, model assumption checking, residual plots. Optimization designs: Response surface methodology – concepts & methods, central composite designs and Box-Behnken design.

References:

1. Sullivan, L.M., *Essentials of biostatistics for the health sciences, (3e*), Jones & Bartlett Learning, 2018.
2. Machin, Campbell and Walters, *Medical Statistics*, (4e)., Wiley, 2007.
3. Motulsky, H., Intuitive Biostatistics: *A nonmathematical guide to statistical thinking*, (3e), Oxford University Press, New York, 2014.
4. Utts, J and Heckard, R., *Mind on statistics*, (5e), Cengage Learning, USA.

ALGORITHMIC TRADING [3 0 0 3]

Basic Trading strategies- Discretionary, Algorithmic Trading, Hybrid. Algorithmic vs. High-Frequency/Low Latency Trading. Industry Overview- Alternatives, Hedge Funds, Commodity Trading Advisor Funds, Quant Funds. Tracking Funds, Tracking Benchmarks, Basic Portfolio Strategies. Mathematics for algorithmic trading- Prediction of prices, Risk calculation, Capital Allocation, locking in Options & Futures Review of Time Series, Capital Allocation, Momentum, Options and futures- trend, seasonal, cyclical and irregular components, white noise, Brownian motion, Auto covariance, autocorrelation and criteria. ARIMA models, Autoregressive Models, Moving Average Models, ARMA Models. Box-Jenkins method, characteristic polynomials, Sharpes and Skewness , Stationary vs. Non-stationary processes, criteria (AIC, BIC) for model choice, Cross Validation, Bootstrap and Stochastic Differential Equations (SDE)s., Kalman Filters. Algorithmic Trading Basics- Back testing, Automated Execution, Momentum, Mean Reversion, Carry, Value, Basic Portfolio Strategies, Over fitting. Mean Reversion Strategies - Mean Reversion of Stocks, ETFs, Currencies and Futures, Timescales/horizons associated with MR, Momentum and Value, Volume and Mean Reversion Liquidity, Unit Root Tests, Augmented Dickey Fuller Tests. KPSS Tests, Variance Ratio Tests. Co-integration and Johansen Test. Momentum/Trend Following- properties and tradeoffs, Inter-day and Intraday Momentum Strategies, Risk Management. Skewness over horizon results, momentum modelling. Filters, Change points - sequential binary segmentation, switching Kalman filters, Carry, Value, P vs. Q-measure. Over fitting- p-hacking, lack of reproducibility, holdout over fitting. Adjusted Sharpe Ratios. Multiple Hypothesis Testing – Holm-Bonferroni . BHY adjustments. ML for Algorithmic trading, pitfalls and future opportunities. Case Studies: Introduction to Quantopian, Mini project using open source technologies to build and test simple algorithmic models.

References:

1. Earnest Chan, Algorithmic Trading: Winning Strategies and Their Rationale, John Wiley &Sons , 1st edition, 2013.
2. Ernie Chan, Quantitative Trading: How to Build Your Own Algorithmic Trading Business, John Wiley & Sons;, 1 edition , 2008

3. Rishi K. Narang, Inside the Black Box: The Simple Truth about Quantitative Trading, John Wiley & Sons , 1st edition, 2009.
4. Barry Johnson, Algorithmic Trading and DMA: An introduction to direct access trading strategies, 4Myeloma Press, 2010.
5. David J. Leinweber, Theodore R. Aronson, Nerds on Wall Street: Math, Machines and Wired Markets , John Wiley & Sons, 1st edition, 2009.
6. Alex Kuznetsov, The Complete Guide to Capital Markets for Quantitative Professionals (McGraw-Hill Library of Investment and Finance) . McGraw-Hill Education, 1 edition, 2006.

APPLIED ECONOMETRICS [3 0 0 3]

Financial Econometrics: Nature of Econometrics and Economic Data. Time Series Econometrics. The Experimental Ideal: selection problem, random assignment, regression analysis of experiments. Regression Modeling: Linear regression modeling, properties of regression, omitted varaibles, decomposition techniques, regression and causality, heterogeneity and nonlinearity. Logit and probit models, problems of inference. Causal Modeling: Panel data, Instrumental variables. Instrumental variables in action: Causality, asymptotic 2SLS Inference, Two sample, Split Sample Instrumental variables, IV with heterogeneous potential outcomes. Individual Fixed Effects. Differences-in-differences, Fixed effects versus lagged dependent variables. Regression discontinuity: designs, sharp and fuzzy regression discontinuity. Quantile regression model: estimation of quantile treatment effects, nonstandard standard error issues, bias of robust standard error estimates, clustering and serial correlation in panels. Methods from Statistical Learning: Cross validation and k-fold, Shrinkage methods (Ridge and LASSO), Basis functions, Tree models.

References:

1. Joshua D. Angrist and Jorn-Steffen Pischke, *Mostly Harmless Econometrics- An Empircist's Companion*, Princeton University Press, 1 edition, 2009.
2. Jeffrey M. Woolridge, *Introductory Econometrics: A Modern Approach*, CENGAGE Learning Custom Publishing; 5th edition , 2012.
3. Maurice DeGroot, Mark J Schervish, *Probability and Statistics*, Pearson Publications, 4 edition ,2011.
4. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer Science, 2017.

Open Elective – I

- **MultimediaTechnology**

Unit	Content	Hrs/Unit	Marks/ Unit
1	**Introduction:**Multimediatoday,Impact of Multimedia,MultimediaSystems,ComponentsandItsApplications	2	
2	**Text and Audio, Imageand Video(14L)** Text: Types ofText,WaystoPresentText, AspectsofTextDesign,Character,CharacterSet, Codes,Unicode,Encryption; Audio: BasicSound Concepts,Types ofSound, DigitizingSound, ComputerRepresentation ofSound (SamplingRate,SamplingSize,Quantization),AudioFormats,Audio tools, MIDI Image: Formats,ImageColor Scheme,ImageEnhancement; Video: AnalogueandDigital Video,RecordingFormatsandStandards (JPEG,MPEG, H.261)Transmission of VideoSignals,VideoCapture,and ComputerbasedAnimation.	14	
3.	Synchronization, Storage models and Access Techniques: Temporal relationships, synchronization accuracy specification factors, quality of service, Magnetic media, optical media, file systems (traditional, multimedia) Multimedia devices – Output devices, CD-ROM, DVD, Scanner, CCD	8	
4.	**ImageandVideoDatabase,DocumentArchitectureandContentManagement(17L):**Imagerepresentation,segmentation,similaritybasedretrieval,imageretrievalby color,shapeandtexture;indexing-k-dtrees,R-trees,quadtrees;Casestudies-QBIC,Virage.VideoContent,querying,videosegmentation,indexing, ContentDesignandDevelopment,General DesignPrinciples Hypertext: Concept, Open DocumentArchitecture(ODA),MultimediaandHypermedia CodingExpertGroup (MHEG),StandardGeneralized MarkupLanguage (SGML),DocumentTypeDefinition(DTD),Hypertext MarkupLanguage(HTML)in Web Publishing.Casestudyof Applications	17	
5.	**MultimediaApplications(4L):**Interactivetelevision,Video-on-demand, Video Conferencing,EducationalApplications,IndustrialApplications, Multimediaarchivesanddigital libraries,mediaeditors	4	

Text book andReference books:

1. RalfSteinmetzandKlaraNahrstedt, Multimedia:Computing,Communications&Applications , Pearson Ed.
2. NalinK.Sharda,MultimediaInformationSystem, PHI.
3. FredHalsall,MultimediaCommunications , PearsonEd.
4. KoegelBuford ,Multimedia Systems , PearsonEd.
5. FredHoffstetter ,MultimediaLiteracy, McGraw Hill.
6. RalfSteinmetzandKlaraNahrstedt,MultimediaFundamentals:Vol.1-MediaCodingandContent Processing,PHI.
7. J.Jeffcoate,Multimedia inPractice:TechnologyandApplication , PHI.
8. V.K.Jain,MultimediaandAnimation,KhannaPublishingHouse,NewDelhi(AICTERecommendedTextbook – 2018)

- **IntroductiontoPhilosophical**

Unit	Content	Hrs/Unit	Marks/Unit
1	**Nature ofIndian Philosophy :**Pluralityaswellascommonconcerns.2.BasicconceptsoftheVedicandUpanisadicviews : Atman,Jagrata,Svapna,Susupti,Turiya,Brahman,Karma,Rta, Rna,	17	
2	**Carvakaschool:**itsepistemology,metaphysicsandethics.Mukti	9	
3	**Jainism:**Concepts of sat,dravya,guna,paryaya,jiva,ajiva,anekantavada,syadvada,andnayavada;pramanas,ahimsa,bondageandliberation.		
4	5. Buddhism:theoryof pramanas, theoryofdependent origination, thefournoble truths;doctrineof momentaryness; theoryof no soul.The interpretation of these theoriesinschools ofBuddhism:Vaibhasika,Sautrantrika,Yogacara,Madhyamika.	5	
5	6. Nyaya:theoryofPramanas; theindividualselfanditsliberation ; the ideaof Godandproofsfor Hisexistence.	5	

Text book andReference books:

1. M. Hiriyanna: OutlinesofIndianPhilosophy.

2. C.D.Sharma:A CriticalSurveyof IndianPhilosophy.
3. S.N.DasGupta:A HistoryofIndianPhilosophyVol–ItoV.
4. S.Radhakrishnan :Indian PhilosophyVol–I&II.
5. T.R.V.Murti: CentralPhilosophyofBuddhism.
6. J.N.Mahanty: ReasonandTradition ofIndianThought.
7. R.D.Ranade:A Constructive SurveyofUpanisadic Philosophy.
8. P.T.Raju : Structural Depths ofIndianThought.
9. K.C.Bhattacharya:Studies in PhilosophyVol– 1.
10. DattaandChatterjee :Introduction of Indian Philosophy