SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING: TIRUPATI
DEPARTMENT OF COMPUTER SCINCE ENGINEERING
Postgraduate Programme
M.Tech Scheme of Instruction for Choice Based Credit System
(With effect from 2023-24 admitted batch)
Total credits (2 year course): 81

SCHEME:2023-2024

SEMESTER I

Course Code	Course Title	L	T	P	Total	Credits	Sectional	End Semester	Total
COPC01	Mathematical Foundation of Computer Science	3	1	0	4	4	40	60	100
COPC02	AdvancedData Structures	3	1	0	4	4	40	60	100
COPC03	Advanced Operating Systems	3	1	0	4	4	40	60	100
COPE 1	Programme Elective-I	3			3	3	40	60	100
COPE11	**Machine Learning**								
COPE12	Data Preparation and Analysis								
COPE 2	Programme Elective-II	3			3	3	40	60	100
COPE21	**Distributed Databases**								
COPE22	Digital Forensics								
COCP 01	Core-I Lab:			3	3	1.5	40	60	100
COEP 01	Elective-I Lab			3	3	1.5	40	60	100
PGPC 01	Research Methodology and IPR	3	0	0	3	3	40	60	100
Total		18	3	6	27	24	320	480	800

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SEMESTER II

Course Code	Course Title	L	T	P	Total	Credits	Seasonal	End Semester	Total
COPC 04	Advanced Algorithms	3	1	0	4	4	40	60	100
COPC 05	Compilers for HPC	3	1	0	4	4	40	60	100
COPE 3	Programme Elective-III	3	0	0	3	3	40	60	100
COPE31	**Big Data Analytics**								
COPE32	Recommender System								
COPE 4	Programme Elective-IV	3	0	0	3	3	40	60	100
COPE41	Computer Vision								
COPE42	Introduction to Intelligent Systems								
COCP02	Core-II Lab			3	3	1.5	40	60	100
COEP02	Elective-II Lab			3	3	1.5	40	60	100
PGPC02	Cyber Security	0	0	4	2	2	100	-	100
COMP 01	Mini Project with seminar	1		4	5	4	100	-	100
		15	2	10	27	23	440	360	800

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SEMESTER III

Course Code	Course Title	L	T	P	Credits	Sessional	End Semester	Total
COP1	Internship/Mini Project (Min 4 Weeks)	0			3	100		100
PGOE 11	MOOCs	0	0	0	3	100		100
PGOE111	Block chain Technology							
PGOE112	IoT							
PGOE113	Mobile Netwoks							
PGOE114	Network Security							
PGOE115	Any other in Current Technology							
COPD01	Dissertation-Phase-I			24	12	40	60	100
Total		0	0	24	18	240	60	300

- Courses selected under Moocs should not be same as Core and Electives

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SEMESTER IV

		L	T	P	Credits	Sessional	End Semester	Total
COPD 02	Dissertation-Phase-II			20	16	40	60	100
	Total			20	16	100		100

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SEMESTER I

PROGRAMME CORE

CourseCode	*COPC 01*
CourseName	*MathematicalFoundationofComputerScience*
Credits	*3*
Pre-Requisites	*DiscreteMathematics*

TotalNumberofLectures:48

COURSEOBJECTIVE
• *To understand the mathematical fundamentals that is prerequisites for avariety of courseslike Data mining, Network protocols, analysis ofWeb traffic, Computer security, Softwareengineering,Computerarchitecture,operatingsystems,distributedsystems,Bioinformatics, Machinelearning.*
• *Todeveloptheunderstandingofthemathematicaland logicalbasistomanymodern techniques in information technology like machine learning, programming language design,and concurrency.*
• *Tostudyvarioussamplingandclassificationproblems.*

LECTUREWITHBREAKUP	**NO. OF LECTURES**
Unit1 *Probabilitymass,density,andcumulativedistributionfunctions,Parametricfamiliesofdistributions,Expectedvalue,variance,conditionalexpectation,Applicationsoftheunivariateandmultivariate CentralLimitTheorem, Probabilisticinequalities,Markovchains*	*10*
Unit2 *Randomsamples,samplingdistributionsofestimators*, *MethodsofMomentsandMaximum Likelihood*,	*9*
Unit3 *Statistical inference*, *Introduction to multivariate statistical models: regression andclassificationproblems,principalcomponentsanalysis*,*Theproblemofoverfitting modelassessment.*	*8*
Unit4 *GraphTheory:Isomorphism,Planargraphs,graphcolouring,hamiltoncircuitsandeulercycles. Permutations and Combinations with and without repetition.Specializedtechniquestosolvecombinatorialenumerationproblems*	*11*
Unit5 **Computerscienceandengineeringapplications**	*10*

Datamining,Networkprotocols,analysisofWebtraffic,Computersecurity, Softwareengineering,Computerarchitecture,operatingsystems,distributedsystems,Bioinformatics,Machinelearning.	
COURSEOUTCOMES	
Aftercompletion ofcourse,studentswould beableto:	
• *Tounderstandthebasicnotionsofdiscreteand continuousprobability.*	
• *Tounderstandthemethodsofstatisticalinference,and therolethatsamplingdistributionsplayinthosemethods.*	
• *To be able to perform correct and meaningful statistical analyses of simple to moderatecomplexity.*	

References

1. *JohnVince,FoundationMathematicsforComputerScience,Springer.*
2. *K.Trivedi.ProbabilityandStatisticswithReliability,Queuing,andComputerScienceApplications.Wiley.*
3. *M.MitzenmacherandE.Upfal.ProbabilityandComputing:RandomizedAlgorithmsandProbabilisticAnalysis.*
4. *AlanTucker, AppliedCombinatorics,Wiley*

CourseCode	*COPC 02*
CourseName	*AdvancedDataStructures*
Credits	*3*
Pre-Requisites	*UGlevelcourseinDataStructures*

TotalNumberofLectures:48

COURSEOBJECTIVE
• *The student should be able to choose appropriate data structures, understand theADT/libraries,anduseittodesign algorithms foraspecificproblem.*
• *Studentsshould beabletounderstandthenecessarymathematicalabstraction tosolveproblems.*
• *Tofamiliarizestudentswithadvancedparadigmsanddatastructureusedtosolvealgorithmicproblems.*
• *Student should beabletocomeupwithanalysisofefficiencyand proofsofcorrectness.*

LECTUREWITHBREAKUP	**NO. OF LECTURES**
Unit1 **Dictionaries:***Definition,DictionaryAbstractDataType,ImplementationofDictionaries.* **Hashing:***ReviewofHashing,HashFunction,CollisionResolutionTechniquesin Hashing,SeparateChaining,OpenAddressing,LinearProbing,QuadraticProbing,DoubleHashing,Rehashing,ExtendibleHashing.*	*9*
Unit2 **SkipLists:***Need forRandomizingDataStructuresand Algorithms,Searchand UpdateOperationsonSkipLists,ProbabilisticAnalysisofSkipLists,DeterministicSkip Lists*	*8*
Unit3 **Trees:***BinarySearchTrees,AVLTrees,RedBlackTrees,2-3Trees,B-Trees,SplayTrees*	*9*
Unit4	*12*
TextProcessing:*StingOperations,Brute-ForcePatternMatching,TheBoyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, CompressedTries,SuffixTries,TheHuffmanCodingAlgorithm,TheLongestCommon SubsequenceProblem (LCS),ApplyingDynamicProgrammingtotheLCSProblem.*	
Unit5 **ComputationalGeometry:***OneDimensionalRangeSearching,TwoDimensionalRangeSearching,ConstructingaPrioritySearchTree,SearchingaPrioritySearch Tree,PriorityRangeTrees,Quadtrees,k-DTrees.*	*10*
COURSEOUTCOMES	
Aftercompletion ofcourse,studentswould beableto:	
• *Understandtheimplementationofsymboltable usinghashingtechniques.*	
• *Developandanalyzealgorithmsforred-blacktrees, B-treesandSplaytrees.*	
• *Developalgorithmsfortextprocessingapplications.*	
• *Identifysuitabledatastructuresanddevelopalgorithmsforcomputationalgeometryproblems.*	

References:

1. *MarkAllenWeiss,DataStructuresand AlgorithmAnalysisinC++,2ndEdition,Pearson,2004.*
2. *M TGoodrich,RobertoTamassia,AlgorithmDesign,John Wiley,2002.*

CourseCode	COPC 03
CourseName	Advanced OperatingSystem
Credits	3
Pre-Requisites	DataStructure,Algorithms,ComputerArchitectureandOrganization

TotalNumberofLectures:48

COURSEOBJECTIVE
• Theobjectiveofthecourseistoprovideintroductiontooperatingsystemdesignandconceptofprocess, processlifecycleandschedulingapproaches.

LECTUREWITHBREAKUP	**NO.OF LECTURES**

Unit1: Computersystem andoperatingsystem overview,Operatingsystem functionsanddesign issues,Designapproaches,Typesofadvanced operatingsystems.	10
Unit2: Processabstraction,Processmanagement,systemcalls,Threads,Symmetricmultiprocessingandmicro-kernels.	8

Unit3: Scheduling: Uniprocessor, Multiprocessor and Real time systems, concurrency, classical problems, mechanisms for synchronization:semaphores,monitors,Processdeadlockanddeadlock handlingstrategies.	10
Unit4: Memory management, Virtual memory concept, Virtual machines, I/O management,Fileanddiskmanagement,Operatingsystemsecurity.	9
Unit5: Distributed Operating system:Architecture, Design issues, Distributed mutualexclusion,Distributeddeadlockdetection,sharedmemory,Distributedscheduling.Multiprocessoroperatingsystems:architecture,operatingsystemdesignissues, threads, processsynchronization,processscheduling,memory management,reliabilityand faulttolerance.	11

COURSEOUTCOMES
Aftercompletion ofcourse,studentswouldbe:
• Understandingadvancedconceptsinoperatingsystems.
• LearningprinciplesofDistributedandmultiprocessoroperatingsystems

References:

1. Advancedconceptinoperatingsystem:M.Singhal,N.G.Shivratri
2. Operatingsysteminternalanddesignprinciples: WilliamStallings

PROGRAMME ELECTIVE-I *TotalNumberofLectures:48*

CourseCode	COPE 11
CourseName	*Machinelearning*
Credits	*3*
Pre-Requisites	
COURSEOBJECTIVE	
• *Tolearntheconceptofhowtolearnpatternsandconceptsfromdata withoutbeingexplicitlyprogrammed invarious IOTnodes.*	
• *To design and analyse various machine learning algorithms and techniques with a modernoutlookfocusing onrecentadvances.*	
• *Exploresupervisedandunsupervisedlearningparadigmsofmachinelearning.*	
• *ToexploreDeep learningtechniqueand variousfeatureextractionstrategies.*	
LECTUREWITHBREAKUP	**NO. OFLECTURES**
Unit1: SupervisedLearning(Regression/Classification) • *Basicmethods:Distance-basedmethods,Nearest-Neighbours,DecisionTrees,NaiveBayes*	*10*
• *Linear models: Linear Regression, Logistic Regression, Generalized LinearModels* • *Support VectorMachines,Nonlinearityand KernelMethods* • *BeyondBinaryClassification:Multi-class/StructuredOutputs,Ranking*	
Unit2: UnsupervisedLearning • *Clustering:K-means/KernelK-means* • *DimensionalityReduction:PCAand kernelPCA* • *MatrixFactorizationandMatrixCompletion* • *GenerativeModels(mixturemodelsandlatentfactormodels)*	*9*
Unit3 *EvaluatingMachineLearningalgorithmsandModelSelection,IntroductiontoStatisticalLearningTheory,EnsembleMethods(Boosting,Bagging,Random Forests)*	*9*
Unit4 *SparseModelingandEstimation,ModelingSequence/Time-SeriesData,DeepLearningandFeatureRepresentationLearning*	*9*
Unit5 *ScalableMachineLearning(OnlineandDistributedLearning)* *Aselectionfromsomeotheradvancedtopics,e.g.,Semi-supervisedLearning, ActiveLearning,ReinforcementLearning,InferenceinGraphicalModels,Introduction toBayesianLearningandInference*	*9*
COURSEOUTCOMES	
Aftercompletion ofcourse,studentswouldbeableto:	
• *Extract features that can be used for a particular machine learning approach in various IOTapplications.*	
• *To compare and contrast pros and cons of various machine learning techniques and to get aninsight ofwhentoapplyaparticularmachinelearning approach.*	
• *Tomathematicallyanalysevariousmachinelearningapproachesand paradigms.*	

References:1 *KevinMurphy,MachineLearning:AProbabilisticPerspective,MITPress,2012*

1 *TrevorHastie,RobertTibshirani,JeromeFriedman,TheElementsofStatisticalLearning,Springer2009(freely availableonline)*

2 *ChristopherBishop,PatternRecognitionandMachineLearning,Springer,2007.*

CourseCode	COPE12
CourseName	DataPreparationandAnalysis
Credits	3
Pre-Requisites	

TotalNumberofLectures:48

COURSEOBJECTIVE
• Topreparethedataforanalysisanddevelopmeaningful DataVisualizations

LECTUREWITHBREAKUP	**NO.OFL ECTURES**
Unit1: **DataGatheringandPreparation:** Dataformats,parsingandtransformation, Scalabilityandreal-timeissues	9
Unit2: **Data Cleaning:** Consistencychecking,Heterogeneousandmissingdata,DataTransformationandsegmentation	11
Unit3: **ExploratoryAnalysis:** Descriptiveandcomparativestatistics,Clusteringandassociation,Hypothesisgeneration	13
Unit4: **Visualization:** Designingvisualizations,Timeseries,Geolocateddata,Correlationsandconnections, Hierarchiesandnetworks,interactivity	10
Unit5: **Current trends**	5

COURSEOUTCOMES
Aftercompletion ofcourse,studentswouldbe:
• Abletoextractthedatafor performingtheAnalysis.

References:

1.MakingsenseofData:A practical Guide toExploratoryDataAnalysisandDataMining,byGlenn J.Myatt

PROGRAMME ELECTIVE-II

CourseCode	*COPE 21*
CourseName	*DistributedDatabase*
Credits	*3*
Pre-Requisites	

TotalNumberofLectures:48

COURSEOBJECTIVE
• *Theobjectiveofcourseistoprovideinsighttodistributeddatabase,normalizationtechniquesandintegrity rules.Italsoincludesparalleldatabase systemsalongwithobjectorientedmodels.*

LECTUREWITHBREAKUP	**NO. OF LECTURES**
Unit1: *Introduction: Distributed Data processing, Distributed database system (DDBMS),PromisesofDDBMSs,ComplicatingfactorsandProblemareasinDDBMSs,OverviewOfRelationalDBMSRelationalDatabaseconcepts,Normalization, Integrityrules,RelationalDataLanguages,RelationalDBMS.*	*11*
Unit2: *Distributed DBMS Architecture: DBMS Standardization, Architectural models forDistributed DBMS, Distributed DBMS Architecture. Distributed Database Design:AlternativedesignStrategies,Distributiondesignissues,Fragmentation,Allocation.SemanticDataControl:ViewManagement,Datasecurity,Semantic*	*10*
IntegrityControl.	
Unit3: *OverviewofQueryProcessing:Queryprocessingproblem,ObjectivesofQueryProcessing, Complexity of Relational Algebra operations, characterization of Queryprocessors,Layers ofQueryProcessing.* *Introduction to Transaction Management: Definition of Transaction, Properties oftransaction, types of transaction. Distributed Concurrency Control: Serializabilitytheory,Taxonomyofconcurrencycontrolmechanisms,lockingbasesconcurrency controlalgorithms.*	*9*
Unit4: *Parallel Database Systems: Database servers, Parallel architecture, Parallel DBMStechniques,Parallelexecutionproblems,Parallelexecutionforhierarchicalarchitecture.*	*10*
Unit5: *Distributed Object Database Management systems: Fundamental Object conceptsandObjectmodels,Objectdistributiondesign.Architecturalissues,Objectmanagement,Distributedobjectstorage,Objectqueryprocessing.Transactionmanagement.DatabaseInteroperability:DatabaseIntegration,Queryprocessing.*	*8*

COURSEOUTCOMES
Aftercompletionofcourse,studentswouldbe:
• *Abetounderstandrelationaldatabasemanagementsystems,normalizationtomakeefficient retrievalfromdatabaseandquery.*

References:

1.PrinciplesofDistributedDatabaseSystems,SecondEdition,M.TamerOzsuPatrickValduriez
2.DistributedDatabasesprinciplesandsystems,StefanoCeri,GiuseppePelagatti,TataMcGrawHill.

CourseCode	COPE 22
CourseName	DigitalForensics
Credits	3
Pre-Requisites	CybercrimeandInformationWarfare, ComputerNetworks

TotalNumberofLectures:48

COURSEOBJECTIVE
• Providesanin-depthstudyofthe rapidlychangingandfascinating fieldofcomputerforensics.
• Combines both the technical expertise and the knowledge required to investigate, detectandpreventdigitalcrimes.
• Knowledge on digital forensics legislations, digital crime, forensics processes andprocedures,dataacquisitionandvalidation,e-discoverytools
• E-evidence collection and preservation, investigating operating systems and file systems,networkforensics,artofsteganographyandmobiledeviceforensics

LECTUREWITHBREAKUP	**NO.OF LECTURES**
Unit1: **DigitalForensicsScience:**Forensicsscience,computerforensics,anddigitalforensics **ComputerCrime:**Criminalisticsasitrelatestotheinvestigativeprocess,analysisofcyber-criminalisticsarea,holisticapproachtocyber-forensics	9
Unit2: **Cyber Crime Scene Analysis:** Discuss the various court orders etc., methods tosearchandseizureelectronicevidence,retrievedandun-retrievedcommunications,Discusstheimportanceofunderstandingwhatcourt documentswould berequired foracriminalinvestigation.	10
Unit3: **Evidence Management&Presentation:** Create and manage shared foldersusing operating system, importance of the forensic mindset, define the workloadof law enforcement, Explain what the normal case would look like, Define whoshouldbenotifiedofacrime,partsofgatheringevidence,Defineandapply probablecause.	9
Unit4: **ComputerForensics:**Prepareacase,Beginaninvestigation,Understandcomputerforensicsworkstationsandsoftware,Conductaninvestigation,Complete acase,Critiquea case, **Network Forensics:** open-source security tools for network forensic analysis,requirementsforpreservationofnetworkdata.	10
Unit5: **MobileForensics:**mobileforensicstechniques,mobileforensicstools. **LegalAspectsofDigitalForensics:**ITAct2000,amendmentofITAct 2008.	10

COURSEOUTCOMES
Aftercompletion ofcourse, studentswould beableto:
• Understandrelevantlegislationandcodesofethics
• Computer forensicsanddigitaldetectiveandvariousprocesses, policiesandprocedures
• E-discovery,guidelinesandstandards,E-evidence,toolsandenvironment.
• Emailandwebforensicsandnetworkforensics

References:1 JohnSammons,TheBasicsofDigitalForensics,Elsevier
JohnVacca,ComputerForensics:ComputerCrimeSceneInvestigation,LaxmiPublications
gn,JohnWilley,2002.

CourseCode	PGPC 01
CourseName	**ResearchMethodologyandIPR**
Credits	3

ResearchMethodologyandIPR

TeachingScheme

Lectures:1hrs/week

nation, it is needless to emphasis the need of information about Intellectual Property Righttobe promotedamongstudentsingeneral&engineeringinparticular.

- Understand that IPR protection provides an incentive to inventors for further research workand investment in R & D, which leads to creation of new and better products, and in turnbringsabout,economic growthandsocialbenefits.
-

SyllabusContents:

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics ofa good research problem, Errors in selecting a research problem, Scope and objectives ofresearchproblem.

Approachesofinvestigationofsolutionsforresearchproblem,datacollection,analysis,interpretation, Necessaryinstrumentations

Unit2: Effective

literaturestudiesapproaches,analysisPlagiarism,Researchet

hics,

Unit 3: Effectivetechnicalwriting, howtowritereport,Paper

Developing a Research Proposal,Formatof research proposal,a presentation and

assessmentbyareviewcommittee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process ofPatentingandDevelopment:technologicalresearch,innovation,patenting,development.International Scenario: International cooperation on Intellectual Property. Procedure for grantsofpatents,PatentingunderPCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patentinformationanddatabases.GeographicalIndications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments inIPR;IPRofBiologicalSystems,ComputerSoftwareetc.TraditionalknowledgeCaseStudies,IPRandIITs.

References:

- StuartMelvilleandWayneGoddard,"Researchmethodology:anintroductionforscience&engineeringstudents'"
- WayneGoddardandStuartMelville,"ResearchMethodology:AnIntroduction"
- RanjitKumar,2ndEdition,"ResearchMethodology:AStepbyStepGuideforbeginners"
- Halbert, "ResistingIntellectualProperty",Taylor &FrancisLtd,2007.
- Mayall,"IndustrialDesign",McGrawHill,1992.
- Niebel,"Product Design",McGrawHill,1974.
- Asimov,"IntroductiontoDesign", PrenticeHall, 1962.
- RobertP.Merges,PeterS.Menell,MarkA.Lemley,"IntellectualPropertyinNewTechnological Age",2016.
- T.Ramappa,"IntellectualPropertyRightsUnder WTO",S.Chand, 2008

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SEMESTER II

PROGRAMME CORE

CourseCode	*COPC 04*
CourseName	*AdvancedAlgorithms*
Credits	*3*
Pre-Requisites	*UGlevelcoursein AlgorithmDesign and Analysis*

TotalNumberofLectures:48

COURSEOBJECTIVE

• *Introducestudentstotheadvancedmethodsofdesigningandanalyzingalgorithms.*
• *Thestudent should beabletochooseappropriatealgorithmsanduseit foraspecificproblem.*
• *Tofamiliarizestudentswithbasicparadigmsanddatastructuresused tosolveadvancedalgorithmicproblems.*
• *Studentsshouldbeabletounderstanddifferentclassesofproblemsconcerningtheircomputa tiondifficulties.*
• *Tointroducethestudents torecent developments in theareaofalgorithmicdesign.*

LECTUREWITHBREAKUP	**NO. OF LECTURES**
Unit1 **Sorting:***Review ofvarioussortingalgorithms,topologicalsorting* **Graph:** *DefinitionsandElementaryAlgorithms:ShortestpathbyBFS,shortestpathinedge-weightedcase (Dijkasra's),depth-firstsearchandcomputationofstronglyconnectedcomponents,emphasisoncorrectnessp roofofthealgorithm andtime/spaceanalysis,exampleofamortizedanalysis.*	*9*
Unit2 **Matroids:** *Introductiontogreedyparadigm,algorithmtocomputeamaximumweight maximalindependentset.ApplicationtoMST.* **GraphMatching:***Algorithmtocomputemaximummatching.Characterizationofmaximu mmatchingbyaugmentingpaths,Edmond'sBlossomalgorithmto computeaugmentingpath.*	*10*
Unit3 **Flow-Networks:***Maxflow-mincuttheorem,Ford-FulkersonMethodtocomputemaximumflow,Edmond-Karpmaximum-flowalgorithm.* **MatrixComputations:***Strassen'salgorithmandintroductiontodivideandconquerpara digm,inverseofatriangularmatrix,relationbetweenthetime complexitiesofbasicmatrixoperations,LUP-decomposition.*	*9*
Unit4 **Shortest Path in Graphs:** *Floyd-Warshall algorithm and introduction to dynamicprogrammingparadigm.Moreexamples ofdynamicprogramming.* **Modulo Representation of integers/polynomials:** *Chinese Remainder Theorem,Conversion between base-representation and modulo-representation. Extension topolynomials.Application:Interpolationproblem.* **DiscreteFourierTransform(DFT):***Incomplexfield,DFTinmoduloring.Fast FourierTransformalgorithm.Schonhage-StrassenIntegerMultiplicationalgorithm*	*10*
Unit5 **LinearProgramming:***GeometryofthefeasibilityregionandSimplexalgorithm* **NP-completeness:***Examples,proofofNP-hardnessandNP-completeness.* **Oneormoreofthefollowingtopicsbasedon timeandinterest** *ApproximationalgorithmsRandomizedAlgorithms,InteriorPointMethod,Advanced NumberTheoreticAlgorithm*	*10*

COURSEPOUTCOMES
Aftercompletion ofcourse,studentswould beableto:
• *Analyzethecomplexity/performanceofdifferentalgorithms.*
• *Determinetheappropriatedatastructureforsolvingaparticularset ofproblems.*
• *Categorizethedifferentproblemsinvariousclassesaccordingtotheircomplexity.*
• *Studentsshouldhaveaninsightofrecentactivitiesinthefieldoftheadvanceddatastructure.*

References:

1. *"Introduction toAlgorithms"byCormen,Leiserson,Rivest,Stein.*
2. *"TheDesign andAnalysisofComputerAlgorithms"byAho,Hopcroft,Ullman.*
3. *"AlgorithmDesign"byKleinbergandTardos.*

CourseCode	COPE 05
CourseName	Compilers for HPC
Credits	3
Pre-Requisites	DataStructure,CompilerDesign,TheoryofComputation

TotalNumberofLectures:48

COURSEOBJECTIVE
• Theobjectiveofthiscourseistointroducestructureofcompilersandhighperformancecompilerdesign forstudents.Conceptsofcachecoherenceandparallelloopsincompilersare included.

LECTUREWITHBREAKUP	**NO.OFL ECTURES**
Unit1: **HighPerformanceSystems,**StructureofaCompiler,ProgrammingLanguageFeatures,LanguagesforHighPerformance.	9
Unit2: **Data Dependence:** Data Dependence in Loops, Data Dependence inConditionals, Data Dependence in Parallel Loops, Program Dependence Graph.**ScalarAnalysiswithFactoredUse-DefChains:**ConstructingFactoredUse-DefChains,FUDChainsforArrays,InductionVariablesUsingFUDChains,Constant PropagationwithFUDChains,DataDependenceforScalars.Data DependenceAnalysisforArrays.	10
Unit3: Array Region Analysis,PointerAnalysis,I/O Dependence,Procedure Calls,Inter-proceduralAnalysis. **LoopRestructuring:**SimpleTransformations,LoopFusion,LoopFission,LoopReversal,LoopInterchanging,LoopSkewing,LinearLoopTransformations, Strip-Mining, Loop Tiling, Other Loop Transformations, andInter-proceduralTransformations. **OptimizingforLocality:**SingleReferencetoEachArray,MultipleReferences, GeneralTiling, FissionandFusionfor Locality.	10
Unit4: **Concurrency Analysis:** Concurrency from Sequential Loops, Concurrency fromParallelLoops,NestedLoops,RoundoffError,ExceptionsandDebuggers. **VectorAnalysis:**VectorCode,VectorCodefromSequentialLoops,VectorCodefrom ForallLoops,NestedLoops, RoundoffError,Exceptions, and Debuggers,Multi-vectorComputers.	10
Unit5: **Message-PassingMachines:**SIMDMachines,MIMDMachines,DataLayout,ParallelCodefor ArrayAssignment,RemoteDataAccess,AutomaticData Layout,MultipleArrayAssignments,OtherTopics.	10
ScalableShared-MemoryMachines: GlobalCacheCoherence,LocalCache Coherence,LatencyTolerantMachines.	

COURSEOUTCOMES
Aftercompletion ofcourse,studentswouldbe:
• Familiarwiththestructureofcompiler. • Parallelloops, datadependencyandexceptionhandlinganddebuggingincompiler.

References:*1.MichaelWolfe,High-PerformanceCompilersforParallelComputing,Pearson*

PROGRAMME ELECTIVE- III

CourseCode	*COPE31*
CourseName	*BigDataAnalytics*
Credits	*3*
Pre-Requisites	*DataStructure,ComputerArchitectureandOrganization*

TotalNumberofLectures:48

COURSEOBJECTIVE
• *Understandbigdataforbusinessintelligence.Learnbusinesscasestudiesforbigdataanalytics.Understandnosqlbigdatamanagement.Performmap-reduceanalyticsusingHadoopandrelated tools*

LECTUREWITHBREAKUP	**NO. OFLECTURES**
Unit1: *Whatisbigdata, whybigdata,convergenceofkeytrends, unstructureddata,industry examples of big data, web analytics, big data and marketing, fraud and bigdata, risk and big data, credit risk management, big data and algorithmic trading,big data and healthcare, big data in medicine, advertising and big data, big datatechnologies,introductiontoHadoop,opensourcetechnologies,cloudandbigdata,mobilebusinessintelligence,Crowdsourcinganalytics,interandtransfirewallanalytics.*	*8*
Unit2: *IntroductiontoNoSQL,aggregatedatamodels,aggregates,key-valueanddocumentdatamodels,relationships,graphdatabases,schemalessdatabases,materialized views, distribution models, sharding, master-slave replication, peer-peerreplication,shardingandreplication,consistency,relaxingconsistency,version stamps, map-reduce, partitioning and combining, composing map-reducecalculations.*	*8*
Unit3: *Data format, analyzing data with Hadoop, scaling out, Hadoop streaming, Hadooppipes,designofHadoopdistributedfilesystem(HDFS),HDFSconcepts,Javainterface, data flow, Hadoop I/O, data integrity, compression, serialization, Avro,file-based datastructures*	*9*
Unit4: *MapReduce workflows, unit tests with MRUnit, test data and local tests, anatomy ofMapReduce job run, classic Map-reduce, YARN, failures in classic Map-reduce andYARN, job scheduling, shuffle and sort, task execution, MapReduce types, inputformats,outputformats*	*10*
Unit5:	*13*
Hbase,datamodelandimplementations,Hbaseclients,Hbaseexamples,praxis.Cassandra, Cassandra data model, Cassandra examples, Cassandra clients,Hadoop integration. *Pig,Grunt,pigdatamodel,PigLatin,developingandtestingPigLatinscripts.* *Hive,datatypes and fileformats,HiveQLdatadefinition,HiveQLdatamanipulation,HiveQL queries.*	

COURSEOUTCOMES
Aftercompletionofcourse,studentswouldbe:
• *Describebig dataand usecases fromselected business domains* • *ExplainNoSQLbigdatamanagement* • *Install,configure,andrunHadoopandHDFS* • *Performmap-reduceanalyticsusingHadoop* • *UseHadoop relatedtoolssuchasHBase,Cassandra,Pig,andHiveforbigdataanalytics*

References:

1. *MichaelMinelli,MichelleChambers,andAmbigaDhiraj,"BigData, BigAnalytics:Emerging*
2. *BusinessIntelligenceandAnalyticTrendsforToday'sBusinesses",Wiley,2013.*
3. *P.J.SadalageandM.Fowler,"NoSQL Distilled:A BriefGuidetotheEmergingWorld of*
4. *PolyglotPersistence",Addison-WesleyProfessional,2012.*
5. *TomWhite,"Hadoop:TheDefinitiveGuide",ThirdEdition,O'Reilley,2012.*
6. *EricSammer,"HadoopOperations",O'Reilley,2012.*
7. *E.Capriolo,D. Wampler,and J.Rutherglen,"ProgrammingHive",O'Reilley,2012.*
8. *LarsGeorge,"HBase:TheDefinitiveGuide",O'Reilley,2011.*
9. *EbenHewitt,"Cassandra:TheDefinitiveGuide",O'Reilley,2010.*
10. *AlanGates,"ProgrammingPig",O'Reilley,2011.*

CourseCode	COPE32
CourseName	*RecommenderSystem*
Credits **Prerequisites**	*3*

TotalNumberofLectures:48

COURSEOBJECTIVE	
• *Tolearntechniquesformakingrecommendations,includingnon-personalized,content-based,and collaborativefiltering* • *To automate a variety of choice-making strategies with the goal of providing affordable, personal,and high-qualityrecommendations*	
LECTUREWITHBREAKUP	**NO. OFLECTURES**
Unit1: **Introduction:** *Overview of Information Retrieval, Retrieval Models, Search andFiltering Techniques: Relevance Feedback, User Profiles, Recommender systemfunctions,Matrixoperations,covariancematrices,Understandingratings, Applicationsofrecommendationsystems,Issueswithrecommendersystem.*	*9*
Unit2: **Content-basedFiltering:***Highlevelarchitectureofcontent-basedsystems,Advantages and drawbacks of content based filtering, Item profiles, Discoveringfeaturesofdocuments,pre-processingandfeatureextraction,Obtainingitem features from tags, Methods for learning user profiles, Similarity based retrieval,Classification algorithms.*	*8*
Unit3: **CollaborativeFiltering:***User-basedrecommendation,Item-basedrecommendation,Modelbasedapproaches,Matrixfactorization,Attacksoncollaborativerecommendersystems.*	*9*
Unit4: **Hybrid approaches:** *Opportunities for hybridization, Monolithic hybridizationdesign:Featurecombination, Featureaugmentation,Parallelizedhybridizationdesign:Weighted,Switching,Mixed,Pipelinedhybridizationdesign:Cascade Meta-level,Limitationsofhybridizationstrategies*	*8*
Unit5: **EvaluatingRecommenderSystem:***Introduction,Generalpropertiesofevaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty,diversity,scalability,serendipity,Evaluationonhistoricaldatasets,Offlineevaluations.* **Types of Recommender Systems:** *Recommender systems in personalized websearch,knowledge-basedrecommendersystem,Socialtaggingrecommendersystems,Trust-centricrecommendations,Group recommendersystems.*	*14*
COURSEOUTCOMES	
Aftercompletionofcourse, studentswould beableto:	
• *Designrecommendationsystemforaparticular applicationdomain.* • *Evaluaterecommendersystemsonthebasisofmetricssuchasaccuracy,rankaccuracy,diversity,productcoverage,andserendipity*	

References:

1. *JannachD.,ZankerM.andFelFeringA.,RecommenderSystems:AnIntroduction,Cambridge UniversityPress (2011),1sted.*
2. *CharuC.Aggarwal,RecommenderSystems:TheTextbook,Springer(2016),1sted.*
3. *RicciF.,RokachL.,ShapiraD.,KantorB.P.,RecommenderSystemsHandbook,Springer(2011),1sted.*
4. *ManouselisN.,DrachslerH.,VerbertK.,DuvalE.,RecommenderSystemsForLearning,Springer(2013),1sted.*

PROGRAMME ELECTIVE-IV

CourseCode	COPE41
CourseName	ComputerVision
Credits	3
Pre-Requisites	Linearalgebra,vectorcalculus,DatastructuresandProgramming.

TotalNumberofLectures:48

COURSEOBJECTIVE
• Befamiliarwiththboththetheoreticalandpracticalaspectsofcomputing withimages.
• Havedescribedthefoundationofimageformation,measurement,andanalysis.
• Understandthegeometricrelationshipsbetween2Dimagesandthe3Dworld.
• Graspthepprinciplesofstate-of-the-artdeep neuralnetworks.

LECTUREWITHBREAKUP	**NO.OFL ECTURES**
Unit1: Overview,computerimagingsystems,lenses,Imageformationandsensing,Imageanalysis,pre-processingandBinaryimageanalysis	10
Unit2: Edgedetection,Edgedetectionperformance,Houghtransform,cornerdetection	10
Unit3: Segmentation,Morphologicalfiltering,Fouriertransform	9
Unit4: Featureextraction,shape,histogram,color,spectral,texture,usingCVIPtools,Featureanalysis,featurevectors,distance/similaritymeasures,datapre-processing	10
Unit5: PatternAnalysis: Clustering:K-Means,K-Medoids,MixtureofGaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised Classifiers:Bayes,KNN,ANNmodels;DimensionalityReduction:PCA,LDA,ICA,andNon-parametricmethods.	9

COURSEOUTCOMES
Aftercompletion ofcourse, studentswould beableto:
• Developedthepracticalskillsnecessarytobuildcomputervisionapplications.
• Tohavegainedexposuretoobjectandscenerecognitionandcategorizationfromimages.

References:

1. *ComputerVision:AlgorithmsandApplicationsby*RichardSzeliski.
2. *DeepLearning,byGoodfellow,Bengio,andCourville.*
3. *DictionaryofComputerVisionandImageProcessing,byFisheretal.*

CourseCode	COPE42
CourseName	IntroductiontoIntelligentSystems
Credits	3
Pre-Requisites	DataStructuresand DataManagement orDataStructures

TotalNumberofLectures:48

COURSEOBJECTIVE	
• TheaimofthecourseistointroducetothefieldofArtificialIntelligence(AI)withemphasisonitsusetosolverealworldproblemsforwhichsolutionsaredifficulttoexpressusingthetraditionalalgorithmicapproach.Itexplorestheessentialtheorybehindmethodologiesfordevelopingsystemsthatdemonstrateintelligentbehaviourincludingdealingwithuncertainty, learningfromexperienceandfollowingproblemsolvingstrategiesfoundinnature.	
LECTUREWITHBREAKUP	**NO.OF LECTURES**
Unit1: BiologicalfoundationstointelligentsystemsI:Artificialneuralnetworks,Back-propagationnetworks, Radialbasisfunctionnetworks, andrecurrentnetworks.	9
Unit2: BiologicalfoundationstointelligentsystemsII:Fuzzylogic,knowledgeRepresentation and inference mechanism, genetic algorithm, and fuzzy neuralnetworks.	8
Unit3: Search Methods Basic concepts of graph and tree search. Three simple searchmethods:breadth-firstsearch,depth-firstsearch,iterativedeepeningsearch.Heuristicsearchmethods:best-firstsearch,admissibleevaluationfunctions,hill-climbing search.Optimisationandsearchsuchasstochasticannealing and geneticalgorithm.	10
Unit4: KnowledgerepresentationandlogicalinferenceIssuesinknowledgerepresentation. Structured representation, such as frames, and scripts, semanticnetworksandconceptualgraphs.Formallogicandlogicalinference.Knowledge-basedsystemsstructures,itsbasiccomponents.IdeasofBlackboard architectures.	9
Unit5: ReasoningunderuncertaintyandLearningTechniquesonuncertaintyreasoningsuchas Bayesianreasoning,CertaintyfactorsandDempster-ShaferTheoryof Evidentialreasoning,Astudyofdifferentlearningandevolutionaryalgorithms,suchasstatisticallearningandinductionlearning.	7

COURSEOUTCOMES
Aftercompletion ofcourse,studentswouldbe:
• Able to Demonstrate knowledge of the fundamental principles of intelligent systems andwould be able to analyse and compare the relative merits of a variety of AI problem solvingtechniques.

References:

1. *LugerG.F.andStubblefieldW.A. (2008).ArtificialIntelligence:StructuresandstrategiesforComplexProblemSolving.AddisonWesley,6thedition.*
2. *RussellS.andNorvigP.(2009).ArtificialIntelligence:AModernApproach.Prentice-Hall,3rdedition.*

CourseCode	PGPC 02
CourseName	Cyber Security
Credits	2
Pre-Requisites	Information Communication Technology

TotalNumberofLectures:48

COURSEOBJECTIVE

(a) LearnthefoundationsofCybersecurityandthreatlandscape.

(b) Toequipstudentswiththetechnicalknowledgeandskillsneededtoprotectanddefendagainstcyberthreats.

(c) Todevelopskillsinstudentsthatcanhelpthemplan,implement,andmonitorcybersecuritymechanismstoensuretheprotectionofinformationtechnologyassets.

(d) Toexposestudentstogovernance,regulatory,legal,economic,environmental,socialandethicalcontextsofcybersecurity.

(e) Toexposestudentstoresponsibleuseofonlinesocialmedianetworks.

(f))

Tosystematicallyeducatethenecessitytounderstandtheimpactofcybercrimesandthreatswithsolutionsinaglobalandsocietalcontext.

LECTUREWITHBREAKUP	**NO.OF LECTURES**
Unit1: Cyber security increasing threat landscape,Cyber security terminologies- Cyberspace,attack, attack vector, attack surface, threat,risk, vulnerability, exploit, exploitation,hacker., Non-state actors, Cyber terrorism,Protection of end user machine, CriticalIT and National Critical Infrastructure,Cyberwarfare,CaseStudies.	10
Unit2: Cyber crimes targeting Computer systemsandMobiles-datadiddlingattacks,spyware, logic bombs, DoS, DDoS, APTs,virus, Trojans, ransomware, data breach.,Online scams and frauds- email scams,Phishing,Vishing,Smishing,Onlinejobfraud,Onlinesextortion,Debit/credit card fraud, Online payment fraud,Cyberbullying,websitedefacement,Cyber-squatting,Pharming,Cyberespionage,Cryptojacking,Darknet-illegaltrades,drug trafficking, human trafficking., SocialMedia Scams & Frauds-impersonation,identitytheft,jobscams,misinformation,fake newscyber crime against persons -cyber grooming, child pornography, cyberstalking.,SocialEngineeringattacks,CyberPolicestations,Crimereporting procedure,Casestudies.	10
Unit 3: Cybercrimeandlegallandscapearound the world, IT Act,2000 and itsamendments.LimitationsofITAct,2000.Cybercrimeandpunishments,Cyber Laws and Legal and ethical aspectsrelated to new technologies- AI/ML, IoT,Blockchain, Darknet and Social media,CyberLawsofothercountries,CaseStudies.	10
Unit4: Defining data, meta-data, big data, non-personaldata.Dataprotection,Dataprivacy and data security, Personal DataProtection Bill and its compliance, Dataprotection principles, Big data securityissuesandchallenges,Dataprotectionregulations of other countries- GeneralData Protection Regulations(GDPR),2016PersonalInformationProtectionandElectronicDocumentsAct(PIPEDA).,Social media- data privacy and securityissues.	8

Unit5: Cyber security Plan- cyber security policy,cyber crises management plan., Businesscontinuity,Riskassessment,Typesofsecurity controls and their goals, Cybersecurity audit and compliance, Nationalcybersecuritypolicyandstrategy.	10

COURSEOUTCOMES

Oncompletionofthecoursethestudentshould beable to

(a) Understandthecybersecuritythreatlandscape.

(b) Developadeeperunderstandingandfamiliaritywithvarioustypesof cyberattacks, cybercrimes,vulnerabilitiesandremediesthereto.

(c) Analyseandevaluateexistinglegalframeworkandlawsoncybersecurity.

(d) Analyse and evaluate the digital payment systemsecurity and remedial measuresagainstdigitalpaymentfrauds.

(g) Analyseandevaluatetheimportanceofpersonaldataitsprivacyandsecurity.

(h))
Analyseandevaluatethesecurityaspectsofsocialmediaplatformsandethical aspectsassociatedwithuseofsocialmedia.

(i) Analyseandevaluatethecybersecurityrisks.

(j) BasedontheRiskassessment,plansuitablesecuritycontrols,auditandcompliance.

(k) Evaluateandcommunicatethehumanroleinsecuritysystemswithanemphasiso nethics,socialengineeringvulnerabilitiesandtraining.

(l) Increaseawarenessaboutcyber-attackvectorsandsafetyagainstcyber-frauds.

(m) Takemeasuresforself-cyber-protectionaswellassocietalcyber-protection.

References:

1. CyberSecurityUnderstandingCyberCrimes,ComputerForensicsandLegalPerspectivesbySumitBel apureandNinaGodbole,WileyIndiaPvt.Ltd.
2. Information WarfareandSecuritybyDorothyF.Denning,Addison Wesley.
3. SecurityintheDigitalAge:SocialMediaSecurityThreatsandVulnerabilitiesbyHenryA.Oliver,Create SpaceIndependentPublishingPlatform.
4. DataPrivacyPrinciplesandPracticebyNatrajVenkataramananandAshwinShriram,CRCPress.
5. InformationSecurityGovernance,GuidanceforInformationSecurityManagersby W.KragBrothy,1stEdition,WileyPublication