OP JINDAL UNIVERSITY

Raigarh-Chhattisgarh

Scheme and Syllabus

Of

B. Tech. (01UG020)

Department of

Computer Science and Engineering

School of Engineering

Batch 2021-2025

Scheme for B. Tech (CSE) Programme

Computer Science and Engineering
L: Lecture, T: Tutorial, P: Practical, C: Credit

Scheme of Teaching and Examination
B. Tech (Computer Science and Engineering) Prog. Code- 01UG020

Academic Semester VI

Board of Study	Subject Code	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit L+(T+P) /2
						PRE**		ESE*	Total Marks	
			L	T	P	Mid Sem	TA			(L+T+P)
CSE	SOE-B-CSE-21-601	Software Engineering	3	0	0	30	20	50	100	3
CSE	SOE-B-CSE-21-602	Data Analytics and Visualization	3	0	0	30	20	50	100	3
CSE	SOE-B-CSE-21-603	Blockchain Technology	3	0	0	30	20	50	100	3
CSE	SOE-B-CSE-21-604	Management and Organizational Behavior	2	0	0	15	10	25	50	2
CSE	SOE-B-CSE-21-605 (X)	Professional Elective-II	3	0	0	30	20	50	100	3
CSE	SOE-B-CSE-21-606 (X)	Professional Elective-III	3	0	0	30	20	50	100	3
CSE	SOE-B-CSE-21-607	Software Engineering Lab	0	0	4	0	30	20	50	2
CSE	SOE-B-CSE-21-608	Data Analytics and Visualization Lab	0	0	2	0	30	20	50	1
CSE	SOE-B-CSE-21-609	Blockchain Technology Lab	0	0	2	0	30	20	50	1
CSE	SOE-B-CSE-21-610	Professional Development - VI	0	0	2	0	30	20	50	1
CSE	SOE-B-CSE-21-611	Open Elective (MOOCS/SWAYAM/Certification/Liberal Arts)	_	_	_	_	30	20	50	2
		Total	**17**	**0**	**10**	**165**	**260**	**375**	**800**	**24**

Professional Elective - II

Sr. No.	Subject Code	Board of Study	Subject
1	SOE-B-CSE-21-605 (1)	CSE	Computer Vision
2	SOE-B-CSE-21-605 (2)	CSE	Industrial IoT
3	SOE-B-CSE-21-605 (3)	CSE	Soft Computing

Professional Elective - III

Sr. No.	Subject Code	Board of Study	Subject
1	SOE-B-CSE-21-606 (1)	CSE	Digital Forensics
2	SOE-B-CSE-21-606 (2)	CSE	Wireless sensor network
3	SOE-B-CSE-21-606 (3)	CSE	Natural Language Processing

Detailed Syllabus

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Software Engineering**	**Course Code:**		**SOE-B-CSE-21-601**
Credits	**:**	**3**	**No of Hours :**		**3 Hr. / Week**
Max Marks	**:**	**100**			

Course Description:

This course offers lectures, tutorials, case studies, laboratory, and online interaction to provide a foundation in software engineering concepts. It includes representing information with the traditional and modern approaches in software engineering including knowledge of CASE tools. This course further explains concepts of software development process, agile, scrum and DevOps development process, software project management, software requirement and design engineering, development, quality assurance, automated testing, operational support and software maintenance.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	To learn and understand the Concepts of Software Engineering
CO2	To Learn and understand Software Development Life Cycle
CO3	To apply the project management and analysis principles to software project development.
CO4	To apply the design & testing principles to software project development.

Syllabus:

Unit-I: Introduction Software Engineering and Process Models

Software, Types of software, Characteristics of Software, Attributes of good software, Software Engineering, Software engineering costs, key challenges, software process, software process model, waterfall model, Evolutionary development, Component-Based Software Engineering (CBSE), Process Iteration, Incremental delivery, Spiral development, Agile methods, Extreme programming, Rapid application development (RAD), Software prototyping, Computer Aided Software Engineering (CASE)

Unit-II: Software Requirement and Specification

System and software requirements, Types of software requirements, Functional and non-functional requirements, Domain requirements, User requirements, Elicitation and analysis of requirements, Overview of techniques: Viewpoints, Interviewing,

Scenarios, Use-cases, Process modeling with physical and logical DFDs: Entity Relationship Diagram, Data Dictionary, Requirement validation, Requirement specification: Software requirement Specification (SRS), Structure and contents, SRS format, Feasibility Study.

Unit-III: Software Design

Design concepts: Abstraction, Architecture, Patterns, Modularity, Cohesion, Coupling, Information hiding, Functional independence, Refinement. Design of User Interface design: Elements of good design, Design issues, Features of modern GUI - Menus, Scroll bars, windows, Buttons, icons, panels, error Messages.

Unit-IV: Software Implementation, Testing and Quality Assurance

Programming languages and development tools, Selecting languages and tools, Good programming practices, Coding Standards. Verification and validation, Techniques of testing: Black-box and White-box testing, Inspections. Levels of testing: Unit testing, Integration Testing, Interface testing, System testing, Alpha and beta testing, Regression testing. Design of test cases, Quality management activities, Product and process quality. Standards: ISO9000, Capability Maturity Model (CMM), Six Sigma.

Unit-V: Software Operation Support and Maintenance

Need for the proper management of software projects, Management activities, Project planning, Software Size Estimation and Cost Estimation, Software Estimation –Size Estimation, Function Point Analysis, LOC Estimation, what is Productivity, COCOMO, Project scheduling, Task set for Software project, defining a task network, Scheduling, earned value analysis, Risk management, Reactive versus proactive Software Risk, Risk Identification, Risk projection, Risk refinement, Risk mitigation, monitoring & management-The RMMM, Managing people

Text Books:

- Pearson Edu, “Software Engineering by Ian SomMerville”, 9th edition, 2010
- Roger P, “Software Engineering – A Practitioner’s Approach”, seventh edition, Pressman, 2010.
- The unified modeling language user guide Grady Booch, James Rambaugh, Ivar Jacobson, Pearson Education, 2nd Edition, 2005.

Reference Books:

- Agile Product Management with Scrum: Creating Products that Customers Love by Roman Pichler, Addison-Wesley Professional, 2010.
- The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations by Gene Kim, Jez Humble, Patrick Debois, John Willis, 2016.

CO-PO & PSO Correlation

Course Name: Software Engineering												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	1	3	1			1			2	2	1	1
CO2:	1	2							1		1	
CO3:	2	2				1			1		1	
CO4:	1	2	1			2			1	2	2	2

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Data Analytics and Visualization**	**Course Code:**		**SOE-B-CSE-21-602**
Credits	**:**	**3**	**No of Hours :**		**3 Hr. / Week**
Max Marks	**:**	**100**			

Course Description:

This course introduces students to data analysis and visualization in the field of exploratory data science using Python. The Applied Data Analytics and Visualization will prepare to transform data into valued insight for a variety of decision makers. Will learn techniques to set-up systems to retrieve, aggregate, and process large data sets; separate big data sets into manageable and logical components; and eliminate "noise" by cleaning data. Also learn different methods of data analysis and visualization, aided by statistical and graphics software.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	To Introduce the concept of Data Analytics, python & Data analytics tools
CO2	Use data analysis tools in the panda's library
CO3	Load, clean, transform, merge and reshape data.
CO4	Handle external files as well as exceptions.
CO5	Analyse and manipulate time series data.

Syllabus:

Unit-I Introduction:

Introduction to Data Science, Exploratory Data Analysis and Data Science Process. Motivation for using Python for Data Analysis, Introduction of Python shell ipython and Jupiter Notebook. Essential Python Libraries: NumPy, pandas, matplotlib, SciPy, scikit-learn, stats models.

Unit-II Getting Started with Pandas:

Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Storage and File Formats, Reading and Writing Data in Text Format, Web Scraping, Binary Data Formats, Interacting with Web APIs, Interacting with

Databases, Data Cleaning and Preparation, Handling Missing Data, Data Transformation, String Manipulation.

Unit-III Data Wrangling

Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, other python visualization tools.

Unit-IV Data Aggregation and Group operations

Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation

Unit-V Time Series Data Analysis

Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.

Text Books:

- Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education services Wiley Publication
- Data Analytics using Python: Bharati Motwani, Wiley Publications.
- Practical Statistics for Data Scientists 50+ Essential Concepts Using R and Python, O 'Reilly Publications 2nd Edition
- Practical Text Mining and statistical Analysis for non-structured text data applications,1st edition, Grey Miner, Thomas Hill

Reference Books:

- Python for Data Analysis: 3rd Edition, Wes McKinney, Publisher(s): O'Reilly Media, Inc.
- Getting Started with Business Analytics: Insightful Decision-Making, David Roi Hardoon, GalitShmueli, CRC Press Business Analytics, James R Evans, Pearson
- Python Data science Handbook, Jake VanderPlas, Orally publication
- Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking, Vovost Foster, Fawcett Tom

CO-PO & PSO Correlation

Course Name: Data Analytics and Visualization												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	3	3	2	1	2				2	2	1	1
CO2:	3	3	3	1	2				1	1	1	1
CO3:	3	2	2	1	2				2	1	1	1
CO4:	2	1	1	1	3				2	1	1	1
CO5:	3	3	3	1	2				2	2	1	1

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Blockchain Technology**	**Course Code:**		**SOE-B-CSE-21-603**
Credits	**:**	**3**	**No of Hours :**		**3 Hr. / Week**
Max Marks	**:**	**100**			

Course Description:

This course provides a broad overview of the essential concepts of Blockchain technology by initially exploring Bitcoin followed by the Ethereum platform to lay the foundation necessary for developing applications and programming. The students will learn about the decentralized peer-to-peer network, an immutable distributed ledger and the trust model that defines a Blockchain. This course enables you to explain basic components of a Blockchain (transaction, block, block header, and the chain), its operations (verification, validation, and consensus model), underlying algorithms, and essentials of trust (hard fork and soft fork).

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	Introduce and define Blockchain, explain Blockchain types, Platforms, Components and Its Applications.
CO2	Understand and explain about the various cryptography used in Blockchain along with Bitcoin Platform.
CO3	Discuss the innovation of the Smart Contract, Ethereum Blockchain, review its protocol, and explore the payment model for code execution in solidity.
CO4	Discuss the concepts used in various Consensus Protocols and Blockchain Security Threats.
CO5	Understand the need of Enterprise Blockchain Platforms, its features and should be able to propose Blockchain based solution for a given Use Cases.

Syllabus:

Unit-I: Introduction to Blockchain and Applications

Introduction to Blockchain and Distributed Ledger, Blockchain Properties, Blockchain, Features, Blockchain Platforms, Generalized Architecture of Blockchain Platform, Applications of Blockchain

Unit-II: Essentials of Cryptocurrencies

Distributed identity: Public and private keys, Digital identification, and wallets; Decentralized network- Distributed ledger: Permissioning framework, Blockchain data structure- Double spending; Network consensus- Sybil attack, Block rewards and miners, Difficulty under competition, Forks and consensus chain, the 51% attack, Confirmations and finality- The limits of proof-of-work- Alternatives to Proof of work.

Unit-III: Blockchain Foundational Concepts & Bitcoin Platform

Bitcoin Architectures: Distributed peer-to-peer network, nodes, consensus protocol, mining: Type, Process, Bitcoin Crypto: Hashing, Digital Signatures, Wallet and Transactions in Bitcoin; Smart Contract and Ethereum Platform: Introduction Ethereum, Architecture, Smart Contracts, Elements of Smart Contracts, Ethereum Operations, Incentive Model, Transactions in Ethereum, Introduction Solidity

Unit-IV: Consensus Protocols and Security Issues

Trust Essentials: Decentralized Systems, Consensus Protocols: Proof-of-Work (PoW), Proof-of-Stake (PoS), Delegated Proof-of-Stake (DPoS), Proof-of-Burn (PoB), Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT), Proof-of-Activity (PoA), Proof of Elapsed Time (PoET). Blockchain Security Threats, Challenges and Issues.

Unit 5: Enterprise Blockchain Platforms and Blockchain Use Cases

Introduction to Enterprise Blockchain Platforms and tools: Hyperledger, Corda, Ripple, Staler, Blockchain Use Cases in Finance and Banking, International Trade, Supply-Chain, Healthcare and Pharmaceuticals, Energy and Power, Government public services and Defense.

Text Books:

- Debjani Mohanty, Blockchain from Concept to Execution: BitCoin, Ethereum, Quorum, Ripple, R3 Corda, Hyperledger Fabric/Saw Tooth/Indy, Multi Chain, IOTA, CoCo, BPB Publications, 2018.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University
- Andreas M. Antonopoulos, Gavin Wood Ph.D., Mastering Ethereum: Building Smart Contracts and DApps, O'Reilly Media, 2018
- Ashwani Kumar, Hyperledger Fabric In-Depth Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, BPB PUBN, 2020.
- Debajani Mohanty, R3 Corda for Architects and Developers with Case Studies in Finance, Insurance, Healthcare, Travel, Telecom, and Agriculture, Apress, 2019

Reference Books:

- Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained, Author- Imran Bashir, Packt Publishing Ltd, Second Edition, ISBN 978-1- 78712-544-5, 2017
- Kenny Vaneetvelde, Ethereum Projects for Beginners: Build Blockchain-based Cryptocurrencies, Smart Contracts, and DApps, 2018
- Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media, First Edition, 2014
- Jamiel Sheikh, Mastering Corda Blockchain for Java Developers,O'Reilly Media, 2020

CO-PO & PSO Correlation

Course Name: Blockchain Technology												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	3	3	2	1	3				1	2		
CO2:	2	2	2	1	3				1	2		
CO3:	3	3	2	2	3				1	3		
CO4:	2	2	1	1	3				1	2		
CO5:	3	3	2	2	3				1	3		

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Management and Organizational Behaviour**	**Course Code:**		**SOE-B-CSE-21-604**
Credits	**:**	**2**	**No of Hours :**		**2 Hr. / Week**
Max Marks	**:**	**50**			

Course Description

The major aim of this course is to enhance students' understanding of the scope of OB as a field of study and its potential value in today's organizational life. It focuses on three levels of analysis: the individual, group, and organization. Topics selected will help students to assess how basic theories of human behaviour may be applied to organizational settings.

Course Outcomes

After completion of the course students will be able to:

CO Numbers	Course Outcomes
CO1	Demonstrate a thorough knowledge and understanding of organizational behaviour at individual, group and organizational level
CO2	Apply relevant contemporary theories, concepts and models in order to analyze organizational environments, cases and issues.
CO3	Communicate their findings clearly and effectively using a variety of media
CO4	Communicate their findings clearly and effectively using a variety of media
CO5	Relate real work life organizational behaviour issues & concerns

Syllabus:

Unit I: Introduction to OB

Understanding Human Behaviour, Conceptual framework for understanding individual behaviour as an input-output system, biological foundation of Behaviour, The dynamics of people and Organization; Comprehensive organizational behaviour model; Determinants of organizational effectiveness; Biographical characteristics of individual behaviour.

Unit II: Individual Dynamics

Personality- Theories of Personality Importance of Personality, Perception- Perceptual Process, Motivation- Types and Theories, Attitude, Leadership, Emotional Intelligence, Creativity, Transactional Analysis, Learning.

Unit III: Group Dynamics

Nature of Group, Types of Group, Importance and need for group formation, Intra-group & Inter-group processes and behaviour, Team building & Teamwork, Punctuated Equilibrium model, Group v/s Team,

Unit IV: Organizational Dynamics

Organizational Culture & Climate, Organizational Structure, Job Design, Conflict, Power & Politics, Organizational Change, Forces of Change, Resistance to Change, Lewin's Three-Step Model,

Unit V: Stress Management

Stress Meaning & Nature; Characteristics; Types of stress, Stages and Models of Stress Stages of stress, Causes and symptoms of stress Consequences of stress Effect on behavior and personality; Effect of stress on performance; Strategies for stress management, Consequences and Coping strategies for stress

Text Books:

- Robbins S.P., Organizational Behaviour, New Delhi, PHI.
- Luthans Fred: Organizational Behaviour, TMH New Delhi.
- Davis Keith, Human Behaviour at Work, TMH, New Delhi

Reference Books:

- Nelson, Quick, Khandelwal, Organizational Behavior, Cengage Learning.
- Singh, Dalip, Emotional Intelligence at Work, Response Books, Sage Publications, Delhi.
- Pareek Udai, Organisational Behaviour, Oxford, IBH, Mumbai.

CO-PO & PSO Correlation

Course Name: Management and Organizational Behaviour												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:						1	1	1			1	1
CO2:		1				1	1				1	1
CO3:		2				1	1				1	1
CO4:			1			1	1				1	1

Note: 1: Low 2.: Moderate 3: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Computer Vision**	**Course Code:**		**SOE-B-CSE-21-605(1)**
Credits	**:**	**3**	**No of Hours :**		**3 Hr. / Week**
Max Marks	**:**	**100**			

Course Descriptions:

The course will cover techniques and tools for rrecent advances in algorithmic techniques, computation and memory technologies have reinvigorated interest in artificial intelligence (AI). Many of the successes in AI in last few years have come from its sub-area computer vision which deals with understanding, and extracting information from digital images and videos. This course provides an introduction to computer vision including fundamentals of image formation, camera imaging geometry, feature detection and matching, multiview geometry including stereo, motion estimation and tracking, and some machine learning problems such as image classification, object detection, and image segmentation.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	Know the theoretical and practical aspects of computing with images and the foundation of image formation, measurement, and analysis
CO2	Implement common methods for robust image matching and alignment
CO3	Understand the geometric relationships between 2D images and the 3D world
CO4	Gain exposure to object and scene recognition and categorization from images
CO5	Develop the practical skills necessary to build computer vision applications

Syllabus:

Unit-I: Digital Image Fundamentals:

Introduction: Image Processing, Computer Vision and Computer Graphics , What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image, Analysis, Bio-metrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality.

Unit-II: Image enhancement and filtering in spatial domain:

Image Formation Models: Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus, Construction of 3D model from images.

Unit-III: Image filtering in the frequency domain:

Image Processing, Feature Extraction, and Motion Estimation: Image pre-processing, Image representations (continuous and discrete) , Edge detection, Regularization theory , Optical computation ,Stereo Vision , Motion estimation , Structure from motion.

Unit-IV: Image restoration:

Shape Representation and Segmentation: Contour based representation, Region based representation, De-formable curves and surfaces, Snakes and active contours, Level set representations, Fourier, and wavelet descriptors, Medial representations, Multi-resolution analysis, Object recognition.

Unit-V: Image Compression and Segmentation

Image Understanding and Computer Vision Applications: Pattern recognition methods, Face detection, Face recognition, 3D shape models of faces Application: Surveillance – foreground-background separation –human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.

Text Books:

- D. Forsyth and J. Ponce, Computer Vision - A modern approach, Prentice Hall
- Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA), Springer, 2010

Reference Books:

- E. R. Davies, , Computer & Machine Vision, Academic Press, 2012
- Dana H. Ballard, Christopher M. Brown, Computer Vision, Prentice Hall 1st Edition (May 1, 1982) , ISBN-978-0131653160

CO-PO & PSO Correlation

Course Name: Computer Vision												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**1**	**2**	**3**	**4**	**5**				**1**	**2**	**3**	
CO2:	**2**	**2**							**1**	2	1	
CO3:	**2**			**1**	**1**					1	1	
CO4:	**2**	**2**								2		
CO5:	**2**	**1**							**1**	1	1	

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Industrial IoT**	**Course Code:**		**SOE-B-CSE-21-605 (2)**
Credits	**:**	**3**	**No of Hours :**		**3 Hr. / Week**
Max Marks	**:**	**100**			

Course Description

Industry 4.0 concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	Describe Industrial Internet of Things and Cyber Physical manufacturing Demonstrate Cyber Physical and Cyber Manufacturing systems
CO2	Describe Architectural design patterns for industrial Internet of Things 20
CO3	Analyse AI and data Analytics for Industrial Internet of Things 20
CO4	Evaluation of Workforce and Human Machine Interaction and Application
CO5	Industrial Internet of Things

Syllabus:

Unit-I: Understanding Industrial Internet of Things (IIoT):

Industrial Internet of Things and Cyber Manufacturing Systems, Application map for Industrial Cyber Physical Systems.

Unit-II: Modeling of CPS and CMS:

Modeling of Cyber Physical Engineering and manufacturing, Model based engineering of supervisory controllers for cyber physical systems, formal verification of system, components.

Unit-III: Architectural Design Patterns for CMS and IIoT:

CPS-based manufacturing and Industries 4.0., Integration of Knowledge base data base and machine vision, Interoperability in Smart Automation, Communication and Networking of IIoT.

Unit-IV: Artificial Intelligence and Data Analytics for manufacturing:

Application of CPS in Machine tools, Digital production, Cyber Physical system, Intelligence, Introduction to big data and machine learning and condition Monitoring.

Unit-V: Evaluation of Workforce and Human Machine Interaction:

Worker and CPS, Strategies to support user intervention. Introduction to Advance manufacturing and Innovation Ecosystems.

Unit-VI: Application of IIoT:

Smart Metering, e-Health Body Area Networks, City Automation, Automotive, Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector.

Text Books:

- Sabina Jeschke, Christian Brecher Houbing Song , Danda B. Rawat Editors Industrial Internet of Things Cyber Manufacturing Systems
- Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi,
- The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
- Inside the Internet of Things (IoT), Deloitte University Press
- Peter Waher "Learning Internet of Things"
- S. Misra, C. Roy, and A. Mukherjee, 2020 "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press.
- Simone Cirani, Gianluigi Ferrari, Marco Picone, and Luca Veltri, "Internet of Things: Architectures, Protocols and Standards", WILEY.

Reference Books:

- Internet of Things- From Research and Innovation to Market Deployment; By Ovidiu & Peter; River Publishers Series
- Five thoughts from the Father of the Internet of Things; by Phil Wainewright - Kevin Ashton
- How Protocol Conversion Addresses IIoT Challenges: White Paper By RedLion.
- Dr. Guillaume Girardin , Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024',Yole Development Copyrights ,2014

CO-PO & PSO Correlation

Course Name: Industrial IoT												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1				2		1		2		3	1
CO2:	2	2		3				2		3		
CO3:	3				1		3				1	
CO4:	1	1			2					2		
CO5:	1		2			3	1		1		2	3

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Soft Computing**	**Course Code:**		**SOE-B-CSE-21-605 (3)**
Credits	**:**	**3**	**No of Hours :**		**3Hrs. / Week**
Max Marks	**:**	**100**			

Course Description:

This course covers the theory and applications of neural networks, fuzzy logic, evolutionary strategies and genetic algorithms in developing intelligent systems with examples and practical applications.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	Apply basic principles of Soft Computing in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO2	Demonstrate proficiency in applying scientific method to models of machine learning and to build intelligent systems through soft computing techniques.
CO3	Recognize the feasibility of applying a soft computing methodology for a particular problem.
CO4	Develop intelligent machines to provide solutions to real world problems, which are not modeled or too difficult to model mathematically.
CO5	Exploit the tolerance for Approximation, Uncertainty, Imprecision, and Partial Truth in order to achieve close resemblance with human like decision making.

Syllabus:

Unit-I: Introduction

Concepts of Artificial Intelligence, Need of Machine Learning, Learning Methods, Soft Computing Approach, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Applications

Unit-II: Artificial Neural Network

Neural Networks Neuron, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory. Architecture: perceptron model, solution,

single layer artificial neural network, multilayer perception model; back propogation learning methods, effect of learning rule co-efficient; back propagation algorithm, factors affecting backpropagation training, applications.

Unit-III: Fuzzy Logic

Fuzzy Logic Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications.

Unit-IV: Genetic Algorithms

Fundamentals of Genetic Algorithms, Chromosomes, Encoding, Selection Operator, Mutation Probability, Mutation Operator, Crossover Probability, Crossover Operator, Fitness Function, Different Variants of Genetic Algorithms, Applications.

Unit-V: Nature Inspired Techniques and Hybrid System

Ant Colony, Particle Swarm Optimization, Integrating Neural Networks, Fuzzy Logic, and Genetic Algorithms, GA based Back Propagation Networks, Fuzzy Back Propagation Networks, Applications

Text Books:

- S N Sivanandam, S N Deepa, “Principles of Soft Computing”, Wiley India, 2007.
- Fakhreddine 0 Karray, Clarence D Silva, “Soft Computing and Intelligent System Design”, Pearson Edition, 2004.
- B. Yagnanarayana, "Artificial Neural Networks", 1st Ed., PHI, 2009.
- S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", PHI, 2007.

Reference Books:

- Siman Haykin, “Neural Netowrks”, Prentice Hall of India
- Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley India

CO-PO & PSO Correlation

Course Name: Soft Computing												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1	2	1						1	2	2	
CO2:	2	2	2						1	2		1
CO3:	1	2	3						1		1	1
CO4:	2	3	2						1		1	2
CO5:	2	3	2						1		1	

Note: 1.: Low 2.: Moderate 3.: High

Programme :	**B.Tech.**	**Semester :**	**VI**
Name of the Course :	**Digital Forensics**	**Course Code:**	**SOE-B-CSE-21-606(1)**
Credits :	**3**	**No of Hours :**	**3**
Max Marks :	**100**		

Course Description:

A brief explanation of the objective is to provide digital evidences which are obtained from digital media. In order to understand the objectives of computer forensics, first of all, people have to recognize the different roles computer plays in a certain crime. According to a snippet from the United States Security Service, the functions computer has in different kinds of crimes.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	Understand the fundamental and types of Computer Forensics
CO2	Describe about Evidence Collection and Data Seizure
CO3	Describe about Duplication, Preservation, Verification and Authentication of Digital Evidence
CO4	Know about Analysis and Validation of Digital Evidence and Network Forensics
CO5	Know about use various forensic tools for a wide variety of investigations

Syllabus:

Unit-I: Computer Forensics Fundamentals & types

Computer Forensics Fundamentals: What is Computer Forensics? ,Use of Computer Forensics in Law Enforcement, Computer Forensics Assistance to Human Recources/Employment Proceedings, Computer Forensics Services, Benefits of professional Forensics Methodology, Steps taken by Computer Forensics Specialists.

Types of Computer Forensics Technology: - Types of Business Computer Forensic Technology. Types of Military Computer Forensic Technology, Types of Law Enforcement- Computer Forensic Technology, Types of Business Computer Forensic Technology

Unit-II: Evidence Collection and Data Seizure

Evidence Collection and Data Seizure: Why Collect Evidence? Collection Options Obstacles-Types of Evidence-The Rules of Evidence-Volatile Evidence-General

Procedure-Collection and Archiving-Methods of Collections-Art facts-Collection Steps - Controlling Contamination: The chain of custody.

Unit-III: Duplication, Preservation, Verification and Authentication of Digital Evidence

Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene – Computer Evidence Processing Steps — Legal Aspects of Collecting and Preserving Computer Forensic Evidence Computer Image.

Verification and Authentication: Special Needs of Evidential Authentication – Practical Consideration – Practical Implementation.

Unit-IV: Analysis and Validation of Digital Evidence and Network Forensics

Computer forensic analysis and validation: Determining what data to collect and analyze, validating forensic data, addressing data-hiding techniques, performing remote acquisitions

Network Forensics: Network forensic overview, performing live acquisitions, developing standard procedures for network forensics using network tools, examining the honeynet project.

Unit-V: Forensic Tools, E-mail investigations and mobile device forensics

Current Computer Forensic Tools: evaluating computer forensic tool needs, computer forensic software tools, computer forensic hardware tools, validating and testing forensic software.

E-mail investigations: Exploring the role of email in investigations, exploring the role of client and server in email, investigating email crimes and violations, understanding email servers, using specialized email forensic tools.

Mobile device forensics: Understanding mobile device forensic, understanding acquisition procedures for cell phones and mobile devices.

Text Books:

- Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi.
- Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning.

Reference Books:

- Real Digital Forensics by Keith j.Jones, Richard Bejitlich, Curtis W.Rose, Addison Wesley Pearson Education
- Forensic Compiling, A Tractitioneris Guide by Tony Sammes and Brain Jenkinson,

Springer International edition.
- Computer Evidence Collection &Presentation by Chrostopher L.T. Brown, Firewall Media.
- Homeland Security, Techniques & Technologies by Jesus Mena, Firewall Media.
- Software Forensics Collecting Evidence from the Scene of a Digital Crime by Robert M.Slade,TMH 2005
- Windows Forensics by chad Steel, Wiley India Edition.

CO-PO & PSO Correlation

Course Name: Digital Forensics												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	1	1						2			1
CO2:	1	2	2						1	2		1
CO3:	1	2							1			1
CO4:	1	2		1						2	2	1
CO5:		2	2			1			1			1

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course	**:**	**Wireless Sensor Network**	**Course Code:**		**SOE-B-CSE-21-606(2)**
Credits	**:**	**3**	**No of Hours :**		**3 Hrs/Week**
Max Marks	**:**	**100**			

Course Description:

The goal of this course is to introduce the students to wireless network protocols and architecture. This course covers the various aspects of wireless networking such as: fundamentals of cellular communication, mobile radio propagation, multiple access techniques, mobile ad-hoc networks and routing in wireless and mobile networks.

Course Outcomes:

At the end of this course, the student will be able to:

CO Number	Course Outcome
CO1	To describe and analyze the basic mobile network architecture.
CO2	To make critical assessment of mobile systems.
CO3	To be able to analyze and propose broad solutions for a range of mobile scenarios.
CO4	Use the different compiler construction tools.

Syllabus:

Unit - I: Wireless communication standards:

Introduction of Translators, Phases of Compiler, The role of the lexical analyzer- Input Buffering-Specification & Recognition of tokens, Compiler Construction Tools i.e., LEX & YACC etc.

Unit - II: Transmission and receiving technique:

Band-pass transmission technique for mobile radio, digital modulation, power spectral density, receiver technique for fading dispersive channels.

Unit - III: Cellular communication:

Frequency reuse and mobility management, cell cluster concepts, co channel and adjacent channel interference, call blocking and delay at cell site, cell splitting, sectoring.

Unit - IV: Multiple access technique:

Random access, carrier sense multiple access, conflict free multiple access, spectral efficiency.

Unit - V: Mobile network Layer:

Internet protocol, mobile IP, transmission control protocol, wireless application protocol, mobile ad hoc networks.

Text Books:

- Wireless communication & networking by Mark & Zuang, PHI.
- Wireless Communications and networks, William Stallings, PHI.

Reference Books:

- Wireless network performance handbook, by Smith, McGraw-Hill.
- Principles of wireless networks, by Pahlavan, PHI.

CO-PO & PSO Correlation

Course Name: Wireless Sensor Network												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	1	2	2						2	2	2	
CO2:	3	2	3						2	1	2	
CO3:	1		2								2	
CO4:	1		2								3	

Note: 1.: Low 2.: Moderate 3.: High

Programme :	**B. Tech**	**Semester/Year:**	**VI**
Name of the Course:	**Natural Language Processing**	**Course Code:**	**SOE-B-CSE-21-606(3)**
Credits :	**3**	**No of Hours :**	**3 Hrs. / Week**
Max Marks :	**100**		

Course Description:

The course will provide foundational knowledge of natural language processing. In the course, basic concepts of language designing, grammars, syntax and semantics and designing of NLP systems will be covered.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Tag a given text with basic Language features
CO2	Design an innovative application using NLP components
CO3	Implement a rule-based system to tackle morphology/syntax of a language
CO4	Design a tag set to be used for statistical processing for real-time applications
CO5	Compare and contrast the use of different statistical approaches for different types of NLP applications.

Syllabus:

Unit-I: Introduction

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance

Unit-II: Word level analysis

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Hidden Markov and Maximum Entropy models.

Unit-III: Syntactic Analysis

Context-Free Grammars, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing –Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures.

Unit-IV: Semantics and pragmatics

Requirements for representation, First-Order Logic, Description Logics, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

Unit-V: Discourse analysis and lexical resources

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

Text Books:

- Daniel Jurafsky, James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2014.
- Steven Bird, Ewan Klein, Edward Loper, "Natural Language Processing with Python‖", 1st Edition, O_Reilly Media, 2009

Reference Books:

- Breck Baldwin, "Language Processing with Java and LingPipe Cookbook", Atlantic Publisher, 2015
- Richard M Reese, "Natural Language Processing with Java", O_Reilly Media, 2015
- Nitin Indurkhya, Fred J. Damerau, "Handbook of Natural Language Processing", 2nd Edition, Chapman and Hall/CRC Press, 2010.

CO-PO & PSO Correlation

Course Name: Natural Language Processing												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	2							1	2	1	
CO2:	2			1	1					1	1	
CO3:	2	2								2		
CO4:	2	1							1	1	1	
CO5:	1	2		1	1				1	2	1	

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester :**	**VI**
Name of the Course:		**Software Engineering Lab**	**Course Code:**	**SOE-B-CSE-21-607**
Credits	**:**	**2**	**No of Hours :**	**4 Hrs/Week**
Max Marks	**:**	**50**		

Course Descriptions:

This lab deals with the analysis and design of a software problem. The tool used in a lab is rational rose. this tool is used for an object oriented design of a problem. We draw a UML diagram in a rational rose which deals with the objects and classes in a system. The Unified Modeling Language or UML is a mostly graphical modelling language that is used to express designs. It is a standardized language in which to specify the artefacts and components of a software system. It is important to understand that the UML describes a notation and not a process. It does not put forth a single method or process of design, but rather is a standardized tool that can be used in a design process.

Course Outcomes:

At the end of the course, a student will be able to:

CO Number	Course Outcome
CO1	Provide users with a ready-to-use, expressive visual modeling language so they can develop and exchange meaningful models
CO2	Ability to generate a high-level design of the system from the software requirements
CO3	Will have experience and/or awareness of testing problems and will be able to develop a simple testing report
CO4	Ability to translate end-user requirements into system and software requirements

The following concepts will be covered in the lab:

- Introduction to Software Engineering-LAB.
- Data flow diagram:
  - What processes make up a system?
  - What data are used in each process?
  - What data are stored?
  - What data enter and leave the system?
- Sample Design:

- Class Diagram
- Sequence Diagram
- State Chart Diagram
- Use-Case Diagram

- Project:
  - Write down the problem statement for a suggested system of relevance.
  - Do requirement analysis and develop Software Requirement Specification Sheet (SRS) for suggested system.
  - Perform the Data Flow Diagram (DFD).
  - Performa the Sequence Diagram.
  - Perform the State Chart Diagram.
  - Perform The Use-Case Diagram.
  - Perform the ER Diagram (If Database applicable).
  - Prepare time line chart/Gantt Chart/PERT Chart for selected project.

Text Books :

- The unified modeling language user guide Grady Booch, James Rambaugh, Ivar Jacobson, Pearson Education, 2nd Edition, 2005.

CO-PO & PSO Correlation

Course Name: Software Engineering Lab												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	1	3	1			1			2	2	1	1
CO2:	1	2							1		1	
CO3:	2	2				1			1		1	
CO4:	1	2	1			2			1	2	2	2

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester**	**:**	**VI**
Name of the Course:		**Data Analytics and Visualization Lab**	**Course Code:**		**SOE-B-CSE-21-608**
Credits	**:**	**1**	**No of Hours :**		**2 Hrs/Week**
Max Marks	**:**	**50**			

Course Description:

This course is all about the analysis of data and its visualization, the art and science of turning data into readable graphics. We'll explore how to design and create data visualizations based on data available and tasks to be achieved. This process includes data modeling, data processing (such as aggregation and filtering), mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception as well as the task(s) at hand. Students will also learn to evaluate the effectiveness of visualization designs, and think critically about each design decision, such as choice of color and choice of visual encoding.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the key techniques and theory behind analyzing the data.
CO2	Use effectively the various visualization structures (like tables, spatial data, tree and network etc.)
CO3	Evaluate data visualization systems and other forms of visual presentation for their effectiveness.
CO4	Design and build statistical tests for data visualization systems

The following concepts will be covered in the lab:

- Statistical data analysis tools
- Various hypothesis testing methods
- T-test, z-test, Wilcoxon signed rant test etc.
- Introduction to Matplotlib by drawing basic plots (plot, scatter, bar, stem, step)
- Learn to draw various statistical plots like histogram, boxplot, error bar, violin plot, pie plot.
- Explore different parameters of line plot: line color, line width, line style, legend, marker with the help of an example.

- Explore different parameters of bar charts: bar width, bar color, shifting the bars, xticks, legends using the above example
- Explore different parameters of pie chart: strangle, explode, fig size, explode, color options, legend, autopct, title, font etc. with the help of an example.
- Learn to draw Histogram with the help of sample dataset
- Learn to draw Box plot with the help of sample dataset

Text Books:

- Tamara Munzner, "Visualization Analysis and Design", A K Peters Visualization Series, CRC Press, 2014.
- Scott Murray, "Interactive Data Visualization for the Web", O'Reilly, 2013.

Reference Books:

- Alberto Cairo, "The Functional Art: An Introduction to Information Graphics and Visualization", New Riders, 2012
- Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics", John Wiley & Sons, 2011.

CO-PO & PSO Correlation

Course Name: Data Analytics and visualization lab												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1		1						1	2	1	
CO2:	2	1	2	2					1			
CO3:			1								2	
CO4:	1	2									2	1

Note: 1.: Low 2.: Moderate 3.: High

Programme	**:**	**B.Tech.**	**Semester :**	**VI**
Name of the Course:		**Blockchain Technology Lab**	**Course Code:**	**SOE-B-CSE-21-609**
Credits	**:**	**2**	**No of Hours :**	**4 Hrs/Week**
Max Marks	**:**	**50**		

Course Descriptions

The Blockchain Technology Lab is a course designed for B.Tech. students to learn the basics and practical applications of blockchain technology. It covers concepts like distributed ledger technology, smart contracts, and decentralized applications, and provides hands-on coding exercises to develop blockchain projects. By the end of the course, students will have the skills needed to design and implement blockchain solutions in various industries.

Course Outcomes:

At the end of the course, a student will be able to:

CO Number	Course Outcome
CO1	Gain a deep understanding of the fundamental concepts and practical applications of blockchain technology.
CO2	Develop the skills to design, develop, and deploy blockchain solutions using industry-standard tools and frameworks.
CO3	Acquire knowledge of the technical details of distributed ledger technology, including consensus algorithms, cryptographic protocols, and smart contracts.
CO4	Create functional, efficient, and secure blockchain projects that can be applied in various industries.

The following concepts will be covered in the lab:

- Basic Cryptography Concepts for Blockchain
- Overview of Blockchain
- Creating and Building Up Bitcoin Wallet:
- Ethereum Wallet
- Building a Private Ethereum Network and Deploying Smart Contract
- Introduction to Solidity
- Ethereum Smart Contract
- Introduction to Hyperledger
- Creating a Business Network using Hyperledger.

- Creating a Business Network using Hyperledger- II

Text Books:

- "Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher.
- "Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained" by Imran Bashir.
- "Blockchain: Blueprint for a New Economy" by Melanie Swan.
- "Blockchain Technology Explained: The Ultimate Beginner's Guide About Blockchain Wallet, Mining, Bitcoin, Ethereum, Litecoin, Zcash, Monero, Ripple, Dash, IOTA And Smart Contracts" by Alan T. Norman.

CO-PO & PSO Correlation

Course Name: Blockchain Technology Lab												
	Program Outcomes								PSOs			
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	3	3	2	1					1	2		
CO2:	2	2	2	1					1	2		
CO3:	3	3	2	2					1	3		
CO4:	2	2	1	1					1	2		

Note: 1.: Low 2.: Moderate 3.: High