

SYLLABI & COURSE OUTCOMES

Bachelor of Technology in Computer Science and Engineering (2020-21)

CORE

COMPUTER SCIENCE & ENGINEERING

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Fundamentals of Computer Programming-I		3. Course Code	4. L-T-P	5. Credits
		CSL106	2-0-4	4
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Understand the working of a computer system with its all peripherals, and master the conversion from one base of number system to another base			
CO 2	Analyze the problem and apply logic to design programs and learn the basic concepts of programming.			
CO 3	Develop the logic to write code and comprehend the basic programming constructs such as loops used in C language to write structured programs.			
CO 4	Address the concepts of functions, pointers, arrays and strings in C			
CO 5	Apply concepts of structures, pre-processor directives and files to develop management system			
9. Brief Syllabus: This course introduces the intrinsic concepts of programming language that helps the students to mutate from one language to another in future. It provides the sagacity of procedural programming approach applied in C programming language. It fully covers fundamental programming techniques with the most common library functions and the usage of the preprocessor. Through this course, students will be able to fathom all the pivotal concepts, syntax and semantics of C language as well as data types offered by the language They will be able to write the code of a program by developing logic with progression to writing pseudo codes, designing flowcharts and finally developing management projects.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Yashwant Karnetkar, "Let Us C", BPB Publications, 16th Edition, 2018 Byron S. Gottfried, "Programming with C", McGraw-Hill, 4th Edition, 2018 Reference Books: <ol style="list-style-type: none"> J.B. Dixit, "Fundamentals of Computers & Programming in C", Laxmi Publications, 2nd Edition, 2007 Yashwant Karnetkar, "Test your C Skills", BPB Publications, 5th Edition, 2017 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://nptel.ac.in/courses/106104128/ (Introduction to Programming in C) https://lmsncu.ncuindia.edu/course/view.php?id=1193 (Fundamentals of Computer Programming-I) 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Problem Solving and Design Thinking		3. Course Code CSL110	4. L-T-P 2-0-2	5. Credits 3
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Able to eliminate roadblocks to creative thinking			
CO 2	Expand the mental model to discover opportunities			
CO 3	Able to use specific tools to boost their output of innovative ideas in order to look at problems from multiple perspective			
CO 4	Apply pragmatic problem-solving techniques to identify the real cause of and best solutions to problems encountered in daily life			
CO 5	Able to learn team building skills and will have improved communication			
9. Brief Syllabus: This module is intended to reawaken the creativity in students and develop it using pragmatic techniques. The aim is to inculcate design thinking as well as analytical decision-making skills. It simulates the mind from different angles and helps to master the art of critical thinking. The students learn to create personas and storyboards and the overall aim of the subject is to prepare the mind for innovation and generate ideas.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business, 2019. Reference Books: <ol style="list-style-type: none"> Donald A. Norman, The Design of Everyday Things, Basic Books 2nd Edition, 2013 G. Polya, John Conway, How to Solve it – A New Aspect of Mathematical Method, Princeton University Press, 2014 Reference websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://setapp.com/how-to/design-thinking-apps-to-master-the-skill https://www.greatlearning.in/stanford-design-thinking https://nptel.ac.in/courses/109104109/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Fundamentals of Computer Programming-II		3. Course Code	4. L-T-P	5. Credits
		CSL108	2-0-4	4
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Decomposing and solving a complex problem by identifying participating objects and their communication framework.			
CO 2	Applying the concepts of object-oriented paradigm (Classes, Objects, inheritance, polymorphism etc.) for designing solution of a given programming problem.			
CO 3	Writing clean well commented code with proper indentation by applying Single responsibility principle.			
CO 4	Developing applications by considering all possible scenarios thereby employing appropriate exception handling.			
CO 5	Developing applications that can manipulate data stored in files.			
9. Brief Syllabus: This course introduces Java, one of the most in-demand programming languages. Designed for beginners with little or no knowledge about Object Oriented programming concepts, this course covers the core OOP concepts including Encapsulation, Polymorphism, Inheritance etc. and their implementation in Java. In this course, the students will have extensive hands-on experience writing, compiling, testing and executing Java programs applying the above principles for developing modular reusable programs. By the end of this course the students will gain the foundational skills a software engineer needs, to solve real-world problems, from designing algorithms to testing and debugging; and will be able to apply these concepts to build their own interactive Java applications.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Herbert Schildt, Java The Complete Reference, McGraw Hill Education, 9th Edition, 2014 Bert Bates, Head First Java, O'Reilly Media, Inc, 2nd Edition, 2005 Reference Books: <ol style="list-style-type: none"> Paul J. Deitel & Harvey Deitel, Java How to Program (early objects), Pearson, 9th Edition, 2012 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://docs.oracle.com/en/java/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Data Structures		3. Course Code	4. L-T-P	5. Credits
		CSL209	3-0-2	4
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Any programming language				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	To understand and implement various data structures like Arrays, Linked Lists, Stack, Queues, Tree, Graphs and File Organization			
CO 2	To be able to illustrate the basic operations of data structures using Java			
CO 3	To analyze algorithms and calculate their complexities			
CO 4	To apply mathematical functions, Algorithmic principles and theoretical concepts to the modelling and designing of solutions			
CO 5	To use sound development principles to implement various non-linear data structures of varying complexities			
9. Brief Syllabus: Solving computational problems requires the knowledge of efficient data organization and the ability to make effective choices among multiple solutions. In this course, we will explore several fundamental data structures in computer science and learn to implement them in Java. The course aims to teach the fundamentals of data structures, their design, implementation and effective use in problem solving approach. With the knowledge of data structures and practical experience in implementing them, students can become much more effective designer and developer. The course will start with the basic introduction of linear as well as non-linear data structures and further proceeds with the programming intensive task of implementing them. This course will also cover file organization and different hashing techniques in its last module.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Aaron M. Tannenbaum, Yedidyah Langsam, Moshe J. Augenstein, "Data Structure using C", Pearson India, 1st Edition, 2018 2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Java", Wiley Publications, 6th Edition, 2014 Reference Books: <ol style="list-style-type: none"> 1. Robert Lafore, "Data Structures and Algorithms in Java", SAMS publications, 2nd Edition, 2002 2. Seymour Lipschutz, "Data Structures", Schaum's Outlines, McGraw Hill Education, 1st Edition, 2014 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.coursera.org/learn/data-structures?specialization=data-structures-algorithms • https://swayam.gov.in/nd2_cec19_cs04/preview • https://www.edx.org/course/data-structures-an-active-learning-approach 				

COURSE TEMPLATE

1.Department:		Department of Electrical, Electronics and Communication Engineering		
2.Course Name: Digital Electronics and Computer Architecture		3. Course Code ECL255	4. L-T-P 3-0-2	5. Credits 4
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Apply number systems and logic Gates concepts			
CO 2	Minimization of logical expression and Designing digital circuits employing logic gates			
CO 3	Designing any combinational circuit using gates and logic elements like multiplexer, decoder etc.			
CO 4	Designing sequential circuits like latches, flip flops, registers and counters.			
CO 5	Understanding of the various architectural components of a digital computer and Classify various addressing techniques and register operations			
CO 6	Categorize different types of memory			
9. Brief Syllabus: Digital signal, Logic gates, Number system, Boolean Algebra and Switching functions, Minimization Techniques, Combinational circuits, Logic Modules and their functions, Sequential circuits and their applications, Digital Logic families, Building blocks of a computer, Addressing techniques and registers, Memories, Advances in Technology, Current applications of digital electronics, Simulation Software (ORCAD, Labview), Case studies and analysis of Real time Situations				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Morris Mano, "Digital Logic and computer design", Prentice Hall, 4th edition, 2008 2. Dube, Vashisth, "Digital Electronics and Devices", Narosa Publishers, 1st edition, 2019 Reference Books: <ol style="list-style-type: none"> 1. R.P. Jain, "Modern Digital Electronics", McGraw Hill Publishers ,4th edition, 2010 2. Anand Kumar, "Fundamentals of digital circuits", PHI, 5th edition, 2018 3. Malvino, Leach& Saha, "Digital Principles and Applications", McGraw Hill education publishers, 7th edition, 2011 4. MykePredko, "Digital Electronics demystified", McGraw Hill, 2005 5. John .M Yarbrough, "Digital Logic Applications and Design", Published by CL Engineering/Cengage Learning India, 2nd edition, 2009 6. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Morgan Kaufmann, 5th edition, 2014 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • http://nptel.ac.in/courses/117106086/1 • http://nptel.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/digital_circuit/frame/ • http://etech.atu.edu/student.html • www.lms.ncuindia.edu/lms 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Computer Networks		3. Course Code	4. L-T-P	5. Credits
		CSL240	3-0-2	4
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Describing computer network in terms of a layered model.			
CO 2	Implementing data link, network and transport layer protocols in a simulated networking environment			
CO 3	To determine different types of errors and data flow within networks.			
CO 4	Planning logical sub-address blocks with a given address block.			
CO 5	Describing the standard protocols involved with TCP/IP based communications.			
9. Brief Syllabus: This course is designed to provide a complete overview of computer networking and covers everything from the fundamentals of networking technologies and protocols to practical applications. The course builds the basic concepts starting with the OSI reference model and progress to elaborate on the protocol stack that is used in traditional networks. The goals, design principles and implementation at different layers of a network are covered to provide a sound foundation on the subject. After going through this course, the student will be able to set up a basic home network, configure devices for connectivity, understand how communication takes place on a network, and what minimal best practices should be implemented to secure the network.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Behroz Forouzan, "Data Communication and Networking", TMH., 5th Edition, 2017. Tanenbaum, "Computer Network", Pearson, 5th Edition, 2013. Reference Books: <ol style="list-style-type: none"> James Kurose, "Computer Networking: A Top-Down Approach", Pearson, 7th Edition, 2016. Reference websites: <ul style="list-style-type: none"> https://nptel.ac.in/courses/106105081/ 				

COURSE TEMPLATE

1.Department:	Department of Computer Science and Engineering		
2.Course Name: Discrete Mathematics	3. Course Code CSL223	4. L-T-P 3-0-0	5. Credits 3
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.			
CO 1	Apply the operations of sets and use Venn diagrams to solve applied problems; solve problems using the principle of inclusion-exclusion		
CO 2	Simplify and evaluate basic logic statements including compound statements, implications, inverses, converses, and contrapositives using truth tables and the properties of logic.		
CO 3	Identify the base step and the recursive or inductive step in applied problems and give a recursive and a non-recursive definition for an iterative algorithm.		
CO 4	Apply the various algebraic structures in the various research field like cryptography.		
CO5	Perform tree traversals using preorder, inorder, and postorder traversals and apply these traversals to application problems; use binary search trees or decision trees to solve problems.		
9. Brief Syllabus: This course covers widely applicable mathematical tools for computer science, including topics from logic, set theory, combinatorics, Algebraic Structures and graph theory. It includes practice in reasoning formally and proving theorems.			
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Kolman, Busby and Ross, "Discrete Mathematics and its Applications", Pearson; 6th edition, 2008 Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw-Hill Pub. Co. Ltd, 2003. Reference Books: <ol style="list-style-type: none"> Kenneth H.Rosen, "Discrete Mathematics and its Applications", Fifth Edition, Tata McGraw – Hill Pub. Co. Ltd,2003. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://nptel.ac.in/courses/106106094/ 			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Cyber Security		3. Course Code	4. L-T-P	5. Credits
		CSL422	3-0-2	4
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Conduct detailed reconnaissance using document metadata, search engines, and other publicly available information sources to build a technical and organizational understanding of the target environment.			
CO 2	Utilize scanning tools to conduct comprehensive network sweeps, port scans, OS fingerprinting, and version scanning to develop a map of target environments.			
CO 3	Recognize security vulnerabilities, such as weak configurations, unpatched systems.			
CO 4	Apply penetration testing tools to exploit and investigate vulnerable systems.			
CO 5	Implementing on web application-based attacks			
9. Brief Syllabus: This course is focused on the practical side of penetration testing whilst including necessary theoretical details. It will make students learn how to protect users from cyber attackers by becoming an ethical hacker. It takes students from a beginner to a more advanced level, by the time course finishes students will be able to launch attacks and test the security of computers. It commences with different ways of gathering information about the target and consequently discusses various ways to discover and exploit large number of vulnerabilities to gain access. Thereafter, it includes what you can do with the access you gained from exploiting the above vulnerabilities and ways to maintain that access.				
10. Books Recommended: Textbooks: 1. Stuart McClure, Joel Scam bray, George Kurtz, "Hacking Exposed 7: Network Security Secrets and Solutions", Tata McGraw Hill, 1 st edition, 2012 Reference Books: 1. Cyber Security Essentials, James Graham, Richard Howard, Ryan Olson, CRC Taylor and Francis, 1 st edition, 2010 Reference websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.cybrary.it/course/web-application-pen-testing/ • https://www.cybrary.it/course/advanced-penetration-testing/ • https://www.cybrary.it/course/ethical-hacking/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Database Management Systems		3. Course Code CSL214	4. L-T-P 3-0-2	5. Credits 4
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Identifying contrast between traditional and modern Database Systems, thereby recognizing their applications.			
CO 2	Developing conceptual database design for any real time project by defining the relationship, constraints etc. on entities.			
CO 3	Applying appropriate design techniques to design a good database that meets the user requirement.			
CO 4	Creating a database and devising queries for extracting information from the database using Relational Algebra and SQL.			
CO 5	Applying the concepts of DBMS for developing a backend for a non-trivial project using NoSQL.			
CO 6	Ability to improvise data fetching time by applying indexing concepts.			
CO 7	Understanding the concepts of end-to-end transaction processing in a database.			
9. Brief Syllabus: Databases form the core of all major applications – finance, social, administrative, education etc. Organizations work on large volumes of data every day, introducing the need to have database management systems to easily identify, extract, store and transform details in the database. This course will explore concepts and principles of DBMS, database design, data modeling, database implementation, and database management through various assignments and projects. By the end of this course, the student will be able to work as a database engineer by designing, developing and maintaining the database for any project application.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Elmasri R. and Navathe S.B., Fundamentals of Database Management Systems. 6th ed. Pearson, 2010. 2. Silberschatz A., Korth H.F. and Sudarshan S., Database System Concepts. 6th ed. Mc.Graw Hill, 2010. 3. Chodorow K., MongoDB: The Definitive Guide. 2nd ed. O'Reilly Media, 2013. Reference Books: <ol style="list-style-type: none"> 1. Ramakrishnan R. and Gehrke J., Database Management Systems. 3rd ed. McGraw-Hill Education, 2003. 2. Suehring S., My SQL Bible. Wiley Publishing, 2002. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://nptel.ac.in/courses/106105175/2 • https://docs.mongodb.com/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Analysis and Design of Algorithms		3. Course Code	4. L-T-P	5. Credits
		CSL230	3-0-2	4
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Design and analysis of algorithms for a given problem.			
CO 2	Analyze various complexity measures and the performance of algorithms.			
CO 3	Apply and analyze the complexity of certain divide and conquer, greedy, and dynamic programming algorithms.			
CO 4	Explain and apply backtracking algorithms.			
CO 5	Ability to design and analyze branch and bound techniques to deal with some hard problems.			
CO 6	Understand the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.			
9. Brief Syllabus: This course is an introduction to analysis of algorithms. The course will start with designing and analysis of basic algorithms like sorting and searching and will gradually cover advanced techniques such as dynamic programming and greedy algorithms. Throughout the course, you will gain insights to advanced graph algorithms such as minimum spanning trees and shortest paths, NP-completeness theory. At the end of this course, students will be able to design algorithms for various computing problems and analyze the time and space complexity of algorithms, They will be able to critically analyze the different algorithm design techniques for a given problem and modify existing algorithms to improve their efficiency				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Ellis Horowitz, Sartaj Sahani, Sanguthevar Rajashekar, "Fundamentals of Computer Algorithms", Orient Black Swan, 2nd Edition, 2008. 2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", MIT Press, 3rd Edition, 2009. Reference Books: <ol style="list-style-type: none"> 1. J. Kleinberg and E. Tardos, "Algorithm Design", Pearson, 1st Edition, 2013. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://swayam.gov.in/nd1_noc20_cs10/preview 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Artificial Intelligence for Games		3. Course Code	4. L-T- P	5. Credits
		CSL242	3-0-2	4
6. Type of Course (Check one):		Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Programming for Game				
8. Course Outcomes (COs)				
Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Ability to critically evaluate game design concepts, elements and characters by Use of vector mathematics in games and unity's waypoint system.			
CO 2	The students will be able to Create an AI based car game in unity using waypoint system. Will learn algorithms for path planning and navigation.AI techniques in games and selection of techniques.			
CO 3	Knowledge about Graph theory and Pathfinding to find the shortest path for an enemy or NPC.Students will be able to create car game - Using Pathfinding& waypoints.			
CO 4	Understand why navmeshes are better than waypoints and create a crowded city with npc's walking around based on navmeshes.			
CO 5	Student will be able to simulation crowd, create a crowded city, and Convert finite state machines to work on a nav mesh.			
CO 6	Understand the use of finite state machines, behavior trees, nodes, goal-oriented action planning and create AI behaviors in the game.			
9. Brief Syllabus:				
<p>Artificial intelligence (AI) is used to generate responsive, adaptive or intelligent behaviors primarily in non-player characters (NPCs) like human-like intelligence. This module will teach students how non-playable entities in games interact with player or other simulated entities themselves. Topics will go through different simulated 'thinking' agent's development features and paradigms. Different 'brain' design will be discussed in this module such as FSM, fuzzy logic, and weighted behavior tree to achieve relatable and believable autonomous agents in games This is an introductory course for students will learn Master Ai for game development (produce, test and present a beta version of a game of your own design).Understand game design and apply the concepts for game development.</p>				
10.Books Recommended:				
Textbooks: None				
Reference Books:				
1. Ian Millington and John David Funge, Artificial Intelligence for Games, CRC Press (Taylor & Francis Group), 2006 2. Mat Buckland, Programming Game AI by Example, 1 st Edition, Word ware Publishing, Inc., 2005				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> https://www.gamedev.net/articles/programming/artificial-intelligence/the-total-beginners-guide-to-game-ai-r4942/ https://www.geeksforgeeks.org/game-playing-in-artificial-intelligence/ https://www.udemy.com/courses/search/?src=ukw&q=Ai%20for%20games 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Introduction to Artificial Intelligence and Machine Learning		3. Course Code	4. L-T-P	5. Credits
		CSL236	3-0-2	4
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Understand the strengths and limitations of various ML algorithms			
CO 2	Understand and Implement the preprocessing of the data to be used for machine learning models			
CO 3	Understand why models degrade and how to maintain them			
CO 4	Implement and use model grading metrics			
CO 5	Apply ML techniques and technologies to solve real world business problems			
9. Brief Syllabus: Introduction to artificial intelligence, History of AI, Proposing and evaluating AI application, Preprocessing and Feature Engineering, Case study: Exploratory Analysis of Delhi Pollution , Simple Linear Regression, Multiple Regression, Polynomial Regression, Support Vector Regression SVR, Decision Tree Regression, Random Forest Regression, Logistic Regression, K Nearest Neighbors, Support Vector Machine, Kernel SVM, Naïve Bayes, Decision Trees Classification, Random Forest Classification, Basic Terminologies: Over fitting, Under fitting, Bias and Variance model, Bootstrapping, Cross-Validation and Resampling Methods, Performance Measures: Confusion matrix, ROC. Comparing two classification Algorithms: McNamara's Test, paired t-test.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Michael Bowles, "Machine Learning in Python" Wiley, Third Edition, 2019 2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2015 Reference Books: <ol style="list-style-type: none"> 1. Ian H. Witten & Eibe Frank., "Data Mining Practical Machine Learning Tools and Techniques", Morgan Kauffmann Publishers, Second Edition, 2010 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • www.lms.ncuindia.edu/lms • https://www.simplilearn.com/big-data-and-analytics/machine-learning-certification-training-course • https://www.coursera.org/learn/machine-learning 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Operating System		3. Course Code	4. L-T-P	5. Credits
		CSL303	3-0-2	4
4. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
5. Pre-requisite(s), if any: None				
6. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him/her once it is completed.				
CO 1	To understand the working of an OS as a resource manager, file system manager, process manager, memory manager and I/O manager, and the methods used to implement the different parts of OS			
CO 2	To know about different challenges related to Process management and finding effective solutions for their synchronization. Understanding different types of CPU scheduling techniques and their performance trade-offs.			
CO 3	To learn about device/resource management and various policies involved in decision making such as deadlock detection, deadlock avoidance and deadlock prevention			
CO 4	To learn and understand the distinct mechanisms involved in memory management in contemporary OS			
CO 5	To acquire knowledge about Disk management and different file allocation methods			
7. Brief Syllabus: This is an introductory course in Operating System concepts that forms an integral part of computer science engineering in development of software applications in many diverse areas, including Web Development, Windows Applications, Research, Analytics and Processing. It lays the foundation of Process Management, Scheduling, Memory Management, Deadlocks and other Operating system concepts.				
8. Books Recommended: Textbooks: 1. Abraham Silberschatz , Peter B Galvin and Gerg Gagne, Operating system concepts, 9th ed, WILEY, 2018 Reference Books: 1. Andrew S. Tanenbaum and Herbert Bos, Modern Operating Systems, 4th ed., Pearson, 2016. 2. Sumitabha Das, UNIX concepts and applications, 4 th ed., Tata McGraw Hill, 2017. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://swayam.gov.in/nd1_noc19_cs50/preview • https://nptel.ac.in/courses/106/106/106106144/# • https://www.udacity.com/course/introduction-to-operating-systems--ud923 • https://www.udemy.com/course/operating-systems-from-scratch-part1/ 				

COURSE TEMPLATE

1.Department:		Department of Computer Science and Engineering		
2. Course Name: Software Engineering and Project Management		3. Course Code	4. L-T-P	5. Credits
		CSL229	3-0-2	4
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Identification a suitable software development model for a given problem statement			
CO 2	Preparation of the SRS (Software Requirement Specification) document and basics of designing approach			
CO 3	Preparation of the design document based on either of the methodologies.			
CO 4	Understand various levels of testing and solve the testing problems by designing software test cases and scenarios			
CO 5	Performing risk assessment and ensuring adherence to quality assurance standards through comprehensive testing			
CO 6	Estimating size, cost, development time and effort of a software product			
9. Brief Syllabus: This course helps students to understand about the systematic approach to the development, operation, maintenance, feasibility analysis, designing and requirement of the software. This course would cover different types of SDLC models, agile practices, requirement analysis and specification, designing document, testing techniques, Software maintenance and reuse approach, re-engineering, reverse engineering and project management techniques. By the end of this course, Students will be able to do understand software engineering and project management concepts and its application to the development and management of software systems and understand professional and ethical responsibilities.				
10. Books Recommended Textbooks: <ol style="list-style-type: none"> 1. Rajib Mall, "Fundamentals of Software Engineering", PHI, 5th Edition, 2018 2. Roger S. Pressman, "Software Engineering: A Practitioner's Approach", 7th Edition; McGraw-Hill, 2016 3. Hughes, Bob and Cotterell, M, "Software Project Management", Tata McGraw Hill, 6th Edition, 2018 Reference Books: <ol style="list-style-type: none"> 1. P. Jalote, "An Integrated Approach to Software Engineering", Springer, New York, 3rd Edition, 2014. 2. Ian Sommerville, "Software Engineering", Pearson Edu, 10th Edition, 2017. 3. K. K. Aggarwal, Yogesh Singh, "Software Engineering", New Age International Publishers, 3rd Edition, 2007. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.classcentral.com/course/swayam-software-engineering-14293?utm_source=cc_mooc_report&utm_medium=web&utm_campaign=swayam_spring_2020 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Theory of Computation		3. Course Code	4. L-T-P	5. Credits
		CSL318	3-0-2	4
6. Type of Course (Check one):	Programme Core <input checked="" type="checkbox"/> Programme Elective <input type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Introduction to the mathematical foundations of computation including automata theory and finite automata			
CO 2	Create awareness among students about formal languages and grammar			
CO 3	Introduction to the concepts and design of pushdown automata			
CO 4	Develop idea about Turing machine and its working and design, notions of algorithm, decidability, complexity, and computability			
CO 5	Learn the various phases of compiler and introduction to various parsing techniques.			
9. Brief Syllabus: This course introduces students to the mathematical foundations of computation including automata theory; the theory of formal languages and grammars; the notions of algorithm, decidability, complexity, and computability. A basic understanding of compiler design is also included as an application of theory of computation. This enables students' ability to understand and conduct mathematical proofs for computation and algorithms, understand the different phases of compilation process and the design of parsers.				
10. Books Recommended: Textbooks: 1. "Introduction to Automata Theory, Languages and Computations", Hopcroft J.E., Motwani R. and ullman J.D, Third Edition, Pearson Education, 2008. Reference Books: 1. Peter Linz, Jones and Bartlett, "An Introduction to Formal Languages and Automata", Sixth Edition, 2016 2. Michael Sipser, "Introduction to The Theory of Computation", Third Edition, Cengage Learning, 2014 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • https://nptel.ac.in/courses/106104148/				

PROGRAM ELECTIVES FOR DATA SCIENCE SPECIALIZATION TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Programming for Data Science		3. Course Code	4. L-T-P	5. Credits
		CSL225	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs)				
On successful completion of this course students will be able to:				
CO 1	Understand and implement the basics of programming in Python.			
CO 2	Understand and implement the Collections in Python.			
CO 3	Apply Object Oriented Programming concepts on real world examples.			
CO 4	Apply the Numpy package for numerical calculations in Python.			
CO 5	Apply Pandas package for loading and preprocessing data in Python.			
CO 6	Implement various data visualization tools of Python on real world data.			
9. Brief Syllabus:				
<p>Introduction to Computer Science, Computer Algorithms, Computer Hardware , Operating Systems—Bridging Software and Hardware , Limits of Integrated Circuits Technology: Moore's , Computer Software , Procedural vs. Object-Oriented Programming, Literals , Variables and Identifiers , Operators, Expressions and Data Types, What Is a Control Structure, Boolean Expressions (Conditions), Relational Operators, Membership Operators, Selection Control, Multi-Way Selection, Iterative Control, While Statement , Infinite loops, Definite vs. Indefinite Loops, Boolean Flags and Indefinite Loops, List Structures, Common List Operations, Tuples , Nested Lists, For Loops , While Loops and Lists (Sequences), Assigning and Copying Lists , Dictionary Type in Python, Set Data Type , Program Routines , Defining Functions, More on Functions , Calling Value-Returning Functions, Calling Non-Value-Returning Functions, Parameter Passing, Arguments in Python Default Arguments in Python, Variable Scope, Recursive Function, Module Specification , Top-Down Design, Developing a Modular Design of the Calendar Year Program, Object-Oriented Programming concepts, Numpy - Creation on Array ,Array generation from Uniform distribution, Random array generation, reshaping, maximum and minimum, reshaping, Arithmetic operations, Mathematical functions, Bracket Indexing and Selection, Broadcasting, Indexing a 2D array (matrices); Pandas - Creating a Series - from lists, arrays and dictionaries, Storing data in series from intrinsic sources, Creating DataFrames, Imputation, Grouping and aggregation, Merging, Joining, Concatenation, Find Null Values or Check for Null Values, Reading data from csv, txt, excel, web, Visualization - Installing and setting up visualization libraries, Canvas and Axes, Subplots, Common plots – scatter, histogram, boxplot, Logarithmic scale, Placement of ticks and custom tick labels, Pandas Viz, Style Sheets, Plot type, Area, Barplots, Histograms, Line Plots, Scatter Plots, BoxPlots, Hexagonal Bin Plot, Kernel Density Estimation plot (KDE), Distribution Plots, Categorical Data Plots, Combining Categorical Plots, Matrix Plots, Regression Plots, Grids.</p>				
10. Books Recommended :				
Textbooks:				
1. Charles Dierbach., Introduction to Python using Computer Science, Wiley Publications, Second Edition, 2015				
2. Mark Lutz , Learning Python, O'Reilly publications , Fifth Edition, 2015				
Reference Books:				
1. Paul Barry, Head First Python, Orielly Publications, Second Edition, 2010				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> • www.lms.ncuindia.edu/lms • https://swayam.gov.in/nd1_noc19_cs59/preview • https://www.python.org/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Applied Computational Statistics		3. Course Code	4. L-T-P	5. Credits
		CSL 227	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Programming for Data Science (Python)				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Apply appropriate descriptive statistical and exploratory methods in the analysis of datasets			
CO 2	Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables.			
CO 3	Understand the probability mass function and various discrete distributions through application on real world examples			
CO 4	Understand the probability density function and various continuous distributions through application on real world examples			
CO 5	Understand and interpret statistical hypothesis test			
CO 6	Translate real-world problems into probability models using Bayesian Statistics.			
9. Brief Syllabus:				
Types of Data (Quantitative, Qualitative, Logical), Exploratory Data Analysis (Histogram, Scatter plots, Box plot), Fundamentals of Descriptive Statistics (moments- Measures of Central Tendency, Measure of spread, Measure of Shape), Markov Chains, LATEX, Probability and Combinatorics: Sample Statistics and Population Parameters, Events (Mutually Exclusive, Disjoints, Independent), Counting Methods Permutations and Combinations), Joint, Conditional Probability, Bayes' Rule, Discrete Distributions Introduction, Probability Mass Function, Cumulative Distribution Function, Geometric Distribution, Binomial Distribution, Poisson Distribution, Continuous Distributions: Probability Density Functions, Cumulative Distribution Function, Inferential Statistics (Normal Distribution, Statistical Sampling, Central Limit Theorem), Estimations (Point and Intervals- Confidence intervals with means, sample, proportions), Hypothesis Testing :Introduction, Confidence Intervals, Critical Value based approach, P-value based approach, ZTests, TTests ,the χ^2 distribution, ANOVA/ANCOVA.				
10. Books Recommended :				
Textbooks:				
1. Ross, Introduction to Probability. 9th edition, Pearson, 2006 2. G. Jay Kerns, Introduction to Probability and Statistics Using R, 2016 3. Andy Field, An Adventure in Statistics, SAGE Publications, 2016				
Reference Books:				
1. Dawn Griffiths, Head First Statistics, O'Reilly media Inc., 2019 2. Timothy C Urdan, Statistics in Plain English, Taylor and Francis Publisher, 2010				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> https://www.coursera.org/learn/probability-intro/ https://www.coursera.org/learn/bayesian/ www.lms.ncuindia.edu/lms/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Data Engineering		3. Course Code	4. L-T-P	5. Credits
		CSL234	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Programming for Data Science				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Understand the need and process of Data Engineering, Data Warehousing & Mining.			
CO 2	Apply different operations and visualize multidimensional views of OLAP servers			
CO 3	Apply Association Rules on real world data.			
CO 4	Implement Regular Expressions(Regex) and data wrangling			
CO 5	Implement operations related to warehousing on big data using the Google Cloud Platform.			
9. Brief Syllabus: Introduction to Data Engineering (Definitions, Applications and examples) and Data Warehouse, Need of Data Warehouse, Types of Data Warehouse, functions of data warehouse tools and utilities, Process flow in Data Warehouse, Applications of Data Warehouse. Different views in Business Analysis framework, Three-tier Data Warehouse Architecture, Data Warehouse Models, Differentiate between OLAP and OLTP, Types of OLAP servers, OLAP operations , ETL, Process of ETL, Need of ETL, Challenges in ETL systems, Data Wrangling, Goals of Data Wrangling, Importance, How different from ETL, Combining and Merging Data Sets, Bitmap Index and Join index, OLAP Server (ROLAP, MOLAP, HOLAP), Creation of Data Warehouse and Cubes, Regular Expressions (Regex), Data Aggregation, Association Rules. Introduction to Google Cloud Platform, GCP Setup, CloudSQL (RDMS) (OLTP), Cloud Spanner (RDMS) (OLTP), Big query (OLAP), Data Prep (UI for Dataflow) and Cloud Composer Airflow.				
10. Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Paulraj Ponniah, <i>Data Warehousing Fundamentals</i>, Wiley, Second Edition, 2010 2. Morgan Kauffman, <i>Data Mining Concepts</i>, Han and Kamber, Third Edition, 2012 Reference Books: <ol style="list-style-type: none"> 1. Kimball & Caserta, <i>The Data Warehouse ETL Toolkit</i>, Wiley, 2004 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • www.lms.ncuindia.edu/lms • https://www.udemy.com/learn-etl-using-ssis/ • https://cloud.google.com/ • https://regex101.com/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Business Intelligence and Data Visualization		3. Course Code	2. L-T-P	3. Credits
		CSL232	2-0-4	4
4. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
5. Pre-requisite(s), if any: None				
6. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Demonstrate the ability to use technical skills in descriptive analytics to support business decision-making.			
CO 2	Develop an introductory level of competency on the use of Tableau software for data visualization			
CO 3	Employ BI tools to load and visualize data to generate useful and informative reports from data.			
CO 4	Essential Data Science skills using Knime Analytics to design, build, test and evaluate predictive models			
CO 5	Apply Data Science algorithms identify, understand, analyze, prepare, and present effective visualizations on real world data			
7. Brief Syllabus: Introduction to data analysis, Data processing, Fundamental of Data Visualization Compare and Contrast, Business Intelligence, User Interface –Tableau Desktop . Dashboards and Stories Building a Dashboard, Dashboard Layouts and Formatting , Exploratory vs. Explanatory, Statistical test, Preprocessing, Multidimensional Visualization, Infographics, Level of Details, Building Gapminder in Tableau, Basic Geo-Coding for Tableau, Animations, Introduction to Knime Analytics Platform, Knime workbook, Data exploration, modeling and reporting in Knime, Database operation, web, date and time, loops in knime, advance reporting, Introduction to SQL, Joins, subqueries, store routine, SQL and Tableau problems.				
8. Books Recommended: Textbooks: 1. James Evans, <i>Business Analytics</i> , Global Edition, Pearson, 2nd Edition , 2016 Reference Books: 1. U Dinesh Kumar, <i>Business Analytics: The Science of Data-Driven Decision Making</i> , WILEY INDIA, First Edition, 2017 2. Donabel Santos, <i>Tableau 10 Business Intelligence Cookbook</i> , Packt Publishing Limited, First Edition, 2016 3. Gábor Bakos, <i>KNIME Essentials</i> , Packt Publishing Limited, First Edition, 2013 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://swayam.gov.in/nd1_noc20_mg11/preview • https://www.udemy.com/course/data-visualization-with-tableau-novice-to-pro-5-in-1 • https://www.tableau.com/learn/whitepapers • www.lms.ncuindia.edu/lms 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Machine Learning		3. Course Code	4. L-T-P	5. Credits
		CSL313	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Introduction to AI and ML				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Implement the real-world problems with model selection and optimized feature selection for further processing of the data.			
CO 2	Understand the difference between supervised and unsupervised approaches and design the model with no training data.			
CO 3	Implement dimensionality reduction techniques to improve the efficiency of models			
CO 4	Implement the methods to find frequent patterns and associations in the patterns.			
CO 5	Implement reinforcement techniques with real world data .			
9. Brief Syllabus: Overview to machine learning and pre-processing concepts, Model Selection, Model Selection, XGBoost. Feature Selection- Filter and Wrapper, Dimensionality Reduction, Principal Component Analysis PCA, Linear Discriminant Analysis LDA, Kernel PCA, Introduction to Self-Organizing Maps (SOM), Building a Self-Organizing Map. Overview of clustering in machine learning, Different categories of clustering algorithms, similarity/distance measures, K Means algorithm, Hierarchical, DBSCAN, Fuzzy C-Means , Agglomerative clustering algorithm, Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabeled data., Evaluation methods, A case study with clustering implementation, Eclat, Reinforcement Learning, Upper Confidence Bound UCB, Thompson.				
10. Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Sebastian Raschka, "Python Machine Learning", Packt Publications, Second Edition, 2017. 2. Han and Kamber, "Data Mining Concepts", Morgan Kauffman Publications, Third Edition, 2012 3. Chris Albon, "Machine Learning with Python Cookbook: Practical Solutions from Pre-processing to Deep Learning Paperback" O'Reilly Publications, First Edition, 2018. Reference Books: <ol style="list-style-type: none"> 1. Matthew Kirk, "Thoughtful Machine Learning: A Test-Driven Approach" , First Edition, O'Reilly Publications, 2014. 2. Tom Mitchell,"Machine Learning", McGraw Hill, 1997. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.coursera.org/learn/practical-rl#syllabus • www.lms.ncuindia.edu/lms • https://nptel.ac.in/courses/106/106/106106139/ • https://www.coursera.org/learn/machine-learning 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Big Data		3. Course Code	4. L-T-P	5. Credits
		CSL311	2- 0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Data Engineering				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Deploy big data architecture for data analytics on cloud.			
CO 2	Understand various Big Data tools and terminologies and where they fit in the grand scheme of things.			
CO 3	Perform data preprocessing on large datasets.			
CO 4	Map big data concepts with potential use in a corporate environment.			
CO 5	Design predictive analytics projects on big data.			
9. Brief Syllabus: Characteristics of big data, Big Data and its importance, Challenges of big data, Big data applications, Hadoop Architecture, HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read NameNode, Secondary NameNode and DataNode, Hadoop Technologies – Cassandra, Understanding Inputs and Outputs of MapReduce, Elastic MapReduce on Cloud, Hadoop MapReduce paradigm Map and Reduce tasks, Cluster Setup , Getting Started with Spark, Setting up Python with Spark, RDD, Functional Programming, Local Virtual Box Set-up, Amazon Web Service (AWS) EC2 PySpark Set-up, Databricks Setup (Optional), AWS EMR Cluster Setup, Running Spark on a Cluster, SparkSQL, Spark DataFrame Basics, Spark Graph X, Collaborative Filtering for Recommender Systems, Natural Language Processing in Spark, Real-time analytics with Spark Streaming				
10. Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, <i>Professional Hadoop Solutions</i>, Wiley, First Edition, 2015 2. Michael Minelli, Michehe Chambers, <i>Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business</i>, Wiley CIO Series, First Edition, 2013 Reference Books: <ol style="list-style-type: none"> 1. O'Reilly, White, <i>Hadoop: The Definitive Guide</i>, Third Edition, 2012. 2. Tom Plunkett and Brian Macdonald, <i>Oracle Big Data Handbook</i>, Oracle Press, 2014. 3. Furht, Borko, Villanustre, Flavio, <i>Big Data Technologies and Applications</i>, First Edition, Springer Series, 2016 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.coursera.org/specializations/big-data • www.lms.ncuindia.edu/lms 				

COURSE TEMPLATE

1.Department:	Department of Computer Science and Engineering		
2.Course Name: Introduction to Image Processing and Recognition	3.Course Code	4.L-T-P	5.Credits
	CSL316	2-0-4	4
6.Type of Course (Check one):	Programme Core <input type="checkbox"/>	Programme Elective <input checked="" type="checkbox"/>	Open Elective <input type="checkbox"/>
7.Pre-requisite(s), if any: None			
8.Course Outcomes (COs) On successful completion of this course students will be able to:			
CO 1	Implement fundamental image processing techniques required for computer vision.		
CO 2	Analyze the different segmentation techniques and shape analysis		
CO 3	Apply 3D vision techniques to images		
CO 4	Develop projects that can detect faces and objects using Open CV		
9.Brief Syllabus: Elements of digital image processing, Image model, Sampling and quantization, Relationships between pixels, Image Transforms, Discrete Fourier Transform, Discrete Cosine Transform, Haar Transform, Hadamard Transform, Image Enhancement, Enhancement by point processing, Spatial filtering, Enhancement in the frequency domain, Color Image Processing, Image Segmentation, Discontinuity detection, Edge linking and boundary detection, Thresholding, Region oriented segmentation, Use of motion for segmentation Introduction to CV, Introduction to Face Detection, Face Detection with OpenCV, Object Detection Introduction, Object Detection with SSD, Generative Adversarial Networks (GANs) Introduction.			
10.Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Szeliski, Richard , Computer Vision Algorithms and Applications, Microsoft, Fourth Edition, 2012 2. Jan Erik Solem, Programming Computer Vision with Python: Tools and algorithms for analyzing images, O'Reilly Media, First Edition, 2015 3. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Prentice, Third Edition, 2016 4. D. L. Baggio et al, Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing, First Edition, 2012 Reference Books: <ol style="list-style-type: none"> 1. Mark Nixon and Alberto S. Aquado, —Feature Extraction & Image Processing for Computer Vision, Academic Press, Third Edition,2012 2. Simon J. D. Prince, —Computer Vision: Models, Learning, and Inference, Cambridge University Press, First Edition, 2012 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.edx.org/course/computer-vision-image-analysis-1/ • http://www.cse.iitm.ac.in/~vplab/computer_vision.html • www.lms.ncuindia.edu/lms 			

COURSE TEMPLATE

1.Department:		Department of Computer Science and Engineering		
2.Course Name: Deep Learning		3. Course Code	4. L-T-P	5. Credits
		CSL312	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Introduction to AI and ML				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Understand concepts of neural networks and deep learning.			
CO 2	Implement Convolutional Neural Network.			
CO 3	Implement other Deep Learning Architectures, Autoencoder, Recurrent Neural Network and its variations. Applications in different domains.			
CO 4	Design Chatbots using (Natural language Processing) NLP.			
CO 5	Understand other deep learning topics such as optimization, attention models, transfer learning approach for various areas.			
9. Brief Syllabus: Introduction to ANN, Building an ANN, Evaluating, Improving and Tuning the ANN, Restricted , Boltzmann Machine ,CNN Introduction-Building a CNN, Evaluating, Improving and Tuning the CNN RNN Introduction - Building a RNN Evaluating, Improving and Tuning the RNN, LSTM, Boltzmann Machine Intuition, Building a , Boltzmann Machine, Auto Encoders Fundamentals Building an Auto Encoder, Types of Encoder, Deep Learning NLP Chat bots: Introduction to NLP (Natural Language Processing), Deep NLP Introduction, Building a ChatBot with Deep NLP.				
10.Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Ian Goodfellow ,Yoshua Bengio, Aaron Courville, <i>Deep Learning</i> , MIT Press, First Edition, 2016 2. Stephen Boyd, <i>Convex Optimization</i>, Cambridge University Press, First Edition, 2015 Reference Books: <ol style="list-style-type: none"> 1. Francois Chollet, <i>Deep Learning with Python</i>, Manning Publications, First Edition, 2018 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.coursera.org/learn/neural-networks-deep-learning • www.lms.ncuindia.edu/lms 				

PROGRAM ELECTIVES

FOR

CLOUD COMPUTING SPECIALIZATION

TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Programming for Data Science		3. Course Code	4. L-T-P	5. Credits
		CSL225	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
Course Outcomes (COs)				
8. On successful completion of this course students will be able to:				
CO 1	Understand and implement the basics of programming in Python.			
CO 2	Understand and implement the Collections in Python.			
CO 3	Apply Object Oriented Programming concepts on real world examples.			
CO 4	Apply the Numpy package for numerical calculations in Python.			
CO 5	Apply Pandas package for loading and preprocessing data in Python.			
CO 6	Implement various data visualization tools of Python on real world data.			
9. Brief Syllabus:				
<p>Introduction to Computer Science, Computer Algorithms, Computer Hardware , Operating Systems—Bridging Software and Hardware , Limits of Integrated Circuits Technology: Moore's , Computer Software , Procedural vs. Object-Oriented Programming, Literals , Variables and Identifiers , Operators, Expressions and Data Types, What Is a Control Structure, Boolean Expressions (Conditions), Relational Operators, Membership Operators, Selection Control, Multi-Way Selection, Iterative Control, While Statement , Infinite loops, Definite vs. Indefinite Loops, Boolean Flags and Indefinite Loops, List Structures, Common List Operations, Tuples , Nested Lists, For Loops , While Loops and Lists (Sequences), Assigning and Copying Lists , Dictionary Type in Python, Set Data Type , Program Routines , Defining Functions, More on Functions , Calling Value-Returning Functions, Calling Non-Value-Returning Functions, Parameter Passing, Arguments in Python Default Arguments in Python, Variable Scope, Recursive Function, Module Specification , Top-Down Design, Developing a Modular Design of the Calendar Year Program, Object-Oriented Programming concepts, Numpy - Creation on Array ,Array generation from Uniform distribution, Random array generation, reshaping, maximum and minimum, reshaping, Arithmetic operations, Mathematical functions, Bracket Indexing and Selection, Broadcasting, Indexing a 2D array (matrices); Pandas - Creating a Series - from lists, arrays and dictionaries, Storing data in series from intrinsic sources, Creating DataFrames, Imputation, Grouping and aggregation, Merging, Joining, Concatenation, Find Null Values or Check for Null Values, Reading data from csv, txt, excel, web, Visualization - Installing and setting up visualization libraries, Canvas and Axes, Subplots, Common plots – scatter, histogram, boxplot, Logarithmic scale, Placement of ticks and custom tick labels, Pandas Viz, Style Sheets, Plot type, Area, Barplots, Histograms, Line Plots, Scatter Plots, BoxPlots, Hexagonal Bin Plot, Kernel Density Estimation plot (KDE), Distribution Plots, Categorical Data Plots, Combining Categorical Plots, Matrix Plots, Regression Plots, Grids.</p>				
10. Books Recommended :				
Textbooks:				
1. Charles Dierbach., <i>Introduction to Python using Computer Science</i> , Wiley Publications, Second Edition, 2015 2. Mark Lutz , <i>Learning Python</i> , O'Reilly publications , Fifth Edition, 2015				
Reference Books:				
1. Paul Barry, <i>Head First Python</i> , Orielly Publications, Second Edition, 2010				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> www.lms.ncuindia.edu/lms https://swayam.gov.in/nd1_noc19_cs59/preview https://www.python.org/ 				

COURSE TEMPLATE

1.Department:		Department of Computer Science and Engineering		
2.Course Name: Introduction to Cloud Computing		3. Course Code	4. L-T-P	5. Credits
		CSL238	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Identify the Parallel and Distributed computing technologies involved in Cloud.			
CO 2	Explain the design principles involved in building a Cloud platform over virtualized clusters and data centers.			
CO 3	Analyze different performance metrics for evaluating Cloud Applications.			
CO 4	Prepare Cloud based applications that can scale out.			
CO 5	Apply task and data parallel distributed algorithms for Cloud.			
9. Brief Syllabus: Parallel and Distributed System Models, Cloud enabling technologies, Cloud Platform Architecture, Service Oriented Architecture, Cloud Programming and Software environments, Performance Scalability and Consistency on Cloud, Cloud Security. The course examines the most important APIs used in the Amazon and Microsoft Cloud, including the techniques for building, deploying, and maintaining machine images and applications. Students will learn how to use Cloud as the infrastructure for existing and new services, Amazon's Elastic Block Storage and Amazon's Virtual Private Cloud.				
10. Books Recommended: Textbooks: <ul style="list-style-type: none"> Distributed and Cloud Computing: From Parallel Processing to the Internet of Things by Kai Hwang, Jack Dongarra and Geoffrey Fox, Elsevier, 2012 Reference Books: <ul style="list-style-type: none"> Cloud Computing Principles and Paradigm by RajKumar Buyya, James Broberg and Andrzej Goscinski, John Wiley & Sons, 2011. Reference Websites: <ul style="list-style-type: none"> (https://aws.amazon.com/education/awseducate/) 				

COURSE TEMPLATE

1.Department:	Department of Computer Science and Engineering		
2.Course Name: Cloud Architecture	3. Course Code	4. L-T-P	5. Credits
	CSL337	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs)			
Possible usefulness of this course after its completion i.e. how this course will be practically useful to students once it is completed.			
CO 1	This module gives students the skills and knowledge to understand how Cloud Computing Architecture can enable transformation, business development and agility in an organization.		
CO 2	It provides a comprehensive view of storage and networking infrastructures for highly virtualized cloud ready deployments.		
CO 3	Understanding the concepts and features related to Virtualized datacenter and cloud, Information storage security and design, storage network design and cloud optimized storage.		
9. Brief Syllabus:			
This module gives students the skills and knowledge to understand how Cloud Computing Architecture can enable transformation, business development and agility in an organization. and provides a comprehensive view of storage and networking infrastructures for highly virtualized cloud ready deployments. The course discusses the concepts and features related to Virtualized datacenter and cloud, Information storage security and design, storage network design and cloud optimized storage.			
10.Books Recommended:			
Text Books:			
1. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010			
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach" McGraw-Hill Osborne Media; 1 edition [ISBN: 0071626948], 2009.			
Reference Books:			
• Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press; 1 edition [ISBN: 1439834539],2010			
• Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications [ISBN: 978-1439851739], 2011.			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2 Course Name: Virtualization & Cloud Computing		3. Course Code	4. L-T-P	5. Credits
		CSL338	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs)				
Possible usefulness of this course after its completion i.e. how this course will be practically useful to students once it is completed.				
CO 1	This module gives students the skills and knowledge to understand how Cloud Computing Architecture can enable transformation, business development and agility in an organization.			
CO 2	This course deals with management of complex virtual environments, analysis of key performance factors of virtualized systems.			
CO 3	The principal issues in troubleshooting virtual environments, evaluation of small-scale virtual environment developed in the lab.			
9. Brief Syllabus:				
The basic objective of this course is to gives students the skills and knowledge to understand how Cloud Computing can enable transformation, business development and agility in an organization. This course deals with management of complex virtual environments, analysis of key performance factors of virtualized systems, principal issues in troubleshooting virtual environments, evaluation of small-scale virtual environment developed in the lab.				
10. Books Recommended:				
Text Books:				
1. Abhay Bhadani, "Cloud Computing and Virtualization", VDM Verlag; ISBN-10: 9783639347777, 2011				
Reference Books:				
1. Dac-Nhuong Le, Raghvendra Kumar, Gia Nhu Nguyen and Jyotir Moy Chatterjee, "Cloud Computing and Virtualization", Wiley Online Library, Print ISBN:9781119487906 Online ISBN:9781119488149 DOI:10.1002/9781119488149				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Big Data on Cloud	3. Course Code	4. L-T-P	5. Credits
	CSL339	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to students once it is completed.			
CO 1	Evaluate the criteria for a Big Data solution		
CO 2	Understand the components of a Big Data solution		
CO 3	Compare the benefits and drawbacks of relational databases, NoSQL databases, and data warehousing solutions		
CO 4	Characterize potential use cases for the AWS big data ecosystem		
9. Brief Syllabus: In this, you will learn about Big Data and basic architecture, value, and potential use cases. The course introduces you to specifics of some key technologies, including Apache Hadoop, Amazon EMR, Apache Hive, and Apache Pig. Although the course focuses on industry-standard Big Data solutions, you will learn about the AWS Big Data ecosystem, a set of services and solutions provided by AWS to build and enhance Big Data solutions.			
10. Books Recommended: Text Books: <ol style="list-style-type: none"> 1. Boris Iublinky, Kevin t. Smith, Alexey Yakubovich, <i>Professional Hadoop Solutions</i>, Wiley, First Edition, 2015 2. Michael Minelli, Michehe Chambers, <i>Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business</i>, Wiley CIO Series, First Edition, 2013 Reference Books: <ol style="list-style-type: none"> 1. O'Reilly, White, <i>Hadoop: The Definitive Guide</i>, Third Edition, 2012. 2. Tom Plunkett and Brian Macdonald, <i>Oracle Big Data Handbook</i>, Oracle Press, 2014. 3. Furht, Borko, Villanustre, Flavio, <i>Big Data Technologies and Applications</i>, First Edition, Springer Series, 2016 Reference Websites: <ul style="list-style-type: none"> • (https://aws.amazon.com/education/awseducate/) • https://d0.awsstatic.com/whitepapers/Big_Data_Analytics_Options_on_AWS.pdf • https://www.coursera.org/specializations/big-data 			

COURSE TEMPLATE

1.Department:	Department of Computer Science and Engineering		
2.Course Name: Artificial Intelligence & Machine Learning on Cloud	3. Course Code CSL346	4. L-T-P 2-0-4	5. Credits 4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/>	Programme Elective <input checked="" type="checkbox"/>	Open Elective <input type="checkbox"/>
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to students once it is completed.			
CO 1	Identify the computing technologies involved in Cloud Machine Learning & AI.		
CO 2	Explain the design principles involved in building a Cloud.		
CO 3	Analyze different performance metrics for evaluating Machine Learning Fundamentals.		
CO 4	Prepare Cloud & Machine Learning applications that can scale out.		
CO 5	Apply task and deep learning concepts for Cloud.		
9. Brief Syllabus: Overview of Cloud, Overview to machine learning, this course will teach you how to get started with AWS Machine Learning. Key topics include: Machine Learning on AWS, storage and security on AWS, Big data query on AWS. Each topic consists of several modules deep-diving into variety of ML concepts as well as insights of AWS services to put the concepts into practice.			
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Cloud Computing Principles and Paradigm by RajKumarBuyya, James Broberg and Andrzej Goscinski, John Wiley & Sons, 2011. Ethem Alpaydin, "Introduction to Machine Learning", MIT press, 2004 Reference Books: <ol style="list-style-type: none"> T. Mitchell, "Machine Learning", McGraw-Hill, 1997. Reference Websites: <ul style="list-style-type: none"> (https://aws.amazon.com/education/awseducate/) 			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Cloud Application Development & Deployment		3. Course Code CSL445	4. L-T-P 2-0-4	5. Credits 4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to students once it is completed.				
CO 1	Articulate the basic concepts, key technologies, for AWS cloud deployment.			
CO 2	Understand the components of AWS cloud service provider.			
CO 3	Explore the various cloud services according to the market requirement.			
CO 4	Understanding and using the management tools for development & deployment.			
CO 5	Evaluate security issues while deploying cloud services.			
9. Brief Syllabus: This course will introduce students to Amazon Web Services (AWS) core services and infrastructure. Through demonstrations students will use and configure AWS services to deploy and host a cloud-native application. Early in the course, students will learn about how AWS cloud infrastructure is built, walk you through Amazon Elastic Compute Cloud (Amazon EC2) and Amazon Lightsail compute services. Networking on AWS, including how to set up Amazon Virtual Public Cloud (VPC) and different cloud storage options, including Amazon Elastic Block Storage (EBS), Amazon Simple Storage Service (S3) and Amazon Elastic File Service (EFS). Later in the course students will learn about AWS Database services, such as Amazon Relational Database Service (RDS) and Amazon DynamoDB. To monitor and scale you application on AWS using Amazon CloudWatch and Amazon EC2 Elastic Load Balancing (ELB) and Auto Scaling. Security on AWS, as well as how to manage costs when using the AWS cloud platform.				
10. Books Recommended: Text Books: <ul style="list-style-type: none"> • Rajkumar Buyya, James Broberg, Andrzej Goscinski, "CLOUD COMPUTING Principles and Paradigms", Wiley, 1 edition, 2011. • John W. Rittinghouse and Ames F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press, Taylor & Francis Group, 2nd edition, 2010. • Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley, 1st edition, 2010. Reference Books: <ul style="list-style-type: none"> • Vic (J.R.) Winkler, Securing the Cloud, "Cloud Computer Security Techniques and Tactics", Syngress Elsevier, 1st edition, 2011. • Barrie Sosinsky, "Cloud Computing Bible", Wiley, 1st edition, 2011. • Miller Michael, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Pearson Education India, 1st edition, 2008. Reference websites: <ul style="list-style-type: none"> • https://aws.amazon.com/education/awseducate/ • https://swayam.gov.in/nd1_noc19_cs64/preview • https://awseducate.instructure.com/courses/196 • https://awseducate.instructure.com/courses/197 				

COURSE TEMPLATE

1.Department:		Department of Computer Science and Engineering		
2.Course Name: Cloud Security		3. Course Code	4. L-T-P	5. Credits
		CSL446	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs)				
Possible usefulness of this course after its completion i.e. how this course will be practically useful to students once it is completed.				
CO 1	Articulate the main concepts, key technologies, strengths, and limitations of cloud computing.			
CO 2	Understand the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud and hybrid cloud			
CO 3	Acquaint with security and cloud computing architecture			
CO 4	Understand the difference between traditional security concerns and cloud security concerns.			
CO 5	Evaluate security issues with cloud infrastructure			
9. Brief Syllabus:				
<p>This course takes you on a tour of cloud computing systems and its security challenges. During this course, students will develop the necessary skills to identify possible security issues in the cloud environment. This course starts with basics of cloud, cloud security concepts covering encryption and presence of suspect in cloud, cloud security architecture and consequently discuss different ways to secure a cloud. In this course, students will be able to: Understand important concepts of cloud computing such as types of cloud computing, deployment model, virtualization, etc. Design, implement and manage complete cloud computing systems. Identify security issues in cloud computing and different ways to store data safely on cloud.</p>				
10. Books Recommended:				
Text Books:				
<ul style="list-style-type: none"> • Rajkumar Buyya, James Broberg, Andrzej Goscinski, "CLOUD COMPUTING Principles and Paradigms", Wiley, 1 edition, 2011. • John W. Rittinghouse and Ames F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press, Taylor & Francis Group, 2nd edition, 2010. • Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley, 1st edition, 2010. 				
Reference Books:				
<ul style="list-style-type: none"> • Vic (J.R.) Winkler, Securing the Cloud, "Cloud Computer Security Techniques and Tactics", Syngress Elsevier, 1st edition, 2011. • Barrie Sosinsky, "Cloud Computing Bible", Wiley, 1st edition, 2011. • Miller Michael, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Pearson Education India, 1st edition, 2008. 				
Reference websites:				
<ul style="list-style-type: none"> • https://aws.amazon.com/education/awseducate/ • https://swayam.gov.in/nd1_noc19_cs64/preview • https://awseducate.instructure.com/courses/196 • https://awseducate.instructure.com/courses/197 				

PROGRAM ELECTIVES FOR FULL STACK SPECIALIZATION TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Enterprise Web Applications		3. Course Code	4. L-T-P	5. Credits
		CSL273	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: FOCP-II (Java)				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Understand and apply the Type Hierarchy of Collections Framework and type safety features introduced in the Collections API			
CO 2	Understand & apply the basic concurrency constructs and able to synchronize threads using locks and semaphores			
CO 3	Develop applications which can connect to a relational database and apply different SQL based operations			
CO 4	Understand & apply Server-Side Web Application development using the Web components of Java EE			
CO 5	Understand & apply JSP and use JSP tag library for designing dynamic web pages Understand & apply JSP and use JSP tag library for designing dynamic web pages			
CO 6	Understand & apply software testing by performing unit tests and working with the logging service			
9. Brief Syllabus: <p>This course is on Advanced Java with engineering tools. The course is designed as an advanced course of java programming and assumes that students already have strong programming skills on J2SE (Java Standard edition). This intensive, hands-on course explores Java Enterprise Edition (J2EE) language features and packages by going deeper into programming topics that help understand concepts including the MVC Architecture, JDBC, Java Servlets, Java Server Pages and Unit Testing using Mockito & JUnit. By the end of this course the students will have sound knowledge of advanced java concepts and will be able to apply them for designing and developing java based interactive web applications.</p>				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Bryan Basham, Kathy Sierra & Bert Bates, "Head First Servlets & JSP", O'Reilly Media, 2nd Edition, 2009 2. Dreamtech Press, "Core & Advanced Java Black Book", Wiley India , 1st Edition, 2016 3. Brian R Jackson, "Maven The Definitive Guide", O'Reilly Media, 2nd Edition, 2015 4. Sujoy Acharya, "Mastering Unit Testing using Mockito and Junit", Pact Publications, 1st Edition, 2014 Reference Books: <ol style="list-style-type: none"> 1. Herbert Schildt, "Java : The Complete Reference", Oracle Press , 11th Edition, 2018 2. Joel Murach, Michael Urban, "murach's Java Servlets and JSP", Mike Murach & Associates, 3rd Edition, 2014 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.oracle.com/technetwork/java/javaee/documentation/index.html • https://docs.oracle.com/javaee/6/tutorial/doc/bnafd.html • https://docs.oracle.com/javaee/5/tutorial/doc/bnagx.html • https://maven.apache.org/guides/getting-started/ 				

COURSE TEMPLATE

1 Department:	Department of Computer Science and Engineering			
2. Course Name: Middleware Frameworks and ORM	3. Course Code	4. L-T-P	5. Credits	
	CSL274	2-0-4	4	
6. Type of Course (Check one):	Programme Core <input type="checkbox"/>	Programme Elective <input checked="" type="checkbox"/>	Open Elective <input type="checkbox"/>	
7. Pre-requisite(s), if any: Enterprise Web Applications				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Identifying contrast between traditional and modern ways of application development, thereby recognizing their applications and develop the understanding of core architecture of Spring Framework.			
CO 2	Understand and Apply the Aspect Oriented programming Methodology in Spring Framework.			
CO 3	Implementation of third-party integration with Spring for the web Application Development.			
CO 4	Understand and apply the concepts the basics of Object Relational Mapping in Spring Framework.			
CO 5	Understand the Server Side concepts for the development of java based interactive modular web application using Spring Framework.			
9. Brief Syllabus: This course covers the programming topics that help design modular and scalable java applications based on REST services and Hibernate. By the end of this course the students will have sound knowledge of the concepts that will enable them to simplify development and reduce code complexity with Spring and Hibernate while designing and developing java based interactive modular web applications.				
10. Books Recommended: Textbooks: 1. Pro Spring 5: An In-Depth Guide to the Spring Framework and Its Tools Reference Books: None Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • https://spring.io/				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: NoSQL Databases		3. Course Code	4. L-T-P	5. Credits
		CSL276	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Database Management Systems				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Understanding Mongo as a data store			
CO 2	Understanding common use-cases and architectures of Mongo			
CO 3	Performing database operations using Mongo's query and update languages			
CO 4	Query MongoDB using Mongo's JSON-based query language			
CO 5	Understanding the concepts of Graph Databases			
9. Brief Syllabus: NoSQL (Non-SQL or Not-only-SQL) databases are increasing in popularity due to the growth of data as they can store non-relational data on a large scale and can solve problems that regular databases can't handle. MongoDB is one of the popular database systems to store such kind of unstructured data. This course covers MongoDB, its configuration, data access, update and other operations on a No-SQL database. By the end of this course the students will be able to design a No-SQL database and will be able to query the database without SQL by using JavaScript Map and Reduce functions and also using HTTP to retrieve raw JSON data.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. Vaish G., Getting started with NoSQL. 1st ed. Packt Publishing, 2013. 2. Chodorow K., MongoDB: The Definitive Guide. 2nd ed. O'Reilly Media, 2013. Reference Books: <ol style="list-style-type: none"> 1. Fowler A., NoSQL for Dummies. 1st ed. Wiley Publishers, 2015. Reference Websites: <ul style="list-style-type: none"> • https://docs.mongodb.com/ • https://neo4j.com/wp-content/themes/neo4jweb/assets/images/Graph_Databases_for_Beginners.pdf 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Web Frameworks		3. Course Code	4. L-T-P	5. Credits
		CSL253	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Understanding the design of single-page applications and how Angular facilitates their development			
CO 2	Properly separating the model, view, and controller layers of an application			
CO 3	Developing Components using Type Script, Templates, and Decorators			
CO 4	Implementing dependency injections into Components and Services			
CO 5	Implementing server-side scripting using Node.js.			
9. Brief Syllabus: In enterprise environments, the architectural style of micro services is gaining momentum. This course explains why micro services are well-suited to modern cloud environments which require short development and delivery cycles. It covers characteristics of micro services, comparison of the micro service architecture with monolithic style and explains why micro services are well suited to continuous delivery. The course progresses to explain how the concept of micro services map to Cloud environments, the DevOps environments in which micro services run and the different tools to manage the complexity that micro services bring to the operational and production environment.				
10. Books Recommended: Textbooks: 1. Ng-Book, the complete book on Angular, Version 8 Reference Books: 1. Angular -2 Cookbook, Packt publications, 1 st Edition 2. Pro Angular – 6, by Adam Freeman, 2 nd Edition Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • https://angular.io/ • https://devdocs.io/angular/				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Mobile Application Development		3. Course Code	2. L-T-P	3. Credits
		CSL371	2-0-4	4
4. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
5. Pre-requisite(s), if any: None				
6. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	To understand and learn fundamentals of Dart Programming Language.			
CO 2	To understand the function programming and object-oriented Programming in DART.			
CO 3	To learn Flutter Mobile Development by building apps.			
CO 4	To design, build, and debug Flutter Android and iOS Apps by fetching data from Server.			
CO 5	Build Flutter apps to communicate with a real-time database and incorporating features which required Sensor and hardware API calls.			
7. Brief Syllabus: Introduction to Dart, Dart basics, Flutter Mobile Development Framework, Flutter: Dynamic App development, Database connectivity, Sensor and hardware API call.				
8. Books Recommended: Textbooks: 1. Rap Payne, Beginning App Development with Flutter, Apress Reference Books: 1. Eric Windmill, Flutter in Action, Manning Publications Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • https://dart.dev/ • https://flutter.dev/				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Devops	3. Course Code	4. L-T-P	5. Credits
	CSL373	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/>	Programme Elective <input checked="" type="checkbox"/>	Open Elective <input type="checkbox"/>
7. Pre-requisite(s), if any: FOCP II			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.			
CO 1	Understanding the objectives of DevOps and the associated vocabulary		
CO 2	Understanding DevOps relationship to Agile, Lean and ITSM		
CO 3	Building CI / CD pipeline		
CO 4	Applying automation practices including deployment pipelines and DevOps toolchains		
CO 5	Implementing DevOps scaling for enterprise		
9. Brief Syllabus: DevOps is a fast-growing field that bridges the gap between software developers and operations. This course is the first course of a two-course module and covers the foundational principles of DevOps involving continuous development and deployment, automation of configuration management, inter-team collaboration and IT service agility, using modern DevOps tools such as Git, Docker and Jenkins. The course will help become a DevOps practitioner who can apply the latest principles in DevOps methodology to automate software development lifecycle.			
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Gene Kim, Patrick Debois, John Willis, Jez Humble, "The Devops Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations", IT Revolution Press, 1st edition, 2016 Jennifer Davis, Ryn Daniels, "Effective DevOps: Building a culture of Collaboration, Affinity and Tooling at Scale" O'Reilly Media, 1st Edition, 2016 Reference Books: <ol style="list-style-type: none"> James Turnbull, 'The Docker Book: Containerization is the new virtualization', Amazon Asia-Pacific Holdings Private Limited, 1st edition Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.docker.com/solutions/cicd https://maven.apache.org/ https://kubernetes.io/docs/tutorials/ https://jenkins.io/doc/tutorials/ 			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Big Data		3. Course Code	4. L-T-P	5. Credits
		CSL311	2- 0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Data Engineering				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Deploy big data architecture for data analytics on cloud.			
CO 2	Understand various Big Data tools and terminologies and where they fit in the grand scheme of things.			
CO 3	Perform data preprocessing on large datasets.			
CO 4	Map big data concepts with potential use in a corporate environment.			
CO 5	Design predictive analytics projects on big data.			
9. Brief Syllabus: Characteristics of big data, Big Data and its importance, Challenges of big data, Big data applications, Hadoop Architecture, HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read NameNode, Secondary NameNode and DataNode, Hadoop Technologies – Cassandra, Understanding Inputs and Outputs of MapReduce, Elastic MapReduce on Cloud, Hadoop MapReduce paradigm Map and Reduce tasks, Cluster Setup , Getting Started with Spark, Setting up Python with Spark, RDD, Functional Programming, Local Virtual Box Set-up, Amazon Web Service (AWS) EC2 PySpark Set-up, Databricks Setup (Optional), AWS EMR Cluster Setup, Running Spark on a Cluster, SparkSQL, Spark DataFrame Basics, Spark Graph X, Collaborative Filtering for Recommender Systems, Natural Language Processing in Spark, Real-time analytics with Spark Streaming				
10. Books Recommended : Text Books: <ul style="list-style-type: none"> Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, <i>Professional Hadoop Solutions</i>, Wiley, First Edition, 2015 Michael Minelli, Michehe Chambers, <i>Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business</i>, Wiley CIO Series, First Edition, 2013 Reference Books: <ol style="list-style-type: none"> O'Reilly, White, <i>Hadoop: The Definitive Guide</i>, Third Edition, 2012. Tom Plunkett and Brian Macdonald, <i>Oracle Big Data Handbook</i>, Oracle Press, 2014. Furht, Borko, Villanustre, Flavio, <i>Big Data Technologies and Applications</i>, First Edition, Springer Series, 2016 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.coursera.org/specializations/big-data www.lms.ncuindia.edu/lms 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Micro service Based Applications		3. Course Code	4. L-T-P	5. Credits
		CSL374	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Middleware Frameworks & ORM				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Identifying the characteristics of micro services			
CO 2	Understanding the design differences between a micro service-based application and a monolithic application			
CO 3	Understanding various approaches used in deploying micro services			
CO 4	Decomposing a monolithic application into constituent micro services			
CO 5	Designing applications by employing micro services-based design approach			
9. Brief Syllabus: In enterprise environments, the architectural style of micro services is gaining momentum. This course explains why micro services are well-suited to modern cloud environments which require short development and delivery cycles. It covers characteristics of micro services, comparison of the micro service architecture with monolithic style and explains why micro services are well suited to continuous delivery. The course progresses to explain how the concept of micro services map to Cloud environments, the DevOps environments in which micro services run and the different tools to manage the complexity that micro services bring to the operational and production environment.				
10. Books Recommended: Textbooks: 1. Rajesh RV, "Spring 5.0 Micro services", Ingram short title, 2017 Reference Books: 1. John Carnell, "Spring Micro services in Action", Manning Publications; Pap/Psc edition, 2017 Reference Websites: • https://spring.io/				

PROGRAM ELECTIVES FOR GAME TECH SPECIALIZATION TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Game Design and Asset Creation		3. Course Code CSL 243	4. L-T-P 2-0-4	5. Credits 4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: No Pre-requisite required				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	The students will be able to do basic Drawing and apply principle of Design to create UI for game application.			
CO 2	The students will be able to create 2D Asset -Adobe Photoshop - Basic Tools.			
CO 3	Students will be able to understand the Game Art Creation Pipeline /Introduction to 2d and 3D Space.			
CO 4	The students will be able to understand Tools and Techniques: Polygon Modeling in 3D Studio Max.			
CO 5	They will understand and Learn the Advance tools - Material System, Texturing techniques in 3D Studio Max and Production Work Flow - 3Ds Max to Unity.			
CO 6	Students will understand what the essentials documentation for a game design are and will be able to develop and create a "Physical Board Game".			
9. Brief Syllabus: This is course students will learn to create 2D and 3D assets essentials for game development with introduction of the skills required to create 3D Models in Industry Standard 3D Software efficiently. Students will learn different methods of modelling and texturing, and how to achieve good topology in a 3D model. Students will have the ability to develop, discuss, and implement from preproduction, to production, Assets for video game Industry. Students will have the skills to model, articulate, and render game requirement. Students will learn professional terms relating to real-time game asset creation. Produce professional game model renderings and breakdowns for use in a portfolio. Be familiar with time management as per professional asset development pipelines. This module will also give a theoretical and conceptual understanding of the field of game design, along with practical exposure to the process of creating a game and understand what defines a "game" and the mechanics and rules behind different types of games. Topics covered include iteration, rapid prototyping, mechanics, dynamics, flow theory, the nature of fun, game balance, and user interface design. Primary focus is on non-digital games. By end of the module, students will be creating a physical board game as their final project				
10. Books Recommended : Text Books: 1. Luke Ahearn, 3D Game Textures: Create Professional Game Art Using Photoshop, Paperback – November 23, 2011. Reference Books: 1. Brathwaite & Schreiber, Challenges for Game Designers ,Course Technology 2. Koster, Theory of Fun for Game Design Links Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://area.autodesk.com/all/tutorials/3ds-max/ • https://www.lynda.com/3ds-Max-training-tutorials/138-0.html • http://docs.autodesk.com/3DSMAX/16/ENU/3ds-Max-Tutorials/ • https://www.udemy.com/course/3ds-max-modeling/?src=sac&kw=3d • https://www.udemy.com/course/learn-professional-2d-game-asset-graphic-design-in-photoshop/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Programming for Games		3. Course Code	4. L-T-P	5. Credits
		CSL 245	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Program Elective 1 - Game Design & Asset Creation				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO1	Students will be able to write C# program. Variables and Data types, and Comments. Introduction to Decision making statements (if, if-else, nested if, switch), Arithmetic operators, Relational operators, Logical operators, Assignment operators and Conditional operators and write Unity based C# Program .Object oriented programming.			
CO2	Students will be able to work on Unity 3D architecture, Editor basics, Game objects, Components, MonoBehaviour class and its lifecycle. Flappy bird.			
CO3	Students will be able to Setting up repository on Git, Branches, Pull requests and Merging, Space shooter game .			
CO4	Students will be independently Importing 2D Character from Asset Store/Library, Controlling 2D Character, Setting up the sprites for animations, Controlling the Movement of the Character (WASD and Mouse Click),Controlling Character Animations Base on the Movement			
CO5	They will understand Production Work Flow - 3Ds Max to Unity. Adding, Editing Colliders2D to 2D Assets, Animating UI,Adding Background Music, Adding Sound Effects, Using Audio and Sound Manager.			
CO6	Students will be independently able to develop a Platformer game with features like - Colliders2D to 2D Assets, Applying, Setting Riggidbody2D to Character, Adding Jump or fly to Character using Riggid body Force Interacting with Objects. Will also learn about use cases of coroutines and delegates.			
9. Brief Syllabus: This is an introductory course for students will learn how to program by creating your very own games using Unity3D, an industry-standard program used by many large gaming studios and indie developers across the world and Master basic game development (produce, test and present a beta version of a game of your own design). Understand game design and apply the concepts for game development. Students will also learn most common languages for game designers to learn are C++ and C# for unity will be able to operate and write Unity based C# program with Production Work Flow - 3Ds Max to Unity. By the end of the module, students will create a 2D platformer game.				
10. Books Recommended: Text Books: 1. Alex Okita, Learning C# Programming with Unity 3D,CRC Press,Taylor&Francis Group,2015 Reference Books: 1. C# 2010 for Programmers 4E 2. LEARNING C# BY DEVELOPING GAMES WITH UNITY 3D 3. LEARNING UNITY 2D GAME DEVELOPMENT BY EXAMPLE Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation web link) <ul style="list-style-type: none"> • https://unity3d.com/learning-c-sharp-in-unity-for-beginners • https://unity.com/how-to/programming-unity • https://www.udemy.com/course/3dmotive-intro-to-c-programming-and-scripting-for-games-in-unity/ 				

COURSE TEMPLATE

1.Department:	Department of Computer Science and Engineering		
2.Course Name: Advance Programming for games	3. Course Code	4. L-T-P	5. Credits
	CSL 244	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Program Elective 2 - Programming for Game			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Students will revise programming and will learn the advanced concepts in game design and development.		
CO 2	Understand the different types of axis in 3D game world, characters layout, polygon & vertex construction, characters rotations and angles.		
CO 3	Essential concepts for 3D Game Perspectives and Camera managements		
CO 4	Essential concepts for 3D Game Perspectives and Camera managements		
CO 5	Students will learn how to implement Game graphics, Core Meachincs,Game physics,sound,AI with help of a game		
9. Brief Syllabus: This Module introduces students to more advanced concepts in game design and development such as concept ideation, digital prototyping, Develop Games (3D), interface design, usability testing, communication, project scoping and management. Student will learn advanced game programming techniques, utilize industry-standard technologies, and apply your programming skills to animation, artificial intelligence and multiplayer systems. student will independently Identify, choose, and implement appropriate algorithmic, programming, and mathematical techniques to develop software components for various aspects of computer games, such as character control, scene management, artificial intelligence, graphics and animation. Create prototype games or game fragments by integrating original software components with existing professional tools, such as game engines, middleware, and common application programming interfaces also Test, debug, and optimize a game or game component to meet production requirements.			
10. Books Recommended : Text Books: 1. Mike McShaffry and David Graham, Game Coding Complete, Course Technology PTR, 4 th Edition Reference Books: 1. Unity Game Development Essentials 2. Learning programming with serious games 3. https://www.codingame.com/start 4. https://youtu.be/pTLCMZ_qvTw Reference Websites: : (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • https://academics.sheridancollege.ca/programs/game-development-advanced-programming • https://www.codingame.com/start • https://www.udemy.com/courses/search/?q=advanced%20game%20programming&src=sac&kw=advance%20programming%20for%20games			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Designing Human Computer Interfaces		3. Course Code CSL343	4. L-T-P 2-0-4	5. Credits 4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Program Elective 2 – Programming for Games				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Understand what HCI is, understand the history of HCI and discuss important aspects of interaction design.			
CO 2	Understand interactions from a user's perspective. Understand cognitive aspects of interactions.			
CO 3	Be able to discern what is important to evaluate the performance of a design, given the context, the task and the goals.			
CO 4	Students should have a basic practical understanding of how to design an experiment to evaluate a design			
CO 5	Students are exposed to techniques that are time and cost efficient to test their designs.			
9. Brief Syllabus: Human Computer Interaction (HCI) is a multidisciplinary area concerned with the design, evaluation. This course teaches students to design user interfaces based on the capabilities of computer technology and the needs of human factors. Students design a user interface for a system and implement a prototype from a list of informal requirements. In this course students design projects that are developed by current human-computer interaction principles and understand the User Centre Design (UDC) ,Graphic User Interface (GUI)Design &Aesthetics by Creating a prototype of HCI by end of the course.				
10. Books Recommended: Text Books: <ol style="list-style-type: none"> Dix, A., Finlay, J., Abowd, G.D., & Beale, R. (2004). Human computer interaction (3rd ed.). Prentice Hall. ISBN 0-13-046109-1. Reference Books: <ol style="list-style-type: none"> Preece, J., Rogers, Y., & Sharp, H. (2015). Interaction design: Beyond human-computer interaction (4th ed.) John Wiley & Sons Ltd. ISBN 978-1-119-02075-2. Designing and Analyzing HCI. Experiments. Thomas George. College of IST. Penn State University thomasg@ist.psu.edu. Jan 15, 2008 H. Nguyen, "Human Computer Interaction in Game Design", 2012. Retrieved from https://pdfs.semanticscholar.org/4869/a9cc94292332faee0b9e741bc93419d155a5.pdf Pedersen, R. 2003. Game Design Foundations. Plano: Wordware Publishing, Inc. Bates, B. 2004. Game Design, Second Edition. Boston: Course Technology. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.udemy.com/courses/search/?q=human%20computer%20interaction&src=sac&kw=human%20computer%20inter 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Cross Platform Game Development		3. Course Code	4. L-T-P	5. Credits
		CSL 246	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Program Elective 3 - Advance Programming for Game				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Students Understand how development is a combination of Design, Engineering, and Production for different platforms and What is cross platform development and its uses			
CO 2	Students will be able to Writing a common code and porting it to multiple platforms.			
CO 3	Students will be able to Creating a game for Android			
CO 4	Students will be able to Creating a game for iOS			
CO 5	Students will be able to Creating a game for Xbox One			
CO 6	Students will be able to Creating a game for PS4			
9. Brief Syllabus: In today's world, a growing trend called Bring Your Own Device (BYOD) is rising. In this course, students will learn the best practices and techniques, to build, publish, and maintain your games. Here students will take their game development skills to the next level by deploying your games to different cross platform like – Android, iOS, Xbox and PS4. It is necessary for games development for use across multiple platforms that operate on various networks and operating systems. This course provides practical and relevant skills to allow graduates to be proficient in cross-platform game development aspects such as their tools and programming languages. Graduates will have a deeper understanding of best practices and methods to develop games for a wider set of users.				
10. Books Recommended : Text Books: 1. Sergey Kosarevsky and Viktor Latypov, Android NDK Game Development Cookbook, Packt Publishing, Open source, November 25, 2013 Reference Books: 1. "Using DirectX11 in Unity 4". Unity Technologies. http://docs.unity3d.com/Documentation/Manual/DirectX11.html . Retrieved 19 February 2013. 2. "Unity - Multiplatform". Unity Technologies. http://unity3d.com/unity/multiplatform/ . Retrieved 5 February 2013. 3. IJARCSMS-CrossPlatformApplicationDevelopmentusingUnity3DGameEngine 4. CROSS-PLATFORM MOBILE APPLICATION DEVELOPMENT by Roman Khandozhenko Reference Websites: <ul style="list-style-type: none"> https://epdf.pub/cross-platform-game-programming-game-development15887.html https://www.awesometuts.com/ultimate-game-dev-academy-dis?utm_medium=youtube&utm_source=tutorial_video&utm_campaign=freecodecamp https://www.gamefromscratch.com/page/Game-Development-Tutorial-Series.aspx https://www.udemy.com/courses/search/?q=cross%20platform%20games&src=sac&kw=CrossPlatform%20for%20games 				

COURSE TEMPLATE

1.Department:	Department of Computer Science and Engineering		
2.Course Name: Augmented Reality Development	3. Course Code	4. L-T-P	5. Credits
	CSL 341	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Program Elective 2 - Programming for Game ,Program ,Elective 3 – Advance Programming for Game, Program ,Elective 5 – Cross Platform Game Development			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Students will understand different forms of Augmented Reality and their applications.		
CO 2	Students will be able to Developing an ARBook app that will detect multiple image targets. AR Concepts - Game World and UI		
CO 3	Students will creating an interactive business card using AR Virtual buttons.		
CO 4	Will create an AR application, which will detecting a real toy car using 3D Object tracking and superimposing a digital car on top of the real car. Interactive Games - Concept to Prototype using AR.		
CO 5	Students will learn and implement tracking of cylindrical objects and placing digital models surrounding the cylinder. Games/Applications Interactive using AR. Students will be able to create a marker based and non-marker based AR application.		
9. Brief Syllabus: Augmented reality [AR] is poised to revolutionize the way we understand the world by overlaying physical reality with real-time, interactive virtual content. AR will completely change the way users understand the world and their digital experience. AR will overlay the real world with games, adds, knowledge and much more. This course covers the concepts of Augmented Reality, equips graduates with the practical skills to develop games/applications using this emerging technology, and will break down complex AR concepts to make them easy to understand. Students will start with the fundamentals of augmented reality (AR), and how to build an AR experience using ARCore. Will also learn how to develop their own mobile AR applications in Unity for iOS and Android devices and about the features offered by Unity's AR Foundation, and about additional features in ARKit and ARCore. Using the very latest techniques recommended by Unity, Students would build a complete AR environment that you can continue to use after the course, while learning to apply best practices in user experience and interaction.			
12. Books Recommended : Text Books: 1. Jens Grubert, Raphael Grasset, Augmented Reality for Android, Application Development , Packt Publishing , edition 2013. Reference Books: 1. Unity Virtual Reality Projects by Jonathan Linowes 2. Holistic Game Development with Unity: An All-in-One 3. Guide to Implementing Game Mechanics, Art, Design and Programming by Penny de Byl Reference Websites: • https://docs.unrealengine.com/en-US/Platforms/AR/index.html • https://unity.com/unity/features/ar • https://unity.com/solutions/ar-and-vr-games			

COURSE TEMPLATE

1.Department:		Department of Computer Science and Engineering		
2.Course Name: Virtual Reality Development		1. Course Code	2. L-T-P	3. Credits
		CSL 345	2-0-4	4
4. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
5. Pre-requisite(s), if any: Programme Elective 3 - Advance Programming for games, Programme Elective 5- Cross Platform Game Development				
6. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Students will Understand how modern VR headsets "trick the brain" into believing it is somewhere else. In addition, create a 3D VR project targeting a device as simple as iOS/Android cardboard.			
CO 2	Create interactive VR game plays with advanced Unity features, including Ray Casting and Navigation (Path Finding).			
CO 3	Students will learn how to add support for Game Controllers and Cardboard "Screen Touch" button. Students will be able to Use Unity Remote to test things in the Editor.			
CO 4	Students will learn take advantage of Unity's Events to trigger actions on interactive objects, including loading scenes. Students will be able to Create interactive head's up 3D user interfaces.			
CO 5	Students will learn VR supported hardware like Oculus Rift and HTC Vive. Create an environment and set up game mode how it works with Unreal engine 4. Learn to build beautiful Virtual Reality experiences.			
CO 6	Learn to build a Game in Unreal engine - virtual reality space shooter game combined with real time strategy with a steady focus on cooperation and coordination among the team members during game-play.			
9.Brief Syllabus: Technology is rapidly changing and evolving, with virtual reality (VR) being one of the most popular tech trends today. This course covers the concepts of VR and equips graduates with the practical skills to develop games/applications using this emerging technology. With this new knowledge, graduates will be able to analyze, design, plan, and create game/applications that advantage VR technologies along with VR students will also cultivate the skills to design, program and develop Virtual Reality simulations. Virtual Reality being used to develop apps and experiences for a broad range of industries beyond games. You can do Architectural Visualization by walking around a building before it is built. This course makes understanding Unreal VR super easy. Not only do we show you how to use the engine's VR features, but also we teach you the fundamental concepts of VR development. By teaching you the fundamentals, in the rapidly developing VR space.				
10. Books Recommended : Text Books: 1. Jason Jerarld, Ph.D.The VR Book, Human-Centered Design for Virtual Reality,AMC Books, Reference Books: 1. Unity Virtual Reality Projects by Jonathan Linowes 2. Holistic Game Development with Unity: An All-in-One 3. One—The VR Book, Human-Centered Design for Virtual Reality.by Jason Jerarld, Ph.D. 4. Three—Unity Virtual Reality Projects by Jonathan Linowes 5. Dix, A., Finlay, J., Abowd, G.D., & Beale, R. (2004). Human computer interaction (3rd ed.). Prentice Hall. ISBN 0-13-046109-1. 6. Preece, J., Rogers, Y., & Sharp, H. (2015). Interaction design: Beyond human-computer interaction (4th ed.) John Wiley & Sons Ltd. ISBN 978-1-119-02075-2. Reference Websites: • https://unity.com/solutions/ar-and-vr-games • https://www.unrealengine.com/en-US/vr				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: XR Studio	3. Course Code	4. L-T-P	5. Credits
	CSL342	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/>	Programme Elective <input checked="" type="checkbox"/>	Open Elective <input type="checkbox"/>
7. Pre-requisite(s), if any: Programme Elective 3- Advance Programing for game , Programme Elective 6- AR Development , Programme Elective 7 – VR Development			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Students will learn the definition of Mixed Reality and how to move the first steps using Microsoft HoloLens. Students will be able to Understand the Microsoft Hololens towards the building of their first applications using Gaze, Gestures, Spatial Mapping and Spatial Sound.		
CO 2	Students will be able to working on Gaze, Gestures: Hand detected feedback, Gestures: Click on a model, Voice command, Spatial Mapping and Spatial Sound. Student will be able to Developing 1st Application in Mixed Reality.		
CO 3	Students will be able to Create a mixed reality project, which will be first hologram, project, Build and run your application.		
CO 4	Learn to build exciting AR apps with state-of-the-art tools. Students will Grasp this niche technology by creating AR applications using Play Canvas engine Publish and deploy your applications on various hardware devices. Create your 1st iOS app using Scene Kit, a high-level 3D-graphics framework		
CO 5	Students will gain a solid understanding of XR technology. And learn to create XR(AR/VR/MR) experiences as a Team or Individual that work with current hardware. In addition, will be getting an in-depth understanding of the computer AR/VR/MR landscape. Students will be able to Create a mixed reality project, which will be first hologram, project, Build and run your application.		
CO 6	Students will learn Controlling the Virtual Environment with HTC Vive Controllers and create a interactive MR Application. Students will be able to Create a mixed reality project, which will be first hologram, project, Build and run your application.		
9. Brief Syllabus:			
<p>This course designed to develop Interactive experiences using Mixed Reality software and hardware. Students will learn the fundamental concepts and applications of Mixed reality using a modern game engine and hardware platform. Students will also learn to appreciate the unique design opportunities inherent to the platform. To supplement and simulate the physical world, students will learn methods and practices to meaningfully integration of virtual content into physical world. In addition, in this course students will start of the Live Studio Environment, where students is briefed, and work on XR Projects. Each XR Project simulates real-world entertainment media, such as Games or Simulations. Advanced digital workflows and techniques are covered.</p>			
10. Books Recommended :			
Text Books:			
1. Jesse Glover, Jonathan Linowes, Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications, Packt Publishing, Edition 2018.			
Reference Books:			
1. The VR Book, Human-Centered Design for Virtual Reality.by Jason Jerarld, Ph.D.			
2. Unity Virtual Reality Projects by Jonathan Linowes			
3. One—The VR Book, Human-Centered Design for Virtual Reality.by Jason Jerarld, Ph.D.			
4. Three—Unity Virtual Reality Projects by Jonathan Linowes			
5. iPhone XR-XS: 2 in 1, The Complete Handy Guide To Use Your New iPhone To Its Fullest			
6. by Matthew Stone 2019			
Reference Websites:			
<ul style="list-style-type: none"> https://www.udemy.com/course/extended-reality-xr-building-ar-vr-mr-projects/ https://www.coursera.org/learn/xr-introduction 			

PROGRAM ELECTIVES

FOR

CYBER SECURITY & FORENSICS

SPECIALIZATION TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Secure Communication and Cryptography		3. Course Code	1. L-T-P	2. Credits
		CSL281	2-0-4	4
3. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
4. Pre-requisite(s), if any: Computer Networks				
5. Course Outcomes (COs)				
Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Develop a workable knowledge of the mathematics used in cryptography.			
CO 2	Select a secure communications solution from range of possibilities			
CO 3	Analyze the vulnerabilities/ mistakes in existing systems, hence will be able to design a security solution.			
CO 4	Apply authentication techniques to ensure integrity of data.			
CO 5	Review the principles of asymmetric cryptography and describe how the use of the pair of keys can provide different security properties.			
CO 6	Understand and recognize the security issues involved within network.			
6. Brief Syllabus:				
<p>This course deals with the underlying principles of cryptography, an indispensable tool for protecting information in computer system. In this course, students will acquire knowledge on standard algorithms used to provide confidentiality, integrity, and authenticity. Starting from the classical ciphers to modern day ciphers, the course provides exposure regarding construction and cryptanalysis of symmetric key ciphers. It also covers stream cipher, public key ciphers, key exchange algorithm, one way functions, Message Authentication Codes (MAC) and signature schemes. Finally, it concludes with the design rationale of network protocols for key exchange.</p>				
10. Books Recommended:				
Textbooks:				
1. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill, 3 rd Edition, 2016 2. W. Stallings, "Cryptography and Network Security", Pearson Education, 4 th Edition, 2009				
Reference Books:				
1. Bruce Schneier, "Applied Cryptography", John Willey sons, 2 nd Edition, 2008 2. Atul Kahate, "Cryptography & Network Security", Pearson Education, 4 th Edition, 2009				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> https://nptel.ac.in/syllabus/syllabus.php?subjectId=106105031 https://www.cybrary.it/course/cryptography/ https://nptel.ac.in/syllabus/syllabus.php?subjectId=106105162 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Secure Coding and Vulnerabilities		3. Course Code	4. L-T-P	5. Credits
		CSL283	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: FOCP-I				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Understand the need for secure coding and follow fundamental secure coding guidelines.			
CO 2	Describe and compare software engineering practices and apply reverse engineering on vulnerable software.			
CO 3	Develop skills to find the low-level vulnerabilities in software application and exploit these vulnerabilities using buffer overflow attack			
CO 4	Identify the vulnerabilities of database in the web application and fix these vulnerabilities.			
9. Brief Syllabus: This course deals with security architecture elements within modern object-oriented programming languages that create the framework for secure programming. This course would cover the design and implementation of secure systems. Coding Standards, best practices, guidelines and style will further enhance the ability to develop secure code. This course includes common software vulnerabilities and how to find them, as well as how the vulnerabilities can be exploited using reverse engineering & its tools. It also includes how buffer overflow attack happens and how attackers utilize it to gain access to the vulnerable system. Finally, at the end popular web SQL injection attack, and their common defense is implemented.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Gray R., "Software Security, "Building Security In", Addison-Wesley Software Security, 2nd Edition, 2006 Dafydd stuttard, Marcus Pinto, "The Web Application Hacker's Handbook", Wiley Publishing, 2nd Edition, 2011 Reference Books: <ol style="list-style-type: none"> Kenneth van Wyk, Mark Graff, Secure Coding: Principles and Practices, O'Reilly Media 2nd Edition, 2003 Robert C. Seacord, "Secure Coding in C and C++ ", SEI Series in Software Engineering, 2nd Edition, 2013 Michael Howard, David LeBlanc, "Writing Secure Code", 2nd Edition, 2003 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://nptel.ac.in/noc/individual_course.php?id=noc19-cs29 https://www.cybrary.it/course/cryptography/ https://nptel.ac.in/courses/106106199/ https://www.cybrary.it/course/secure-coding/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
1. Course Name: Digital Forensics and Malware Analysis		2. Course Code	3. L-T-P	4. Credits
		CSL284	2-0-4	4
5. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
6. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Understand and apply digital forensics investigation techniques to forensically investigating Windows systems that conform to accepted professional standards			
CO 2	Apply digital forensics investigation techniques to forensically investigating Linux systems that conform to accepted professional standards			
CO 3	Perform investigation using network logs and mobile devices			
CO 4	Carry out in-depth analysis of modern malware samples using both static and dynamic analysis techniques.			
CO 5	Analyzing memory to assess malware characteristics and reconstruct infection artifacts			
CO 6	Apply techniques and concepts to unpack, extract, decrypt, or bypass new anti-analysis techniques in future malware samples			
9. Brief Syllabus:				
<p>Digital forensics course plays very crucial role in investigating computer related crime. In this course, the different methods for the identification, investigation and analysis of digital evidences are examined. The course aims to present these concepts in a general setting that is not tied to one particular operating system. During this course, students will learn about core forensics procedures to ensure court admissibility of evidence. This course also includes the different methods for the identification, investigation and analysis of malicious code using various network and system-monitoring tools to examine and assess how malware interacts with the file system, registry, network and other processes in order to detect, analyze, understand, control, and eradicate malware. Further, the students will be able to utilize memory forensic techniques to examine, predict and compare capabilities of malware. It blends theoretical concepts with lots of real life examples and case studies to ensure practical exposure and through understanding all the digital forensics artifacts.</p>				
10. Books Recommended :				
Text Books:				
1. John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", Firewall Media, Second Edition, 2019 2. Shiva V.N. Parasram, "Digital Forensics with Kali Linux: Perform data acquisition, digital investigation, and threat analysis using Kali Linux tools", Packt Publishing; 1 edition, 2017 3. M. Sikorski & A. Honig, "Practical Malware Analysis: The Hands- on Guide to Dissecting Malicious Software", No Starch Press, 1st Ed, 2012 4. M.H. Ligh, S. Adair, B. Hartstein & M. Richard, "Malware Analyst's Cookbook and DVD: Tools and Techniques for Fighting Malicious Code", Wiley Publishing, 1st Ed, 2010				
Reference Books:				
1. N. Jaswal, "Hands-On Network Forensics: Investigate network attacks and find evidence using common network forensic tools" Packt Publishing; 1 edition, 2019 2. R. B. Blunden, "The Rootkit Arsenal: Escape and Evasion in the Dark Corners of the System", Jones & Bartlett Publishers, 2nd Ed, 2012				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> https://www.udemy.com/digital-forensic-series-computer-forensics/ https://www.udemy.com/learning-computer-forensics-with-infinite-skills/ https://github.com/volatilityfoundation/volatility/wiki https://support.accessdata.com/hc/en-us/articles/204056525-FTK-User-Guide https://sleuthkit.org/autopsy/docs/user-docs/4.0/ 				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Network Security	3. Course Code	4. L-T-P	5. Credits
	CSL383	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Computer Networks			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Understanding security architectures, protocols and services in both wired and wireless networks		
CO 2	Understand the role of AAA and IPSec in securing networks		
CO 3	Discover, analyze and identify security issues in the network		
CO 4	Evaluate the use of an IDS and IPS in a working environment		
CO 5	Apply security mechanisms, security policies, security components (such as protection domains and firewalls), port security and protection to secure networks.		
9. Brief Syllabus: This course delivers the technical knowledge, insight, and hands-on training students need to identify attacks on network with confidence. This course covers various aspects of network security including security issues in different layers of networks, intrusion detection, prevention and defense against cyber-attacks. Students will be guided through a series of laboratories and experiments in order to understand and analyze different attack/defend scenarios and determine the effectiveness of particular defense deployments against attacks			
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. B William Stallings, " Network Security Essentials (Applications and Standards)", Pearson Education., 5th Edition,2011 2. Ryan Russell, " Hack Proofing your network ", Wiley,2nd Edition,2002 Reference Books: <ol style="list-style-type: none"> 1. Karen Scarf one, "Guide to Intrusion and prevention System", NIST Special Publication, 2nd Edition,2007 Reference Websites: <ul style="list-style-type: none"> • https://nptel.ac.in/syllabus/syllabus.php?subjectId=106105031 • https://www.cybrary.it/course/security-for-beginners/ 			

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Web And Mobile Security	3. Course Code	4. L-T-P	5. Credits
	CSL387	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Develop skills to understand the strengths and weaknesses in web.		
CO 2	Ability to discover, analyze and identify vulnerabilities in web and mobile applications.		
CO 3	Insights into common web attacks and countermeasures.		
CO 4	Identify concrete threats against mobile application and exploits.		
CO 5	Applying best practices to secure web and mobile application.		
9. Brief Syllabus: This course offers you the knowledge and skills to build better and more secure web and mobile applications. It starts with importance of web security, working of web, strengths and weakness of web, factors that makes web vulnerable, and illustrates fundamental countermeasures that every web application should implement. Throughout the course, you will gain insights into the threats that modern web applications face and their countermeasures; not only in theory, but also in practice. Later on, this course focuses on various mobile threats and exploits. Particularly, this course emphasize on android applications as these applications are the biggest surface of attacks.			
10. Books Recommended : Textbooks: <ol style="list-style-type: none"> Bryan Sullivan and Vincent Liu, "Web Application Security: A beginner Guide", McGraw-Hill Education, 1st edition, 2011. Steven Furnell, "Mobile Security: a pocket Guide", IT Governance Publishing, 1st Edition, 2009. Reference Books: <ol style="list-style-type: none"> Nikolay Elenkov, "Android Security Internals: An In-Depth Guide to Android's Security Architecture", No Starch Press, 1st Edition, 2014. Ben Walther and Paco Hope, "Web Security Testing Cookbook: Systematic Techniques to Find Problems fast", O'Reilly Media; 1st edition, 2008. Reference Websites: <ul style="list-style-type: none"> https://www.udemy.com/course/web-application-security/ https://www.iisecurity.in/courses/mobile-security-training-course.php https://www.elearnsecurity.com/course/mobile_application_security_and_penetration_testing/ 			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Risk Analysis & Assessment		3. Course Code	4. L-T-P	5. Credits
		CSL385	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: NA				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Manage Risks by Identifying assets, discovering threats and vulnerability and provide direction for security activities by framing of information security policies, procedures, standards and guidelines			
CO 2	Perform Quantitative and Qualitative risk assessment on the identified risk.			
CO 3	Describe the various access control approaches including technical and non-technical to mitigate risk			
CO 4	Define level of risk tolerance and appropriate protections to reduce or remove risks.			
CO 5	Provide compliance for an organization to improve security values			
CO6	Manage incidents of an organization			
9. Brief Syllabus: The goal of this course is to introduce a suite of risk analysis and assessment techniques to the students. It will assist students to develop an understanding of the fundamentals of risk management and to introduce classical as well as state-of-the-art risk analysis techniques. In this course, student will learn about risk management process, cyber risk exposures, cyber insurance, regulatory environment and how cyber risk management applies to the enterprise. Further, it covers risk assessment, mitigation and treatment of critical risk communication. At the end of this course, student will be able to identify information security related threats, vulnerability; Determine the risk level, define controls and safeguards and utilize a range of popular risk analysis techniques innovatively to examine risk problems				
10. Books Recommended : Text Books: 1. Swiderski, Frank and Syndex, "Threat Modeling", 1 st Edition , Microsoft Press, 2004. Reference Books: 1. Andy Jones, and Debi Ashenden, " Risk management for computer security: Protecting your network and information assets", 1 st Edition, Butterworth-Heinemann, 2005. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.udemy.com/course/risk-management-for-cybersecurity/learn/lecture/8987968?start=0#overview http://csrc.nist.gov/publications/nistpubs/800-39/SP800-39-final.pdf https://www.sans.org/reading-room/whitepapers/auditing/introduction-information-system-risk-management-1204 eBooks: <ul style="list-style-type: none"> https://www.pdfdrive.com/it-governance-an-international-guide-to-data-security-and-iso27001iso27002-e185943941.html https://www.pdfdrive.com/risk-modeling-assessment-and-management-e158542980.html 				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Cloud Security Essentials	3. Course Code	4. L-T-P	5. Credits
	CSL384	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Articulate the main concepts, key technologies, strengths, and limitations of cloud computing.		
CO 2	Understand the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc		
CO 3	Acquaint with security and cloud computing architecture		
CO 4	Understand the difference between traditional security concerns and cloud security concerns.		
CO 5	Evaluate security issues with cloud infrastructure		
9. Brief Syllabus: This course takes you on a tour of cloud computing systems and its security challenges. During this course, students will develop the necessary skills to identify possible security issues in the cloud environment. This course starts with basics of cloud, cloud security concepts covering encryption and presence of suspect in cloud, cloud security architecture and consequently discuss different ways to secure a cloud. In this course, students will be able to: Understand important concepts of cloud computing such as types of cloud computing, deployment model, virtualization, etc. Design, implement and manage complete cloud computing systems. Identify security issues in cloud computing and different ways to store data safely on cloud.			
10. Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "CLOUD COMPUTING Principles and Paradigms", Wiley, 1 edition, 2011. 2. John W. Rittinghouse and Ames F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press, Taylor & Francis Group, 2nd edition, 2010. 3. Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing", Wiley, 1st edition, 2010. Reference Books: <ol style="list-style-type: none"> 1. Vic (J.R.) Winkler, Securing the Cloud, "Cloud Computer Security Techniques and Tactics", Syngress Elsevier, 1st edition, 2011. 2. Barrie Sosinsky, "Cloud Computing Bible", Wiley, 1st edition, 2011. 3. Miller Michael, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", Pearson Education India, 1st edition, 2008. Reference websites: <ul style="list-style-type: none"> • https://aws.amazon.com/education/awseducate/ • https://swayam.gov.in/nd1_noc19_cs64/preview • https://awseducate.instructure.com/courses/196 • https://awseducate.instructure.com/courses/197 			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Blockchain		3. Course Code	4. L-T-P	5. Credits
		CSL382	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Secure communication and Cryptography				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him/her once it is completed				
CO 1	Develop a strong grasp of blockchain technology and its underlying mechanism.			
CO 2	Understand the work flow behind bitcoin and various consensus mechanism.			
CO 3	Identify some of the immediate blockchain use cases in technology, business and enterprises.			
CO 4	Design their own cryptocurrency and decentralized network.			
CO 5	Identify the regulations and challenges in adoption of Blockchain Technology			
9. Brief Syllabus: This course introduces blockchain, a revolutionary technology that enables peer-to-peer transfer of digital assets without any intermediaries. It is designed to provide students with an understanding of key concepts and developments around cryptocurrencies and distributed ledger systems. It develops a basic understanding of blockchain technology while covering basic properties of bitcoin, the mechanics behind it (e.g. including cryptographic hash functions, Bitcoin Script, privacy, and hash commitment schemes). It also demonstrates some of the blockchain use cases in technology, business and enterprise products. Other aspects of course include building a blockchain network and cryptocurrency and challenges in adoption of blockchain technology.				
10. Books Recommended: Textbooks: 1. Antonopoulos A.M., Mastering Bitcoin. 2nd ed. O'Reilly Media, 2017. Reference Books: 1. Raj K., Foundation of Blockchain: The pathway to cryptocurrency and decentralized blockchain application. 1st ed. Packt Publishing Ltd, 2019. Reference Websites: <ul style="list-style-type: none"> • https://www.edx.org/course/bitcoin-and-cryptocurrencies • https://www.udemy.com/blockchain-and-bitcoin-fundamentals/ • https://syllabimedia.s3.amazonaws.com/prod/2018C-LGST299401-6694b431.pdf • https://unglueit-files.s3.amazonaws.com/ebf/05db7df4f31840f0a873d6ea14dcc28d.pdf • https://www.udemy.com/the-basics-of-blockchain/ • https://www.coursera.org/learn/cryptocurrency?utm_medium=email&utm_source=marketing&utm_campaign=NZAGsNJTEeiWlbMCW244MA 				

PROGRAM ELECTIVES FOR BLOCKCHAIN SPECIALIZATION TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Mathematics of Modern Cryptography		3. Course Code	4. L-T-P	5. Credits
		CSL 239	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Develop cryptography and network security concepts and application			
CO 2	Review the mathematical foundations on which modern Asymmetric or public-key cryptosystems are based			
CO 3	Understand the workings of different Asymmetric techniques and cryptosystems and analyze the security of these systems			
CO 4	Detailed understanding of the inner workings of Digital Signatures and hence able to digitally sign emails and files			
CO 5	Apply Authentication and Hashing techniques to ensure integrity of data.			
9. Brief Syllabus: Cryptography is an indispensable tool for protecting information in computer systems. It deals with the mathematics behind the theory of public key cryptosystems and digital signature schemes. This course will cover essentials of cryptography topics that relate to blockchain technology and provide exposure to the students about the events or transactions that are secured cryptographically in blockchain. It will cover the core cryptographic techniques with an emphasis on those parts more relevant to Blockchain. The course will include concepts like public-key Cryptography, Hashing, Digital signatures, Zero Knowledge Proof etc. which are used for wallets, transactions, security, and privacy-preserving protocols in blockchain.				
10 Books Recommended: Textbooks: <ol style="list-style-type: none"> 1. B. A. Forouzan, "Cryptography & Network Security", Tata Mc Graw Hill, 3rd Edition, 2016 2. W. Stallings, "Cryptography and Network Security", Pearson Education, 6th Edition, 2013 Reference Books: <ol style="list-style-type: none"> 1. W. Stallings, "Network Security Essentials Applications and Standards", Pearson Education, 2nd Edition, 2003. 2. Bruce Schneier, "Applied Cryptography", John Willey Sons, 2nd Edition, 2008 3. Atul Kahate, "Cryptography & Network Security", Pearson Education, 4th Edition, 2009 4. J. Hoffstein, J. Pipher, J.H. Silverman, "An Introduction to Mathematical Cryptography", 2nd Edition, Springer, 2010 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.coursera.org/learn/crypto-hashing • https://www.coursera.org/learn/asymmetric-crypto • https://nptel.ac.in/syllabus/syllabus.php?subjectId=106105031 • https://nptel.ac.in/syllabus/syllabus.php?subjectId=106105162 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Introduction to Blockchain Technologies		3. Course Code	4. L-T-P	5. Credits
		CSL 247	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Develop a workable knowledge of basic concepts of blockchain technology and its underlying mechanisms.			
CO 2	Understand cryptographic primitives in blockchain and its impact on implementation related decisions.			
CO 3	Review the principles behind various consensus mechanism models			
CO 4	Define a currency and analyse the workflow behind bitcoin.			
CO 5	Determine smart contract use cases and deploy a minimalist blockchain application.			
CO6	Understand and get familiar with different blockchain platforms.			
9. Brief Syllabus: This course deals with the fundamental components of Blockchain and its potential applications. The course will introduce the students with the theoretical as well as practical aspects of distributed ledger systems and cryptocurrencies. It will develop a strong understanding of the basic concepts underlying the blockchain technology while covering the essential mechanisms, cryptographic principles and consensus building. Further the course equip students with key concepts and developments around cryptocurrencies, Bitcoin and smart contracts .It also demonstrates some of the blockchain use cases in technology, business and enterprise products.				
10. Books Recommended : Text Books: <ol style="list-style-type: none"> Bettina Warburg, Bill Wanger, Tom Serres , “Basics of Blockchain: A guide for building literacy in the economics, technology, and business of blockchain”, Independently Published (2019). Arvind Narayanan , Joseph Bonneau , Edward Felten , Andrew Miller, Steven Goldfeder,” Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction”, Princeton University Press (2016). Reference Books: <ol style="list-style-type: none"> Raj K., Foundation of Blockchain: The pathway to cryptocurrency and decentralized blockchain application.1st ed. Packt Publishing Ltd, 2019. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.edx.org/course/bitcoin-and-cryptocurrencies https://www.udemy.com/blockchain-and-bitcoin-fundamentals/ https://syllabimedia.s3.amazonaws.com/prod/2018C-LGST299401-6694b431.pdf https://unglueit-files.s3.amazonaws.com/ebf/05db7df4f31840f0a873d6ea14dcc28d.pdf https://www.udemy.com/the-basics-of-blockchain/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Bitcoin and Cryptocurrency Technologies		3. Course Code	4. L-T-P	5. Credits
		CSL 355	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: Introduction to Blockchain Technologies				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him/her once it is completed				
CO 1	Develop a workable knowledge of basic properties and challenges associated with crypto currencies.			
CO 2	Understand the mechanics behind working of bitcoin.			
CO 3	Discover the storage mechanisms of bitcoin and gain insights on bitcoin exchanges .			
CO 4	Analyse different mining strategies for bitcoin and identify the regulations behind the technology.			
CO 5	Discover and evaluate other crypto currencies and compare them with bitcoin.			
9. Brief Syllabus: This course introduces the fundamental concepts behind bitcoin and crypto currencies. The course will provide the students with a strong knowledge about the evolution of crypto currency before covering the practical aspects of bitcoin. The students will get an exposure to the mechanics behind the bitcoin including the scripts, wallets and transactions. The course will cover implementation of decentralization and storage of bitcoins. The course includes different mining strategies and the key regulatory guidelines formulated for use of crypto currencies. It will also cover basics of another crypto currency – Altcoin and its comparison with the bitcoin.				
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Narayanan, Bonneau, Felten, Miller and Goldfeder, "Bitcoin and Cryptocurrency Technologies", Princeton University Press, 1st Edition, 2016. Antonopoulos A.M., "Mastering Bitcoin", O'Reilly Media, 2nd Edition, 2017. Reference Books: <ol style="list-style-type: none"> Raj K., Foundation of Blockchain: The pathway to cryptocurrency and decentralized blockchain application. 1st ed. Packt Publishing Ltd, 2019. Reference Websites: <ul style="list-style-type: none"> https://www.edx.org/course/bitcoin-and-cryptocurrencies https://www.coursera.org/learn/cryptocurrency 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Smart Contracts		3. Course Code	4. L-T-P	5. Credits
		CSL356	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Introduction to Blockchain Technologies				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Develop a workable knowledge of basic concepts of smart contracts and ethereum blockchain			
CO 2	Understand cryptographic primitives in blockchain and its impact on implementation related decisions.			
CO 3	Review the principles behind various consensus mechanism models			
CO 4	Define a currency and analyse the workflow behind bitcoin.			
CO 5	Determine smart contract use cases and deploy a minimalist blockchain application.			
9. Brief Syllabus: This course deals with understanding the concepts behind smart contracts which is the computational element of Blockchain Technology. It will cover Ethereum fundamentals and Solidity language programming basics for deployment of smart contracts. In this course, students will learn to design, code, deploy and execute smart contracts. Testing and deployment for smart contracts will be done using the Remix development environment. The course also covers concepts on how to interact with smart contracts as well as the security aspects.				
10. Books Recommended : Text Books: <ol style="list-style-type: none"> Hands-On Smart Contract Development with Solidity and Ethereum Reed, Jeff (2016). Smart contracts: The essential guide to using blockchain smart contracts for cryptocurrency exchange. CreateSpace Independent Publishing Platform. (ISBN-13: 9781539457442). Reference Books: <ol style="list-style-type: none"> Ritesh Modi , "Solidity Programming Essentials", Packt Publishing, April 2018 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> Smart Contracts, University at Buffalo(Coursera) Practical Blockchain & Smart Contracts : Ethereum & Solidity(Udemy) 				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Blockchain for Cyber Security	3. Course Code	4. L-T-P	5. Credits
	CSL357	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Understand the cyber threat landscape and Security Challenges		
CO 2	Provides blockchain solution to the existing Two Factor Authentication credential-based protection system		
CO 3	Describe blockchain based DNS solution to transform its current challenging functionality		
CO 4	Deploying Blockchain-Based DDoS Protection to defend organizations from such massive attack operations		
CO 5	Identify solutions in future for existing problems with blockchain technology		
9. Brief Syllabus: Blockchain plays a crucial role in transforming cybersecurity solutions. This course introduces common cyberthreat landscape and common attacks such as malware, phishing, insider threats, and DDoS. It explains how Ethereum architecture fit into the cybersecurity ecosystem. This course deals with adaptation of security triad with Blockchain. In this course student will be able to build Blockchain-based apps for two factor authentication, DDoS protection and develop Blockchain-based Public Key Infrastructure solutions and apps for storing DNS entries. This course also gives exposure to identify and resolve security issues with smart contracts and explains how defenders including government bodies and businesses are preparing themselves to defend their assets from adversaries. It Integrates the blockchain technology into the current business processes to make them secure.			
10. Books Recommended : Text Books 1. Rajneesh Gupta, Hands-On Cybersecurity with Blockchain, Pack Publishing, 1 st Edition, 2018 Reference Books 1. Srinivas Mahankali Blockchain the Untold Story, 2 nd edition, 2017 Reference Weblinks: <ul style="list-style-type: none"> • PKI - Public Key Infrastructure at https://www.ssh.com/pki/. • https://www.nist.gov/itl/tig/back-basics-multi-factor-authentication. • https://www.dns-oarc.net/. 			

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Blockchain Technology in Web Development	3. Course Code	4. L-T-P	5. Credits
	CSL 358	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Understand and Design a basic web page by using HTML5, CSS		
CO 2	Gain an in-depth understanding of blockchain and the environment setup, Build Dynamic web pages using Client-side JavaScript Programming		
CO 3	Develop JavaScript enabled Blockchain applications and JS with webpack		
CO 4	Design server-side application with Node JS and Web3 JS for Blockchain web applications		
CO 5	Apply Database Connectivity with interactive Web pages		
9. Brief Syllabus: This course is designed to expertise in developing interactive web applications using Blockchain technology with minimum effort. It covers basic designing of web pages, type of scripting and includes client-side scripting with JavaScript enabled Blockchain applications. Further, it includes server-side scripting with Node.js, Web3.js for Blockchain web applications. By the end of this course, students will acquire knowledge and skills for creation of Website considering both client and server-side Programming with database connectivity using MySQL, SQLite, PostgreSQL. This course will also Integrate blockchain technology into the current web applications to make them secure.			
10. Books Recommended: Textbooks: 1. E. Traub, "Learn Blockchain Programming with JavaScript", Packt Publishing, 1 st Edition, 2018 Reference Books: 1. Narayan Prusty, Building Blockchain Projects, Packt Publishing, 1 st Edition, 2017 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • https://www.udemy.com/course/build-a-blockchain-in-javascript/			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Security and Privacy for Big Data Analytics		3. Course Code CSL 449	4. L-T-P 2-0-4	5. Credits 4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed				
CO 1	Understand basic concepts of Big Data and enabling tools and terminologies.			
CO 2	Develop a workable knowledge blockchain oriented tools for data privacy and security.			
CO 3	Review the role of big data in cryptocurrency.			
CO 4	Analyse the techniques for bitcoin visualisation.			
CO 5	Recognise and understand the strategies for adopting blockchain into data science workflows.			
9. Brief Syllabus: This course deals with fusing of big data with blockchain. It will cover the security and privacy aspects of big data including the threats and security goals. The course will familiarize the students with the big data enabling technologies like Map reduce, Apache Hadoop. Starting from how blockchain solves big data problems using decentralized tools and data monetization to big data enabled cryptocurrency, the course includes blockchain data visualization techniques. Finally, it concludes blockchain applications and use cases in big data.				
10. Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Neeraj Kumar, N. Gayathri, Md Arafatur Rahman, B. Balamurugan , "Blockchain, Big Data and Machine Learning Trends and Applications", CRC Press, 2020. 2. Michael Minelli, Michehe Chambers, " Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business" , Wiley CIO Series, First Edition, 2013. Reference Books: <ol style="list-style-type: none"> 1. Hossein Hassani, Xu Huang, Emmanuel Sirimal Silva, "Fusing Big Data, Blockchain and Cryptocurrency: Their Individual and Combined Importance in the Digital Economy", Palgrave Pivot, 2019. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://blockchaintrainingalliance.com/products/data-science-and-blockchain#outline • https://s3.us-east-2.amazonaws.com/brightline-website/downloads/reports/Brightline_van+Rijmenam_The-Convergence-of-Big-Data-and-Blockchain_Blockchain-Research-Institute.pdf?utm_source=resource-page&utm_medium=skip-link 				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Cloud Infrastructure and Services	3. Course Code	4. L-T-P	5. Credits
	CSL 455	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed			
CO 1	Understand the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc		
CO 2	Evaluate security issues while deploying cloud services and Explore the various cloud services according to the market requirement.		
CO 3	Explore Blockchain in preserving privacy of cloud data storage services		
CO 4	Understand the use of blockchain in controlling data management.		
CO 5	Identify solutions in future for existing problems with blockchain technology		
9. Brief Syllabus: Cloud computing has been dramatically adopted in all IT environments for its efficiency and availability. In this course, students will learn how to adapt blockchain security to cloud computing and its secure solutions in detail. Students will be able to understand the practical uses of blockchain technology in cloud computing that are much more significant in terms of having the ability to transform huge amounts of data processing and documentary control in ways that are cost-effective and more secure.			
10. Books Recommended: Text Books 1. Sachin Shetty, Charles A. Kamhoua, Laurent L. Njilla, Blockchain for Distributed Systems Security, 1 st Edition, Wiley pub, 2018. Reference Book 1. Kim, Shiho, Deka, Ganesh Chandra, Advanced Applications of Blockchain Technology, Springer, 2018			

PROGRAM ELECTIVES

FOR

ARTIFICIAL INTELLIGENCE &

MACHINE LEARNING

SPECIALIZATION TRACK

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Programming for Data Science		3. Course Code	4. L-T-P	5. Credits
		CSL225	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs)				
On successful completion of this course students will be able to:				
CO 1	Understand and implement the basics of programming in Python.			
CO 2	Understand and implement the Collections in Python.			
CO 3	Apply Object Oriented Programming concepts on real world examples.			
CO 4	Apply the Numpy package for numerical calculations in Python.			
CO 5	Apply Pandas package for loading and preprocessing data in Python.			
CO 6	Implement various data visualization tools of Python on real world data.			
9. Brief Syllabus:				
<p>Introduction to Computer Science, Computer Algorithms, Computer Hardware , Operating Systems—Bridging Software and Hardware , Limits of Integrated Circuits Technology: Moore's , Computer Software , Procedural vs. Object-Oriented Programming, Literals , Variables and Identifiers , Operators, Expressions and Data Types, What Is a Control Structure, Boolean Expressions (Conditions), Relational Operators, Membership Operators, Selection Control, Multi-Way Selection, Iterative Control, While Statement , Infinite loops, Definite vs. Indefinite Loops, Boolean Flags and Indefinite Loops, List Structures, Common List Operations, Tuples , Nested Lists, For Loops , While Loops and Lists (Sequences), Assigning and Copying Lists , Dictionary Type in Python, Set Data Type , Program Routines , Defining Functions, More on Functions , Calling Value-Returning Functions, Calling Non-Value-Returning Functions, Parameter Passing, Arguments in Python Default Arguments in Python, Variable Scope, Recursive Function, Module Specification , Top-Down Design, Developing a Modular Design of the Calendar Year Program, Object-Oriented Programming concepts, Numpy - Creation on Array ,Array generation from Uniform distribution, Random array generation, reshaping, maximum and minimum, reshaping, Arithmetic operations, Mathematical functions, Bracket Indexing and Selection, Broadcasting, Indexing a 2D array (matrices); Pandas - Creating a Series - from lists, arrays and dictionaries, Storing data in series from intrinsic sources, Creating DataFrames, Imputation, Grouping and aggregation, Merging, Joining, Concatenation, Find Null Values or Check for Null Values, Reading data from csv, txt, excel, web, Visualization - Installing and setting up visualization libraries, Canvas and Axes, Subplots, Common plots – scatter, histogram, boxplot, Logarithmic scale, Placement of ticks and custom tick labels, Pandas Viz, Style Sheets, Plot type, Area, Barplots, Histograms, Line Plots, Scatter Plots, BoxPlots, Hexagonal Bin Plot, Kernel Density Estimation plot (KDE), Distribution Plots, Categorical Data Plots, Combining Categorical Plots, Matrix Plots, Regression Plots, Grids.</p>				
10. Books Recommended :				
Textbooks:				
1. Charles Dierbach., <i>Introduction to Python using Computer Science</i> , Wiley Publications, Second Edition, 2015				
2. Mark Lutz , <i>Learning Python</i> , O'Reilly publications , Fifth Edition, 2015				
Reference Books:				
1. Paul Barry, <i>Head First Python</i> , Orielly Publications, Second Edition, 2010				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> www.lms.ncuindia.edu/lms https://swayam.gov.in/nd1_noc19_cs59/preview https://www.python.org/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Applied Computational Statistics		3. Course Code	4. L-T-P	5. Credits
		CSL 227	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: Programming for Data Science (Python)				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Apply appropriate descriptive statistical and exploratory methods in the analysis of datasets			
CO 2	Calculate probabilities, and derive the marginal and conditional distributions of bivariate random variables.			
CO 3	Understand the probability mass function and various discrete distributions through application on real world examples			
CO 4	Understand the probability density function and various continuous distributions through application on real world examples			
CO 5	Understand and interpret statistical hypothesis test			
CO 6	Translate real-world problems into probability models using Bayesian Statistics.			
9. Brief Syllabus: Types of Data (Quantitative, Qualitative, Logical), Exploratory Data Analysis (Histogram, Scatter plots, Box plot), Fundamentals of Descriptive Statistics (moments- Measures of Central Tendency, Measure of spread, Measure of Shape), Markov Chains, LATEX, Probability and Combinatorics: Sample Statistics and Population Parameters, Events (Mutually Exclusive, Disjoints, Independent), Counting Methods Permutations and Combinations), Joint, Conditional Probability, Bayes' Rule, Discrete Distributions Introduction, Probability Mass Function, Cumulative Distribution Function, Geometric Distribution, Binomial Distribution, Poisson Distribution, Continuous Distributions: ProbabilityDensity Functions, Cumulative Distribution Function, Inferential Statistics (Normal Distribution, Statistical Sampling, Central Limit Theorem), Estimations (Point and Intervals- Confidence intervals with means, sample, proportions), Hypothesis Testing :Introduction, Confidence Intervals, Critical Value based approach, P-value based approach, ZTests, TTests ,the χ^2 distribution, ANOVA/ANCOVA.				
10 . Books Recommended : Textbooks: <ol style="list-style-type: none"> Ross, <i>Introduction to Probability</i>. 9th edition, Pearson, 2006 G. Jay Kerns, <i>Introduction to Probability and Statistics Using R</i>, 2016 Andy Field, <i>An Adventure in Statistics</i>, SAGE Publications, 2016 Reference Books: <ol style="list-style-type: none"> Dawn Griffiths, <i>Head First Statistics</i>, O'Reilly media Inc., 2019 Timothy C Urdan, <i>Statistics in Plain English</i>, Taylor and Francis Publisher, 2010 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.coursera.org/learn/probability-intro/ https://www.coursera.org/learn/bayesian/ www.lms.ncuindia.edu/lms/ 				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Applied Artificial Intelligence and Expert System		3. Course Code CSL 347	4. L-T-P 2-0-4	5. Credits 4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/>	Programme Elective <input checked="" type="checkbox"/>	Open Elective <input type="checkbox"/>	
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) On successful completion of this course students will be able to:				
CO 1	Understand the history and foundations of Artificial Intelligence.			
CO 2	Understand and implement search algorithms.			
CO 3	Understand knowledge representation and apply reasoning			
CO 4	Design and implement Expert System			
CO 5	Understand the basics of neural networks.			
9. Brief Syllabus: History of Artificial Intelligence, state-space, heuristic, depth-first, hill climbing, A, A*, AO*, stochastic, evolutionary search algorithms, Divide and Conquer, Greedy, Branch and Bound, Gradient Descent, minimax and alpha-beta search, Ontologies, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logic, standard logic, uncertainty, probability, probabilistic reasoning, probabilistic inference, bayes's theorem, Bayesian reasoning, bayesian network, fuzzy sets, Semantic web, semantic networks, Architecture, Generation of expert system, Strip, K-strip, meta knowledge, domain expert, knowledge engineer, heuristics, expert system shells, Typical expert system such as MYCIN and DART. Descriptive and Inferential statistics, Regression, Classification, Clustering, Multilayer perceptron, backpropagation algorithm, Convolution neural network, Deep learning.				
10. Books Recommended : Textbooks: 1. Kevin Night, Elaine Rich, Nair B. Artificial Intelligence, New York: McGraw-Hill, Third edition, 2008. 2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007. Reference Books: 1. Luger, G. F., & Stubblefield, W. A., Artificial Intelligence - Structures and Strategies for Complex Problem Solving. New York, NY: Addison Wesley, 5th edition, 2005. 2. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013. 3. Stuart Russell and Peter Norvig. Artificial Intelligence: A Modern Approach, Fourth Edition, Pearson, 2010 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • www.lms.ncuindia.edu/lms • https://swayam.gov.in/nd1_noc20_cs42/preview				

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Reinforcement Learning		3. Course Code	4. L-T-P	5. Credits
		CSL 348	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>			
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs)				
On successful completion of this course students will be able to:				
CO 1	To understand the concept of Reinforcement learning and concepts of probability to be implemented in the related applications.			
CO 2	To understand and implement the k- armed bandit problems .			
CO 3	To apply Markov Decision Process in Reinforcement Learning.			
CO 4	To understand and apply prediction and control using dynamic programming.			
CO 5	To understand and apply Monte Carlo and TD methods for Reinforcement Learning.			
CO 6	To understand and apply Function Approximation methods for Reinforcement Learning.			
9. Brief Syllabus:				
Overview of reinforcement learning: the agent environment framework, successes of reinforcement learning, Axioms of probability, Concepts of joint an multiple random variables, Bandit problems and online learning, Markov decision processes, Prediciton and Control by dynamic programming, Monte Carlo and TD methods, Use of function approximation methods for reinforcement learning, Value function approximation, Models and planning, Case studies.				
10. Books Recommended :				
Textbooks:				
1. "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition, Mark Lutz , Learning Python, O'Reilly publications , Fifth Edition, 2015.				
2. "Reinforcement Learning State-of-the-Art", Wiering and van Otterlo. Springer, Kindle edition, March 2012.				
Reference Books:				
1. "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> www.lms.ncuindia.edu/lms https://nptel.ac.in/courses/106106143/ 				

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Artificial Intelligence for Robotics	3. Course Code	4. L-T-P	5. Credits
	CSL349	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs)			
On successful completion of this course students will be able to:			
CO 1	Learn the fundamentals of robots		
CO 2	Understand robot sensors and understand fundamental signal conditioning		
CO 3	Apply the computational methods necessary to model and solve kinematic problems involving robot manipulators and mobile robots		
CO 4	Develop simple robot control systems in various applications		
9. Brief Syllabus:			
Introduction to Robotics: Progressive advancements, components, Degree of Freedom, Joints, Coordinates, Programming Modes, Robot characteristics, Robot Languages, Applications. Actuators, Sensors, signal conditioning, Kinematics of robots - Position analysis: Robot as Mechanism, Conventions, Matrix representation, Homogeneous Transformation, Representation of transformation, Inverse of Transformation, differential motions, Forward and Inverse Kinematic of Robots, Dynamic analysis of robot, Static force analysis of Robots. Robot Control System - Open and closed loop control, Linear control schemes. Partitioned PD control Schemes, PID control schemes, Force control of Robotics Manipulators tasks, Force control			
10. Books Recommended :			
Textbooks:			
1. Niku Saeed B., Introduction to Robotics, John Wiley & Sons b. Mittal R.K. and Nagrath I.J., Robotics and Control, McGraw Hill Education 2. Saha S.K., Introduction to Robotics, McGraw Hill Education			
Reference Books:			
1. Craig John J., Introduction to Robotics: Mechanics and Control, Pearson			
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)			
<ul style="list-style-type: none"> www.lms.ncuindia.edu/lms https://swayam.gov.in/nd1_noc19_cs59/preview MOOC Platform 			
Expert talk on advancement of Robots /Industrial visit in automation industry			

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Deep Learning	3. Course Code	4. L-T-P	5. Credits
	CSL312	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any:			
8. Course Outcomes (COs) On successful completion of this course students will be able to:			
CO 1	Understand concepts of neural networks and deep learning.		
CO 2	Implement Convolutional Neural Network.		
CO 3	Implement other Deep Learning Architectures, Autoencoder, Recurrent Neural Network and its variations. Applications in different domains.		
CO 4	Design Chatbots using (Natural language Processing) NLP.		
CO 5	Understand other deep learning topics such as optimization, attention models, transfer learning approach for various areas.		
9. Brief Syllabus: Introduction to ANN, Building an ANN, Evaluating, Improving and Tuning the ANN, Restricted , Boltzmann Machine ,CNN Introduction-Building a CNN, Evaluating, Improving and Tuning the CNN RNN Introduction - Building a RNN Evaluating, Improving and Tuning the RNN, LSTM, Boltzmann Machine Intuition, Building a , Boltzmann Machine, Auto Encoders Fundamentals Building an Auto Encoder, Types of Encoder, Deep Learning NLP Chat bots: Introduction to NLP (Natural Language Processing), Deep NLP Introduction, Building a ChatBot with Deep NLP.			
10. Books Recommended : Text Books: <ol style="list-style-type: none"> 1. Ian Goodfellow ,Yoshua Bengio, Aaron Courville Deep Learning , MIT Press, First Edition, 2016 2. Stephen Boyd, Convex Optimization, Cambridge University Press, First Edition, 2015 Reference Books: <ol style="list-style-type: none"> 1. Francois Chollet, Deep Learning with Python, Manning Publications, First Edition, 2018 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> • https://www.coursera.org/learn/neural-networks-deep-learning • www.lms.ncuindia.edu/lms 			

COURSE TEMPLATE

7. Department:	Department of Computer Science and Engineering		
2. Course Name: Introduction to Image Processing and Recognition	3. Course Code	4. L-T-P	5. Credits
	CSL447	2-0-4	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) On successful completion of this course students will be able to:			
CO 1	Implement fundamental image processing techniques required for computer vision.		
CO 2	Analyze the different segmentation techniques and shape analysis		
CO 3	Apply 3D vision techniques to images		
CO 4	Develop projects that can detect faces and objects using Open CV		
9. Brief Syllabus: Elements of digital image processing, Image model, Sampling and quantization, Relationships between pixels, Image Transforms, Discrete Fourier Transform, Discrete Cosine Transform, Haar Transform, Hadamard Transform, Image Enhancement, Enhancement by point processing, Spatial filtering, Enhancement in the frequency domain, Color Image Processing, Image Segmentation, Discontinuity detection, Edge linking and boundary detection, Thresholding, Region oriented segmentation, Use of motion for segmentation Introduction to CV, Introduction to Face Detection, Face Detection with OpenCV, Object Detection Introduction, Object Detection with SSD, Generative Adversarial Networks (GANs) Introduction.			
10. Books Recommended : <div style="margin-left: 20px;"> Text Books: <ol style="list-style-type: none"> Szeliski, Richard , <i>Computer Vision Algorithms and Applications</i>, Microsoft, Fourth Edition, 2012 Jan Erik Solem, <i>Programming Computer Vision with Python: Tools and algorithms for analyzing images</i>, O'Reilly Media, First Edition, 2015 Rafael C. Gonzalez, Richard E. Woods, <i>Digital Image Processing</i>, Prentice, Third Edition, 2016 D. L. Baggio et al, <i>Mastering OpenCV with Practical Computer Vision Projects</i>, Packt Publishing, First Edition, 2012 </div> <div style="margin-left: 20px;"> Reference Books: <ol style="list-style-type: none"> Mark Nixon and Alberto S. Aquado, —<i>Feature Extraction & Image Processing for Computer Vision</i>, Academic Press, Third Edition, 2012 Simon J. D. Prince, —<i>Computer Vision: Models, Learning, and Inference</i>, Cambridge University Press, First Edition, 2012 </div> <div style="margin-left: 20px;"> Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.edx.org/course/computer-vision-image-analysis-1/ http://www.cse.iitm.ac.in/~vplab/computer_vision.html www.lms.ncuindia.edu/lms </div>			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Computational Linguistics and Natural Language Processing		3. Course Code CSI 448	4. L-T-P 2-0-4	5. Credits
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs)				
On successful completion of this course students will be able to:				
CO 1	Gain understanding of linguistic phenomena, the field of natural language processing and the capabilities and limitations of current natural language technologies.			
CO 2	Understanding of language models and implement simple pre-processing tasks imperative for a computer to understand natural language			
CO 3	Ability to use existing natural language processing tools to conduct basic natural language processing, such syntactic parsing, dependency parsing.			
CO 4	Demonstrate computational skills to create NLP pipelines using existing NLP libraries, retrain models and extend existing NLP tools.			
CO 5	Apply existing statistical and deep learning techniques to language applications such as machine translation			
9. Brief Syllabus:				
<p>Computers in Linguistics and Natural Language Processing, Syntax, Semantics, and Pragmatics, Applications of NLP, The role of machine learning, Brief history of the field, The nature and use of text corpora, Pattern matching using Regular Expressions, Corpus Search and Counting, Regular languages: N-grams, The role of language models, Simple N-gram models, Estimating parameters and smoothing, evaluating language models, Lexical syntax, Tokenization, Types of Tokenizers, Part-of-Speech Tagging, Stemming, Lemmatization, Stop-Word Removal. Grammar formalisms and treebanks, Context-free languages, Syntactic ambiguity, Context-free grammars, Push-down automata, Chomsky Hierarchy, Efficient parsing for context-free grammars (CFGs), dependency parsing, Chunking, Chinking. Lexical semantics and Word-Sense Disambiguation, Compositional semantics, Semantic Role Labeling and Semantic Parsing, Named Entity Recognition and relation extraction, Co-reference resolution, Feature Engineering: Bag of Words, Count Vectorizer, TF-IDF, Building a simple ML model for NLP applications like Text Classification and Sentiment Analysis. Basic issues in Machine Translation, Statistical translation, word alignment, phrase-based translation, and synchronous grammars.</p>				
10. Books Recommended :				
Textbooks:				
1. Computational Linguistics: An Introduction (Studies in Natural Language Processing), by Ralph Grishman				
Reference Books:				
1. Natural Language Processing Fundamentals: Build intelligent applications that can interpret the human language to deliver impactful results, by Sohom Ghosh (Author), Dwight Gunning (Author)				
2. NLP at Work: The Essence of Excellence, 3rd Edition (People Skills for Professionals) 3rd Edition by Sue Knight				
3. Natural Language Processing with Python(Analyzing Text with the Natural Language Toolkit) By Steven Bird, Ewan Klein, Edward Loper				
Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)				
<ul style="list-style-type: none"> www.lms.ncuindia.edu/lms http://nlp-iiith.vlabs.ac.in/# 				

OTHER PROGRAM ELECTIVES

COMPUTER SCIENCE & ENGINEERING

COURSE TEMPLATE

1. Department:	Department of Computer Science and Engineering		
2. Course Name: Numerical Methods	3. Course Code	4. L-T-P	5. Credits
	MAL270	2-1-2	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.			
CO 1	Students should be able to understand numerical solutions of non-linear/ transcendental equations		
CO 2	Students should be able to apply various algorithms to solve system of linear equations		
CO 3	Students should be able to approximate mathematical functions and find intermediary values using interpolation and regression techniques		
CO 4	Students should be able to apply numerical techniques for differentiating and integration of non-analytical functions		
CO 5	Students should be able to apply numerical techniques to solve various differential equations of engineering importance		
9. Brief Syllabus: Roots of Non-linear and transcendental Equations, Matrices and Simultaneous linear equations, Interpolation and curve fitting, Numerical differentiation and integration, Numerical solution of ordinary differential equations, Numerical solutions of partial differential equations			
10. Books Recommended: Textbooks: <ol style="list-style-type: none"> Numerical Methods for Engineers, Chapra&Canale, 6th Ed, McGraw Hill Education. Jain Iyenger, Numerical Methods for Scientific and Engineering Computation, New Age International Publisher. Reference Books: <ol style="list-style-type: none"> Jaan Kiusalaas , Numerical Methods in Engg, Cambridge.University.Press5. Numerical Methods in Engineering and Science, B S Grewal, 10th Edition. Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://nptel.ac.in/courses/111107105/ 			

COURSE TEMPLATE

1. Department:		Department of Computer Science and Engineering		
2. Course Name: Web Development Technologies		3. Course Code	4. L-T-P	5. Credits
		CSL223	2-0-4	4
6. Type of Course (Check one):		Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None				
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.				
CO 1	Deploy a website on local server.			
CO 2	Use all the elements introduced in HTML5 and their features.			
CO 3	Manipulate DOM elements using JavaScript			
CO 4	Develop Responsive Web Applications using Bootstrap.			
CO 5	Develop interactive web applications.			
9. Brief Syllabus: With the fast-paced nature of technology, developers can no longer become experts in aspects of development, but now must learn the entire process of development from design to actual deployment. As a Full Stack Web Developer, you are the go-to expert that companies rely on to build, support and maintain their web applications. This course is the first step towards the series of courses crafted to set the students up for success in this critical role. Students will hone their understanding of how the web works, develop complex relational databases used to store applications data, secure and configure their own Linux-based servers, and build complete web applications using HTML, CSS, JavaScript, JQuery and SQL. By the end of this course, a student's portfolio will clearly demonstrate key skills mastery to their future employers.				
10 Books Recommended: Textbooks: 1. David Flanagan, JavaScript: The Definitive Guide 6e, O'Reilly Publication, 6th Edition, 2017 Reference Books: 1. Thomas Powell, JavaScript: The Complete Reference, Mc Graw Hill Publication, 3rd Edition, 2012 Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • (https://developer.mozilla.org › en-US)				

COURSE TEMPLATE

1. Department:	Department of Applied Sciences		
2. Course Name: Linear Algebra and its Applications	3. Course Code	4. L-T-P	5. Credits
	MAL 280	3-1-0	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to student once it is completed.			
CO 1	To develop understanding of structures of R^n and C^n and to be able to solve system of linear equations efficiently.		
CO 2	To learn about matrices and their applications in detail.		
CO 3	To learn about Linear Transformations on a vector space and the subspaces associated with them.		
CO 4	To study more structured vector space such as an Inner Product Space, its various properties. Projections and approximation schemes.		
CO 5	To study in detail the structure of a linear transformation through its eigen values and eigen vectors, Diagonalization and Singular Value decomposition and applications.		
9. Brief Syllabus: Vectors and linear combinations, Linear independence, Matrix factorization, Eigen Values , Vector Spaces, Subspaces, Rank, Dimension, Nullity, Column Spaces, Linear transformations, Matrix of a linear transformation, Linear models in business, science, and engineering, Inner product, length and orthogonality, Orthogonal projections, The Gram-Schmidt process, Inner product spaces, Diagonalization of symmetric matrices, The singular value decomposition and applications.			
10. Books Recommended: Text Books: 1. Linear Algebra and its Applications, Fourth Edition by Gilbert Strang 2. Linear Algebra with Applications, Bernard Kolman and David Hill Reference Books: 1. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi 1975 2. N. Jacobson, Basic Algebra, Vols I and II, Dover Pub., 2009. Reference websites: nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) • http://lmsncu.ncuindia.edu , Khan Academy lectures.			

COURSE TEMPLATE

1. Department:	Department of Applied Sciences		
2. Course Name: Probability and Statistics	3. Course Code	4. L-T-P	5. Credits
	MAL 260	3-1-0	4
6. Type of Course (Check one):	Programme Core <input type="checkbox"/> Programme Elective <input checked="" type="checkbox"/> Open Elective <input type="checkbox"/>		
7. Pre-requisite(s), if any: None			
8. Course Outcomes (COs) Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.			
CO 1	Students should be able to understand principles of counting and constructions of sample space.		
CO 2	Comprehend axioms of probability and to be able to compute probabilities of various events and also compute conditional probabilities.		
CO 3	Distinguish between discrete and continuous random variable and their characteristics such as expectation and higher moments.		
CO 4	Learn to work with special distributions discrete and continuous.		
CO 5	Develop understanding of estimation of parameters and its applications.		
CO 6	Understand hypothesis testing and regression analysis.		
9. Brief Syllabus: Sample space and events, Axioms of probability, Frequency and histogram, measures of central tendency and dispersion, Conditional probability, independence of events, random variables, distribution function, probability density functions, moments generating function, Binomial, Geometric, Poisson, Normal distributions, Sampling distribution, Central Limit Theorem, Estimation of parameters, Test of Hypothesis, Regression Analysis.			
10. Books Recommended: Text Books: <ol style="list-style-type: none"> Introduction to Probability and Statistics for Engineers and Scientists by Sheldon M. Ross, Academic Press – Fourth Edition Probability Statistics and Random Process by Veerarajan, Tata McGraw-Hill Education, 3rd Edition Reference Books: <ol style="list-style-type: none"> Probability and Statistics for Engineers by Miller, Freund's, & JOHNSON (RICHARD A), 6th edition, Pearson Education. ASIA. Reference websites: nptel, swayam, coursera, edx, udemy, lms, official documentation weblink) <ul style="list-style-type: none"> https://www.khanacademy.org/math/statistics-probability http://nptel.ac.in/courses/111104079/1 			