SEVENTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Program Elective-2	PE CS 701/1	Internet of Things	3	0	0	3	3	100
		PE CS 701/2	Kotlin Programming						
		PE CS 701/3	Blockchain Technology						
2.	Program Elective-3	PE CS 702/1	Soft Computing	2	0	0	2	2	100
		PE CS 702/2	Machine Learning						
		PE CS 702/3	Cloud Computing						
3.	Open Elective-1	OE 703	Refer Annexure 1	3	0	0	3	3	100
4.	Open Elective-2	OE 704	Refer Annexure 2	2	0	0	2	2	100
5.	Project - 2	PR CS 705	Project Work Intermediate	0	0	12	12	6	200
6.	Summer Internship-2	SI CS-706	Internship - II	0	0	0	0	1	100
7.	Seminar - 1	SE CS 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	100
Total :				10	0	14	24	18	800

Internet of Things

Course Code	PE CS 701/1
Course Title	Internet of Things
Prerequisites	Computer Networks, Sensors, System Integration
Course Category	Program Elective
Number of classes	36 hours
Number of credits	03 (L: 3, T: 0, P: 0)

Course Outcome:

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Understand internet of Things and its hardware and software components	K2
CO-2	Interface idea of I/O devices, sensors and communication modules	K3
CO-3	Understand about the monitoring of data and control devices	K2
CO-4	Develop IoT based problem solving concepts for real world problems.	K6

COURSE CONTENT

Module 1 (**8** lectures)

Introduction to IoT Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service(XaaS), Role of Cloud in IoT, Security aspects in IoT.

Module 2 (8 Hours)

Elements of IoT Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces. Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.

Module 3 (10 lectures)

IoT Application Development Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices.

Module 4 (10 lectures)

IoT Case Studies IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

References / Suggested Learning Resources:

1. Vijay Madisetti, Arshdeep Bahga, Ïnternet of Things, "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley
6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
7. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media
8. www.nptel.ac.in

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Kotlin Programming

Course Code	PE CS 701/2
Course Title	Kotlin Programming
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	ES 204 and PC CS 307
Course Category	Program Elective(PE)
Number of classes	38 hours

Course Outcome:

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Use the basic concepts of App Development with Kotlin Programming Language	K3
CO-2	Apply operators and arrays in Kotlin Programming Language.	K3
CO-3	Apply Inheritance, Interface and Extensions in kotlin	K4
CO-4	Explain the working of Android Studio on PC and run using emulator	K4

Course Content:

Module 1: Fundamental concepts of Kotlin Programming Language(10)

Kotlin Programming: Advantages and Disadvantages, Architecture; **Kotlin Hello World** - Your First Kotlin Program; How to declare a variable in Kotlin; Difference Between var and val**;Kotlin Basic Types**: Number Type, Short, Int, Long, Double, Float, Char, Boolean; **Kotlin Strings;** IDE, Kotlin syntax, Main Parameter, **Kotlin comments**: Single Line, Multi Line; **Kotlin Operators**: Arithmetic Operators; **Strings; Kotlin Boolean**: Ranges, Functions

Module 2: Kotlin Type Conversion, Basic Input/ Output and Arrays(10)

Kotlin Type Conversion; Conversion from Larger to Smaller Type; **Kotlin Comments**: Traditional comment, End of Line Comment; **Kotlin Basic Input/Output**; Difference Between println() and print(); Print Variables and Literals; **Kotlin Input**: Print String Entered By the User, Getting Integer Input from the User; **Arrays:** Access the elements, Change an element, Length Size, Loop through Array; **Kotlin Class & Object**: Nested Class, Inner Class, Anonymous Inner Class, Type Aliases; **Kotlin Constructors**: Primary Constructor, Initializer Blocks, Secondary Constructor;

Module 3: Kotlin Inheritance, Interface, Visibility Control and Extension (8)

Kotlin Inheritance: Overriding Methods, Overriding Properties, derived Class Initialization Order, Calling the superclass Implementation, overridingrules; **Kotlin Interface**: Implementing Interfaces, Properties in Interface, Interface Inheritance, Resolving Overriding Conflicts, **Kotlin Visibility Control**: Private, Protected, Internal, Public; **Kotlin Extension**: Extension Functions, Nullable Receiver, Extension Properties, Companion Object Extensions, Scope of extensions. **Kotlin Data Classes.**

Module 4: Introduction to Android and Android Architecture (10)

Introduction to Android - What is Android; Popular Android Application Categories; **Features of Android**; Popular Android Apps; **Android Architecture**: Android Platform Architecture Division; **Kotlin Project using Android Studio**: Creating First Project in Android Studio using Kotlin; Step to install Kotlin Plugin for Windows Users; **Running the Emulator on your Android Device.**

References / Suggested Learning Resources:

1. Programming Kotlin by Venkat Subramaniam.
2. Kotlin Programming Cookbook by Anand Shekhar Roy and Rashi Kanupuria
3. Kotlin for Android Developers by Antonio Leiva.
4. Kotlin Blueprints by Ashish Belagali, Hardik Trivedi, Akshay Chordia.
5. Mastering High Performance with Kotlin by Igor Kucherenko.

Blockchain Technology

Course Code	PE CS 701/3
Course Title	Blockchain Technology
Number of Credits	3 (L: 3, T: 1, P: 0)
Prerequisites	Database Management System
Course Category	Block Chain Technology (PE)
Number of classes	36 hours

Course Outcome:-

After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Explain the blockchain technology and its underlying mechanism	K2
CO-2	Explain the work flow behind bitcoin and various consensus mechanism	K2
CO-3	Identify major research challenges and technical gaps between theory and practice in crypto currency domain.	K4
CO-4	Design own cryptocurrency and decentralized network.	K4

Course Content:-

Module- 1: Introduction (8)

Basic of Blockchain Architecture – Challenges – Applications – Block chain Design Principles - The Blockchain Ecosystem - The consensus problem - Asynchronous Byzantine Agreement - AAP protocol and its analysis - Nakamoto Consensus on permission-less, nameless, peer-to-peer network - Abstract Models for BLOCKCHAIN - GARAY model - RLA Model - Proof of Work (PoW) as random oracle - formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS).

Module- 2: Cryptographic Fundamentals (8)

Cryptographic basics for crypto currency - a short overview of Hashing, cryptographic algorithm – SHA 256,signature schemes, encryption schemes and elliptic curve cryptography- Introduction to Hyperledger- Hyperledger framework - Public and Private Ledgers.

Module- 3: Bitcoin (8)

Bitcoin - Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks - double spending - mathematical analysis of properties of Bit coin. Bitcoin blockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their uses.

Module- 4: Ethereum (12)

Ethereum Virtual Machine (EVM) - Wallets for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts. Ethereum and Smart Contracts- The Turing Completeness of Smart Contract Languages and verification challenges- comparing Bitcoin scripting vs. Ethereum Smart Contracts

Blockchain - Recent Trends- Implementation Challenges- Zero Knowledge proofs and protocols in Block chain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves – Zcash - attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - - advent of algorand, and Sharding based consensus algorithms

References/ Suggested Learning Resources:-

1. Melanie Swan, “Block Chain: Blueprint for a New Economy”, O‟Reilly, first edition – 2015.

2. Daniel Drescher, “Block Chain Basics”, Apress; 1stedition, 2017

3. Antonopoulos A.M., Mastering Bitcoin. 2nd ed. O’Reilly Media, 2017.

4. Raj K., Foundation of Blockchain: The pathway to cryptocurrency and decentralized blockchain application.1st ed. Packt Publishing Ltd, 2019

5. Imran Bashir, “Mastering Block Chain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing, first edition – 2012

6. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Block Chain”, Packt Publishing

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Soft Computing

Course Code	PE CS 702/1
Course Title	Soft Computing
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Mathematics, Artificial Intelligence
Course Category	Program Elective
Number of classes	26 hours

Course Outcome:

After completing this course, the student should be able to-

CO Number	CO Description	K-level
CO-1	Explain soft computing techniques and their applications	K2
CO-2	Apply various neural network model to solve real-life problems	K3
CO-3	Explain fuzzy logic and its applications	K2
CO-4	Solve various optimization problems using genetic algorithm	K3

Course Content:

Module 1: Introduction (4 hours)

Introduction to soft computing, soft computing vs. hard computing, various types of soft computing techniques, Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing.

Module 2: Neural Networks (8 hours)

Biological neurons and its working, Simulation of biological neurons to problem solving, artificial neuron, characteristic and applications of ANN, various activation functions, McCulloch–Pitt neural network, Perceptron training algorithm, Linear separability, Hebb's learning rule/Delta rule, Backpropagation Learning and Architecture, Introduction to Associative Memory, Self Organizing Map, Adaptive Resonance Theory, Applications of ANNs to solve some real-life problems.

Module 3: Fuzzy Systems (7hours)

Introduction to Fuzzy logic. Fuzzy versus Crisp set, Fuzzy sets and membership functions, Operations on Fuzzy sets, Fuzzy relations, rules, propositions, implications, and inferences, Defuzzification techniques, Fuzzy logic controller design, Some applications of Fuzzy logic.

Module 4: Genetic Algorithm **(7 hours)**

History of Genetic Algorithms (GA),Concept of "Genetics" and "Evolution", Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc., Solving single-objective optimization problems using Gas, Concept of multi-objective optimization problems (MOOPs) and issues of solving them.

References / Suggested Learning Resources:

1. S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing,Wiley Publications, 2nd Edition, 2011.
2. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks,Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHIPublication, 1st Edition, 2009.
3. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications,S.Rajasekaran, G. A. Vijayalakshami, PHI.
4. Genetic Algorithms: Search and Optimization, E. Goldberg.
5. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI.
6. S.N. Shivanandam, Principle of soft computing, WileyISBN13: 9788126527410 (2011).
7. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2003.
8. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1995
9. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Pearson Edition, 2003.
10. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998.
11. David E. Goldberg, Genetic Algorithms in Search, Optimization & Machine Learning, Addison Wesley, 1997.

Machine Learning

Course Code	PE CS 702/2
Course Title	Machine Learning
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Data Mining, AI
Course Category	Machine Learning (PE)
Number of classes	26 hours

Course Outcome:

After completing this course, the student should be able to-

CO Number	CO Description	K-level
CO-1	Explain the concepts of computational intelligence like machine learning	K2
CO-2	Apply machine learning techniques to address the real time problems in different areas.	K3
CO-3	Illustrate the Ensemble methods and its usage in machine learning application	K3
CO-4	Apply Reinforcement learning techniques to respective problems.	K4

Course Content:

Module 1: Introduction (6)

Introduction: Machine learning, Terminologies in machine learning, Types of machine learning: supervised, unsupervised, semi-supervised learning. Review of probability. **Decision Trees,** Clustering - K-means/Kernel K-means, Dimensionality Reduction - PCA and kernel PCA, Matrix Factorization and Matrix Completion

Module 2: Discriminative Models (6)

Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Prediction Model, probabilistic interpretation, Regularization, Logistic regression, multi class classification, Support Vector Machines- Large margin classifiers, Nonlinear SVM, kernel functions, SMO algorithm.

Module 3: Generative models (6)

k-Nearest Neighbour Classification, Bayesian concept learning, Likelihood, Posterior predictive distribution, beta-binomial model, Naive Bayes classifiers, classifying documents using bag of

words. Bayesian Statistics and Frequentist statistics. Directed graphical models (Bayes nets), Conditional independence, Inference.

Module 4: Advanced ML Models (8)

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Recent trends in various learning techniques of machine learning and classification methods.

References / Suggested Learning Resources:

1. E. Alpaydin, "Introduction to Machine Learning", PHI, 2005.
2. Tom Mitchell, "Machine Learning", McGraw Hill, 1997
3. Kevin P. Murphy, "Machine Learning, a probabilistic perspective", The MIT Press Cambridge, Massachusetts, 2012.
4. Alex Smola and SVN. Viswanathan, "Introduction to Machine Learning", Cambridge University Press, 2008.
5. Introduction to Machine Learning(link is external) | Nils J. Nilsson, Stanford University

Cloud Computing

Course Code	PE CS 702/3
Course Title	Cloud Computing
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Computer Networks
Course Category	Program Elective
Number of classes	26 hours

Course Outcome:

After completing this course, the student should be able to-

CO Number	CO Description	K-level
CO-1	Explain the concept of Cloud Computing	K2
CO-2	Illustrate the various Cloud Architecture, Model and Service Management	K2
CO-3	Apply Virtualization for Cloud Computing	K3
CO-4	Explain Cloud Security	K2

Course Content:

Module 1: Introduction (8hours)

Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture, Evolution of Cloud Computing, usage scenarios and Applications, Business models around Cloud – Major Players in Cloud Computing - Issues in Cloud - Eucalyptus, CloudSim,Research trend in Cloud Computing, Fog Computing.

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Module 2: Cloud Architecture, Model and Service Management (8 hours)

Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges, and risks in cloud adoption.

Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing.

Service Management in Cloud Computing, Data Management in Cloud Computing, Resource Management in Cloud.

Module 3: Virtualization for Cloud (4 hours)

Need for Virtualization – Pros and cons of Virtualization – Types of Virtualizations – Basics of VMWare, advantages of VMware virtualization, using VMware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.

Module 4: Cloud Security (6 hours)

Infrastructure Security: Network level security, Host level security, Application-level security. Data security and Storage: Data privacy and security Issues, Jurisdictional issues raised by Data location. Identity & Access Management, Access Control, Trust, Reputation, RiskAuthentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations. Case Study on Open Source & Commercial Clouds

References / Suggested Learning Resources:

1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley,2011
2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010
5. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press.
6. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach" McGraw-Hill Osborne Media.
7. Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press.

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Project Work Intermediate

Course Code	PR CS 705
Course Title	Project Work Intermediate
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K2
CO-2	Develop the skill of working in a Team	K3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.

10) Demonstrate the implementation of a project work.

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Industry Internship – II

Course Code	SI CS 706
Course Title	Industry Internship – II
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting	K3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K2
CO-4	Show professional ethics by displaying positive disposition during internship	K2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional and educational advancement	K5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify aninternship program of relevance in his/her branch of engineering to undergo during summer break between 6^{th} and 7^{th} semester,
2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

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Seminar on Contemporary Engineering Topics – I

Course Code	SE CS 707
Course Title	Seminar on Contemporary Engineering Topics – I
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K3
CO-2	Survey literature to understand insight of the selected topic	K4
CO-3	Develop report writing and presentation making skill	K3
CO-4	Presentthe topic so prepared among audience using suitable aid	K3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and
5) Present in the class among fellow students and faculty members.

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