Tripura University
(A Central University)

Curriculum
For
B.Tech in Electrical & Computer Science Engineering
(ECSE)

(7th Semester)

2021

7th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-2	PE ECS 701/1	Introduction to Smart Grid	3	0	0	3	3	100
		PE ECS 701/2	Electrical Distribution System Analysis						
		PE ECS 701/3	High Voltage Engineering						
2.	Program Elective-3	PE ECS 702/1	IoT	2	0	0	2	2	100
		PE ECS 702/2	Robotics						
		PE ECS 702/3	Block Chain						
3.	Open Elective-1	OE ECS 703	Annexure -I	3	0	0	3	3	100
4.	Open Elective-2	OE ECS 704	Annexure-II	2	0	0	2	2	100
5.	Project - 2	PR ECS 705	Project Work Intermediate	0	0	12	12	6	200
6.	Summer Internship-2	SI ECS706	Internship - II	0	0	0	0	1	100
7.	Seminar - 1	SE ECS 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	100
			Total :	10	0	14	24	**18**	**800**

Introduction to Smart Grid

Course Code	PE ECS 701/1
Course Title	Introduction to Smart Grid
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System analysis.
Course Category	Program Elective (PE)
Number of classes	38 Hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Generalized the fundamental of Smart grid.	K2
CO-2	Review the concept of Micro grid and also enhancing smart grid with micro grids	K2
CO-3	Analyze the power system performance of Smart grid.	K4
CO-4	Distinguish the Energy management of a Smart Grid	K4

Course Content:

Module 1: Fundamental of Smart Grid (10 Hours)

Advancement of power grid, Introduction of smart grid, Comparison oftoday's grid vs Smart grid, key aspect of smart grid development and deployment, Concept of Resilient & Self-Healing Grid, architecture and functions of Smart Grid, Smart grid technology for Transmission system, and Distribution System, The global reality in the field of smart grids and transition into future grids, Smart Grid Benefits and Challenges.

Module 2: Micro grid (8 Hours)

Concept of Micro grid, enhancing smart grid with micro grids: Challenges and opportunities, Distributed Energy Resource (DER), **bulk electricity system** (BES), Operation and control of AC Micro grid, Operation and control of DC Micro grid, Operation and control of AC-DC hybrid Micro grid.

Module 3: Performance analysis in a Smart Grid (10 Hours)

Load flow studies for smart grid, load flow state of the art: classical, extended formulations, and algorithms, distribution load flow methods, cases for the development of stochastic dynamic optimal power flow (DSOPF) and application, security assessment in a smart grid, contingency studies for smart grid, voltage stability of smart grid.

Module 4: Energy Management in a Smart Grid (10 Hours)

Energy Management System (EMS) - Smart substations, Substation Automation, Feeder Automation, SCADA, Remote Terminal Unit, Intelligent Electronic Devices, Protocols, PMU, Wide area monitoring protection and control, Smart integration of energy resources Renewable, intermittent power sources, Energy Storage, Analysis of AC/DC Smart Grid.

References / Suggested Learning Resources:

1. Smart grid handbook, Vol. 1 ,2,and 3 - By - Liu, Chen-Ching (Ed.) McArthur, Stephen(Ed.) Lee, Seung-Jae (Ed.) 2015
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. Smart Grid: Fundamentals of Design and Analysis Book by James A. Momoh
4. The Smart Grid: Enabling Energy Efficiency and Demand Response by Engr. Talha Arshad
5. Mini S. Thomas, John D McDonald, Power System SCADA and Smart Grids, CRC Press, 2015.

Electrical Distribution System Analysis

Course Code	PEECS 701/2
Course Title	Electrical Distribution System Analysis.
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System Analysis.
Course Category	Program Elective (PE)
Number of classes	38 Hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Outline of electrical distribution system.	K2
CO-2	Classify components of distribution system, nature of loads.	K2
CO-3	Distinguish A.C. & D.C. distribution system.	K3
CO-4	Construct model of distribution system components.	K4
CO-5	Analyze load flow of electrical distribution system.	K4

Course Content:

Module 1: Fundamental Concept of Electrical Distribution System (08Hours)

Introduction to electrical distribution system, structure of an electrical distribution network: components of distribution system substation and bus bar layouts, components of distribution system and feeder configurations, nature of loads in a distribution system,load allocation in a distribution system, load curves,load duration curve, important terms and factors: connected load, maximum demand, demand factor, average load, load factor, diversity factor.

Module 2: Distribution systems general (10Hours)

Classification of distribution systems: A.C. & D.C. distribution, methods of obtaining 3-wire D.C. system, overhead versus underground system, connection schemes of distribution system, requirements of a distribution system, design considerations in distribution system, types of D.C. distributors, A.C. distribution calculations, design considerations of distribution feeders: radial and loop types of primary feeders, voltage levels, factors affecting the feeder voltage level, feeder loading.

Module 3: Modeling of Distribution System Components (10Hours)

Overhead lines, feeders and cables, single and three phase distribution transformers, voltage regulators, load models, capacitor banks, distributed generation, voltage control, and methods of voltage control, power factor improvement techniques, and tariff.

Module 4: Load flow analysis of electrical distribution system (10Hours)

Load flow analysis: Backward/forward sweep, direct approach, direct approach for weakly meshed systems, Gauss Implicit Z-matrix Method. Short-circuit analysis: Sequence-components vs. phase-variable, LG, LLG, LLLG, and LL Faults, weakly meshed system, applications of distribution system analysis.

References / Suggested Learning Resources:

1. W. H. Kresting, Distribution System Modeling and Analysis, CRC Press, New York, 2002.
2. A. A. Sallam and O. P. Malik, Electric Distribution System, IEEE Press, Piscataway, NJ, 2011.
3. J. H. Teng, "A direct approach for distribution system load flow solutions," IEEE Trans. on Power Delivery, vol. 18, no. 3, pp. 882–887, 2003.
4. Edited by B. Das, Power Distribution Automation, IET Power and Energy Series, 75, London, 2016.
5. R. F. Arritt and R. C. Dugan, "Distribution system analysis and the future smart grid," IEEE Trans. on Industry Applications, vol. 47, no. 6, pp. 2343-2350, November/ December 201.

High Voltage Engineering

Course Code	PE ECS 701/3
Course Title	High Voltage Engineering.
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Power System Analysis.
Course Category	Program Elective (PE)
Number of classes	36 Hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Understand the different phenomena of over voltages, switching surges and practices of grounding	K2
CO-2	Understand the different phenomenon of high voltage power transmission and distribution	K2
CO-3	Understand breakdown of gases, liquid and solids	K2
CO-4	Apply different methods of generation of high voltages	K3
CO-5	Analyze the different high voltage measurement techniques	K4

Course Content:

Module 1: High Voltage Power Transmission and Distribution (08 Hours)

High voltage power transmission and distribution, Insulators: Type of insulators and their applications, voltage distribution and string efficiency of disc insulators. Corona: Theory of corona formation, corona loss and radio interference. Overvoltage phenomena: Lightning and switching surges, Travelling waves: Reflection and refraction w.r.t. different type of line terminations, Overvoltage protection: Grounding practice and overvoltage due to earth fault, lightning arresters and surge suppressors.

Module 2:High Voltage Cables and Breakdown Mechanism (10 Hours)

Insulation coordination scheme of open-air substation, High voltage cables: Single core, belted, XLPE and gas-filled. Inter-sheath grading, Requirement of extra high voltage cables, Bushings: Non-condenser and condenser bushings, field distribution.
Breakdown in gases, Townsend mechanism, Paschen's law, Streamer breakdown, Breakdown under Surge Voltages, Different types of breakdown in solid dielectrics, Different types of breakdown in liquids, Partial discharge.

Module 3:Statistical Methods Generation of High Voltages (8 Hours)

Statistical Methods Generation of High AC Voltage, Testing transformer and its cascade connection, single-phase series resonance circuit, Generation of High DC Voltage, Single-stage and multi-stage symmetric as well as asymmetric voltage multiplier circuits, Generation of Impulse Voltage Single-stage and multi-stage impulse generators circuits.

Module 4:Measurement of High Voltages (10 Hours)

Triggering and synchronization with CRO for Measurement of Peak value of high AC Voltage, Frequency dependent method: Chubb & Fortescue Method, Frequency independent methods: Davis-Bowdler Method, Rabus Method, Sphere-Gap Method Measurement of RMS value of high AC Voltage Capacitive Voltage, Transformer, Potential Dividers, Electrostatic Voltmeter Measurement of High DC Voltage Ammeter in series with high resistance Measurement of Dielectric Loss-factor High Voltage Schering Bridge, High Voltage type tests of insulators, Impulse test of transformers as per relevant Indian standards.

References / Suggested Learning Resources:

1. High Voltage Engineering: Kuffel and Zaengl.
2. High Voltage Measurement Techniques: A.J.Schwab.
3. High Voltage Engineering: D.V. Razevig.
4. High Voltage Engineering: Naidu & Kamaraju.
5. "High Voltage Engineering: Converters, Systems and DC Grids" by Dragan Jovcic and Khaled Ahmed.
6. "High Voltage Engineering" by C L Wadhwa

Internet of Things (IoT)

Course Code	PE ECS 702/1
Course Title	Internet of Things (IoT)
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Sensors, System Integration, Cloud and Network Security
Course Category	Program Elective (PE)
Number of classes	26 Hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Understand internet of Things and its hardware and software components.	K2
CO-2	Recognize Interface I/O devices, sensors & communication modules.	K2
CO-3	Remotely monitor& examine data and control devices.	K4
CO-4	Develop real life IoT based projects.	K5

Module 1: Introduction to IoT **(07 Hours)**

Architectural Overview, Design principles and needed capabilities, IoT Applications,
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: Elements of IoT **(05 Hours)**

Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.

Module 3. IoT Application Development **(08 Hours)**

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. Communication Protocols of IoT **(06 Hours)**

Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols- MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP, Wireless communications.

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.

Robotics

Course Code	PE ECS 702/2
Course Title	Robotics
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Basic Engineering Mathematics, Automation and Control.
Course Category	Program Elective (PE)
Number of classes	26Hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Perform kinematic and dynamic analyses with simulation.	K5
CO-2	Design control laws for a robot.	K5
CO-3	Integrate mechanical and electrical hardware for a real prototype of robotic device.	K5
CO-4	Select a robotic system for given application.	K6

Course Content:

Module 1: Introduction to Robotics (04 Hours)

Types and components of a robot, Classification of robots, closed-loop and open loop control systems. Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.

Module 2: Robot Kinematics and Dynamics (06 Hours)

Kinematic Modeling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modeling: Equations of motion: Euler-Lagrange formulation.

Module 3: Sensors and Vision System (06 Hours)

Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.

Module 4: Robot Control (10Hours)

Basics of control: Transfer functions, Control laws: P, PD, PID, Non-linear and advanced controls.

Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.
Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications.

References / Suggested Learning Resources:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi, 2009

7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modelling and Control", John Wiley and Sons Inc, 2005
8. Steve Heath, "Embedded System Design", 2nd Edition, Newnes, Burlington, 2003
9. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould, "Intelligent Mechatronic System: Modeling, Control and Diagnosis", Springer.

Block Chain

Course Code	PE ECS 702/3
Course Title	Block Chain
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Cryptography Techniques, Data Structures and Algorithms, Introduction to Programming
Course Category	Program Elective (PE)
Number of classes	26Hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Understand block chain technology.	K2
CO-2	Develop block chain-based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks.	K5
CO-3	Build and deploy block chain application for on premise and cloud based architecture.	K3
CO-4	Integrate ideas from various domains and implement them using block chain technology in different perspectives.	K5

Module1. Introduction (03 Hours)

Introduction: Overview of Block chain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Block chain, Transactions, Distributed Consensus, Public vs Private Block chain, Understanding Crypto currency to Block chain, Permissioned Model of Block chain, Overview of Security aspects of Block chain
Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic crypto currency.

Module2. Understanding Block chain with Crypto currency (06 Hours)

Bit coin and Block chain: Creation of coins, Payments and double spending, Bit coin Scripts,
Bit coin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and
block relay.
Working with Consensus in Bit coin**:** Distributed consensus in open environments, Consensus in a Bit coin network, Proof of Work (PoW) – basic introduction, Hash cash PoW, Bit coin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bit coin Miner, Mining Difficulty, Mining Pool.

Module3. Understanding Block chain for Enterprises (07 Hours)

Permissioned Block chain: Permissioned model and use cases, Design issues for Permissioned
block chains, Execute contracts, State machine replication, Overview of Consensus models for
permissioned block chain- Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.
Enterprise application of Block chain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Block chain, Block chain enabled Trade, We Trade – Trade Finance Network, Supply Chain Financing, Identity on Block chain.

Module4. Block chain application development (10 Hours)

Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control,
Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda

References / Suggested Learning Resources:

1. Melanie Swan, “Block Chain: Blueprint for a New Economy”, O’Reilly, 2015
2. Josh Thompsons, “Block Chain: The Block Chain for Beginners- Guide to Block chain
Technology and Leveraging Block Chain Programming”
3. Daniel Drescher, “Block Chain Basics”, Apress; 1stedition, 2017
4. Anshul Kaushik, “Block Chain and Crypto Currencies”, Khanna Publishing House, Delhi.
5. Imran Bashir, “Mastering Block Chain: Distributed Ledger Technology, Decentralization
and Smart Contracts Explained”, Packt Publishing
6. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart
Contracts for Ethereum and Block Chain”, Packt Publishing
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman
Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized
Applications with Hyperledger Fabric and Composer”, Import, 2018.

Project Work Intermediate

Course Code	PR ECS 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.

Industry Internship – II

Course Code	SI ECS 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.

Seminar on Contemporary Engineering Topics – I

Course Code	SE ECS 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
7) Identify a topic of current relevance in his/her branch of engineering,
8) Get approval of the faculty concerned/HOD,
9) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
10) Prepare their own report and presentation slides and
11) Present in the class among fellow students and faculty members.

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