TRIPURA UNIVERSITY
(A CENTRAL UNIVERITY)

CURRICULUM STRUCTURE

OF

4 YEARS

BACHELOR OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING(EE)

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	PEEE 701/1	Advanced Electric Drives	3	0	0	3	3	100
		PEEE 701/2	Digital Control Systems						
		PEEE 701/3	Electromagnetic Waves						
2.	Program Elective-3	PEEE 702/1	Electrical Machine Design	2	0	0	2	2	100
		PEEE 702/2	Power Quality & Facts						
		PEEE 702/3	Bio-Medical Instrumentation						
3.	Open Elective-1	OEEE 703	Annexure-I	3	0	0	3	3	100
4.	Open Elective-2	OEEE 704	Annexure-II	2	0	0	2	2	100
5.	Project - 2	PREE 705	Project Work Intermediate	0	0	12	12	6	*200*
6.	Summer Internship- 2	SIEE- 706	Internship - II	0	0	0	0	1	*100*
7.	Seminar - 1	SEEE 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	*100*
Total :				10	0	14	24	**18**	**800**

ADVANCED ELECTRIC DRIVES

Course Code	PEEE701/1
Course Title	Advanced Electric Drives
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electrical Machine, Power Electronics and Electric Drives
Course Category	Program Elective-2(PE-2)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
PEEE701/1.1	Explain the operation of power electronic converters and their control strategies.	K2
PEEE701/1.2	Interpret the vector control strategies for ac motor drives	K2
PEEE701/1.3	Apply the control schemes for PMSM, BLDC and Switched Reluctance Motor drives.	K3
PEEE701/1.4	Interpret the control strategies using digital signal processors.	K2

Course Content:-

Module- 1: Power Converters for AC drives (10 hours):
PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.

Module- 2: Induction and Synchronous motor drives (8 hours):
Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).
Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.

Module- 3: PMSM, BLDC and Switched reluctance motor drives (10 hours) :
Introduction to various PM motors, BLDC and drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM. Switched reluctance motor drives: Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.

Module- 4: **DSP based motion control (8 hours):**
Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.

References/ Suggested Learning Resources:-

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.
5. Mohan, N., Advanced Electric Drives: Analysis, Control, and Modeling Using Simulink, MNPERE (2001).
6. Leonard, W., Control of Electric Drives, Springer-Verlag, New York, (1985)

DIGITAL CONTROL SYSTEMS

Course Code	PEEE-701/2
Course Title	Digital Control Systems
Number of Credits	3 (L: 3, T :0, P:0
Prerequisites	Control of Linear time in-variant Systems.
Course category	Program Elective-2
Number of Classes	38

Course outcomes

CO Number	Corse description	K-level
	After the Completion of the course students will be able to	
PEEE-701/2:OC.01	Explain the discrete-time representation of Linear time in-variant systems and their responses.	K2
PEEE-701/2:OC.02	Determine the stability analysis of Discrete time Systems.	K5
PEEE-701/2:OC.03	Analyze the State-space modeling of Digital Control Systems.	K4
PEEE-701/2:OC.04	Design the Controllers for Digital Control Systems.	K6

Module 1: Discrete Representation of Continuous Systems (12 hours):
Introduction to Digital Control system-components of digital Control System, Z-transformation and inverse Z-transformation, Pulse transfer function. Concept of difference equation-its solutions, Transfer function from difference equation. Sampler in digital Control

system, Choice of sampling rate. Frequency response of discrete functions. Sampling Spectra and Aliasing. Sampling theorem, Zero order Hold, Transient response of discrete time systems.

Module 2: Stability Analysis of Digital Control Systems (10 hours):
z-plane pole-locations. Damping ratio and natural frequency, Steady State errors of Discrete-data System. Stability Analysis: Bilinear Transformation, Stability analysis using Routh-Hurwitz criterion, Jury's stability criterion, Stability analysis using Root-locus technique.

Module 3: State Space Approach for discrete time systems (8 hours):

State space models of discrete-time systems, State space analysis. Controllability and Observability and output Controllability of discrete data systems and proof of related theorems, Effect of pole zero cancellation on the controllability & observability of Discrete-data Systems.

Module : Design of Controllers for Digital Control System(10 hours):
Design of Discrete PI, PD and PID Controllers, Design of PID Controllers using different Algorithms, Design of discrete state-feedback controller. Design of set point tracker. Design of Discrete Observer for LTI Systems. Design of discrete output feedback controller. Periodic output feedback controller design for discrete-time systems.

References/ Suggested Learning Resources:-

1. I. J, Nagrath, M. Gopal, "Control System Engineering". New Age Publication
2. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems",Addison-Wesley, 1998.
5. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.
6. D. Roy Chowdhury "Control System Engineering", PHI

ELECTROMAGNETIC WAVE

Course Code	PE EE 701/3
Course Title	Electromagnetic Wave
Number of Credits	3 (L:3, T:0, P:0)
Prerequisites	Electromagnetic Field Theory
Course category	Program Elective-2
Number of Classes	38

Course Outcomes:

After completion of the course student will be able to

CO Number	CO Description	k-level
CO-1	Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.	K4
CO-2	Analyse the field equations for the wave propagation in special cases such as conducting medium, lossy and low loss dielectric media etc.	K4
CO-3	Handle the Plane waves at medium interface.	K6
CO-4	Abstract TE and TM mode patterns of field distributions in a rectangular wave-guide and characterize radiation by antennas.	K6

Module 1: Transmission Lines (8 hours):

Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

Module 2: Maxwell's Equations Uniform Plane Wave (10 hours):

Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface. Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Pointing vector.

Module 3: Plane Waves at Media Interface (7 hours):

Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

Module 4 : Waveguides and Antenna(7 hours):

Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, rectangular waveguides. Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole,

Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

References/ Suggested Learning Resources:-

1. R. K. Shevgaonkar, **"**Electromagnetic Waves**"**, Tata McGraw Hill, 2005.
2. D. K. Cheng, "Field and Wave Electromagnetics**"**, Addison-Wesley, 1989.
3. M. N.O. Sadiku, "Elements of Electromagnetics**"**, Oxford University Press, 2007.
4. C. A. Balanis, "Advanced Engineering Electromagnetics", John Wiley & Sons, 2012.
5. C. A. Balanis, "Antenna Theory: Analysis and Design**"**, John Wiley & Sons, 2005.

ELECTRICAL MACHINE DESIGN

Course Code	PE EE 702/1
Course Title	Electrical Machine design
Number of Credits	2 (L: 2; T: 0; P: 0)
Prerequisites	Magnetic circuits and Electrical machine
Course Category	Program Elective-3
Number of Classes	26

Course Outcome: After Completion of this course students will able to

CO Number	CO Description	K-level
CO-1	Summarize the construction and performance characteristics of electrical machines.	K2
CO-2	Determine the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines	K3
CO-3	Explain the principles of electrical machine design and carry out a basic design of an AC machine.	K2
CO-4	Formulate design calculations using software tools	K6

Module 1: Introduction and Design of Transformer (8 hours):

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines. Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Module 2: Design of Induction Motors (6 Hours):

Sizing of an induction motor, main dimension, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, and short circuit current.

Module 3: Design of Synchronous Machines (6 hours):

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of airgap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Module 4: Computer aided Design (CAD (6 hours):

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design.

References / Suggested Learning Resources:

1. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. . M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, "Electrical Machine Design Data Book", New Age International, 1979.
6. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

POWER QUALITY AND FACTS

Course Code	PEEE 702/2
Course Title	Power Quality and FACTS
Number of Credits	2(2L:0T:0P)
Prerequisites	Power Electronics, Power Systems and Control Systems.
Course Category	Program Elective-3
Number of classes	26 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation	K2
CO-2	Explain the working principles of FACTS devices and their operating characteristics	K2
CO-3	Understand the basic concepts of power quality	K2
CO-4	Apply the knowledge of FACTS devices to improve power quality	K3

Course Content:-

Module 1:Transmission Lines, Series/Shunt Reactive Power Compensation and Thyristor-based FACTS (8 hours):

Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation, Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation.

Module 2: Voltage Source Converter based (FACTS) controllers and Application of FACTS (6 hours)

Voltage Source Converters (VSC), STATCOM: Principle of Operation, Reactive Power Control, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Application of FACTS devices for power-flow control and stability improvement.

Module 3: Power Quality Problems in Distribution Systems (6 hours)

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve, Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters.

Module 4: DSTATCOM, Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours):
Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM, Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

References / Suggested Learning Resources:

1. N. G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of FACTS Systems",Wiley-IEEE Press, 1999.
2. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Ltd. 2007.
3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New York, 1983.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991

BIOMEDICAL INSTRUMENTATION

Course Code	PEEE 702/3
Course Title	Biomedical Instrumentation
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Electrical measurement and instrumentation, physics, basic electrical engineering
Course Category	Program Elective-3
Number of classes	26 hours

Course Outcome: After the successful completion of the course Students will be

PEEE 702/3:OC.01	Demonstrate the philosophy of the heart, lung, blood circulation and respiration system and also explain the basic components of a biomedical Instrumentation system.	K2
PEEE 702/3:OC.01	Recall the knowledge on various sensing and measurement devices of electrical origin and safety aspects.	K1
PEEE 702/3:OC.01	Use of modern methods of imaging techniques and their analysis	K3
PEEE 702/3:OC.04	Explain the medical assistance/techniques and therapeutic equipments.	K2

MODULE –1: Fundamentals of Biomedical Engineering (6 hrs.)

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals Basic components of a biomedical system- Cardiovascular systems- Respiratory systems – Kidney and blood flow - Physiological signals and transducers - Transducers – selection criteria – Piezo electric, ultrasonic transducers–Temperature measurements.

MODULE –II: Electrical Parameters Acquisition and Analysis (7 hrs.)

Electrodes – Limb electrodes –floating electrodes – Micro, needle and surface electrodes – ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment

MODULE 3: Different Types of Analytical and Diagnostic Instruments (7 hrs.):

Measurement of blood pressure. Measurement of heart rate and heart sound. Blood flow and cardia coutput measurement. Pulmonary function measurements. Spirometer. Plethysmography: Photo Plethysmography and Body Plethysmography.

MODULE 4: Imaging Modalities and Analysis (6 hrs.)

Introduction to Medical Imaging: Computed tomography, MRI, ultrasonography. Doppler ultrasonography and contrast ultrasonography. Pacemakers – Defibrillators – Ventilators – Heart –Lung machine

References / Suggested Learning Resources:

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi,2nd edition, 2003
3. Joseph J Carr and John M.Brown, Introduction to Biomedical Equipment Technology, John
4. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
5. R. Ananda Natarajan, Biomedical Instrumentation and Measurements, PHI.

PROJECT WORK INTERMEDIATE

Course Code	PR EE 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 EE 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 organizational 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 an internship program of relevance in his/her branch of engineering to undergo during summer break between 6th and 7th 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 (SE EE 707)

Course Code	SE EE 707
Course Title	Seminar on Contemporary Engineering Topics – I
Number of Credits	L: 0, T: 0, P: 2)
Prerequisites	1
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	Utilize suitable aid to present the topic among audience.	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