NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL



RULES AND REGULATIONS

SCHEME OF INSTRUCTION AND SYLLABI

for B.Tech. Honors Program

(Effective from AY2021-22)

DEPARTMENT OF ELECTRICAL ENGINEERING

Vision and Mission of the Institute

National Institute of Technology Warangal

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product-oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

Vision and Mission of the Department

Department of Electrical Engineering

VISION

To excel in education, research and technological services in electrical engineering in tune with societal aspirations.

MISSION

- Impart quality education to produce globally competent electrical engineers capable of extending technological services.
- Engage in research & development in cutting edge and sustainable technologies.
- Nurture scientific temperament, professional ethics and industrial collaboration.

Department of Electrical Engineering:

Brief about the Department:

The Department of Electrical Engineering was established in the year 1959 in the Regional Engineering College Warangal, which was converted into a National Institute of Technology in the year 2003.

Since the inception of the Institute, the department has been developing state-of-the-art Infrastructure to cater to the needs of technical education and cutting-edge research. In its formative years, the department received considerable financial and logistical support from UNESCO. Later, the Department was funded principally by the MHRD, GOI, which is augmented by aid from various other agencies such as the Institutional Network Scheme (INS) and TEQIP. Well-qualified, well-trained and dedicated faculty propels the development of the department. The department enjoys a position of eminence in the field of technical education and research. The Department of Electrical Engineering started offering postgraduate programs since the year 1964. Currently, the Department offers three PG programs in Power Systems Engineering, Power Electronics and Drives, and Smart Electric Grid.

The establishment of postgraduate courses has significantly contributed towards the advancement of research and consultancy activities of the department. To fulfill the objectives stated in the mission and vision of the institute, the department organized several faculty development programs, conferences, and refresher courses, which cater to the needs of industries and utilities (DRDO, BHEL, TATA power companies, VSP to name a few). The department also organized several continuing education programs in emerging areas for faculty of educational institutions throughout the country. The Department is recognized as a QIP center for M. Tech programs in Electrical Engineering.

The Department of Electrical Engineering has always been a hub of active research. Several research projects, sponsored by MHRD, CSIR, DST, DRDO, SPARC, and other private and governmental organizations have successfully been executed by the faculty of the department. Currently, about 65 doctoral students are pursuing their Ph.D. degrees in various areas of research.

In its sixty-two years of journey, the department had quite a few academic and research accomplishments. A few of them are enumerated below:

- Several funded research projects, to the tune of Rs. 300 Lakhs, are currently under execution, promising high research outcomes.
- A Power System Study Cell was established by the erstwhile APSEB to train their engineers in software pertaining to power systems.
- A sponsored research project was successfully executed, which aims to study the impact of the electrical load of the Vizag Steel Plant on the grid. This project was awarded to the department despite stiff competition from several institutes of higher learning.
- The department has been awarded a center of excellence in power and energy systems, which is in the process of being established.
- All academic programs offered by the department had been accredited by NBA for a full-time period of 5 years in the years 2008 and 2013
- As many as 26 consultancy projects were completed for the vetting of electromechanical designs for lift irrigation projects by the Governments of Telangana and Andhra Pradesh.

List of Programs offered by the Department:

Program	Title of the Program
B.Tech.	Electrical and Electronics Engineering
BTech (Hons.)	Electrical and Electronics Engineering
	Minor in Electrical Engineering
M.Tech.	Power Electronics and Drives
	Power Systems Engineering
	Smart Electric Grid
PG diploma	Power Electronics and Drives
	Power Systems Engineering
	Smart Electric Grid
Ph.D.	Electrical Engineering

Note: Refer to the Rules and Regulations for B.Tech. program (weblink) given in the institute website.

SCHEME OF INSTRUCTION
Honors Program – Electrical & Electronics Engineering .

S. No.	Course Code	Course Title	L	T	P	Credits	Sem.
1	EE5214	Instrumentation & Automation	3	0	0	3	V
2	EE5153	Digital Control Systems	3	0	0	3	VI
3	EE5163	High Power Inverters	3	0	0	3	VI
4	EE5201	Advanced Computational Methods in Power Systems	3	0	0	3	VII
5	EE5112	Power Quality Improvement Techniques	3	0	0	3	VII
6	EE5251	Digital Protection of Power Systems	3	0	0	3	VIII
		Total	**18**	**0**	**0**	**18**	

DETAILED SYLLABUS

B.Tech. – Honors

Electrical & Electronics Engineering

EE5214	INSTRUMENTATION AND AUTOMATION	3-0-0: 3

Pre-Requisites:

Course Outcomes:

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

CO1	Analyze the performance of physical systems for measurement of physical quantities
CO2	Understand Signal operations and design systems for Conditioning measurement and instrumentation
CO3	Synthesize Industrial Automation and Control technologies
CO4	Implement PLCs for Industrial Automation

Syllabus:

Introduction: Static and Dynamic characteristics of Instrument, measurement of translational and rotational displacement, resistive potentiometers, strain gauges, Linear Variable Differential Transformer (LVDT), Synchros, induction potentiometers, piezoelectric transducers, electro optical devices, digital displacement transducers (translational and rotary encoders), magnetic and photoelectric pulse counting for speed, transducers for torque, voltage, current, power, frequency, power factor and phase angle measurement andmicroprocessor based measurement

Signal Conditioning: Instrumentation amplifiers: Basic characteristics. Chopped and Modulated DC Amplifiers-Isolation amplifiers - Opto couplers - Buffer amplifiers .Noise Reduction Techniques in Signal Conditioning- Fundamentals of 4-20 mA current loops, Regulators and power supplies for industrial instrumentation. Estimation of errors and Calibration, Bus standard for communication between instruments - GPIB (IEEE-488 bus), RS 232 and RS 485 interface, Optical Fiber Based Signal Transmission-Piezoelectric Couplers- Intelligent transmitters. Interrupt-based Data Acquisition. Software Design Strategies-Hardware Vs Software Interrupts-Foreground/ background Programming Techniques

Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems. Data Acquisition systems and PC based automation

Automatic Control, P-I-D Control, Controller Tuning, Special Control Structures: Feed forward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control. Process and Instrumentation Diagrams

Sequence Control: PLCs and Relay Ladder Logic, Scan Cycle, RLL Syntax, Structured Design Approach, Advanced RLL Programming, Hardware environment, Timers and counters: Types of timers, programming timers, ON and OFF- delay timers, pulse timers, forms of counter, programming, up and down counters, timers with counters and sequencer

Learning Resources:

Text Books:

1. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K.Deb, Jaico Publishing House, 2013
2. Measurement Systems, Applications and Design, Doebelin, Tata McGraw Hill, 2008

Reference Books:

1. Programmable Logic controllers, W Bolton, Elsevier- newness, 2009, 5th edition
2. Fundamentals of Industrial Instrumentation, Alok Barua, Wiley India Pvt. Ltd., 2011
3. Measurement & Instrumentation: Trends &Applications, M.K. Ghosh, S. Sen and S. Mukhopadhyay, Ane Books, 2010
4. Chemical Process Control, An Introduction to Theory andPractice, George Stephanopoulos, Prentice Hall India, 2012
5. Programmable Logic Controllers, Frank. D, Petruzella, Tata McGraw Hill 2010, Third Edition

Online Resources:

1. Website reference links: https://paktechpoint.com/free-courses-of-instrumentation-control-automation-scada-electrical/

EE5153	Digital Control Systems	3 – 0 – 0	3 Credits

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

CO1	Evaluate the output of a digital system for a given input.
CO2	Describe the dynamics of a Linear, Time Invariant and Causal digital systems through difference equations.
CO3	Analyze digital systems using the Z-transformation.
CO4	Design digital controllers for Power Electronic Systems.

Syllabus:

Introduction: Digital control systems - Quantizing and quantization error, Data acquisition, Conversion and distribution system

Z-Transform: Z-transform - Z-transforms of elementary functions, important properties and theorems, Inverse Z-transform, Z-transform method of solving difference equations

Z-Plane Analysis of Discrete-Time Control Systems: Impulse sampling and data hold, Pulse transfer function, Realization of digital controllers and digital filters, Mapping between s-plane and z-plane, Stability analysis of closed loop systems in z-plane,Transient and steady state analyses

State Space Analysis: State space representation of digital control systems - Solution of discrete time state space equations, Pulse transfer function matrix, Discritisation of continuous time state space equations, Lyapunov stability analysis

Pole Placement & Observer Design: Controllability, Observability

Quadratic Optimal Control Systems: Design via pole placement, State observers, Quadratic optimal control, Steady state quadratic optimal control, Quadratic optimal control of a servo system

Learning Resources:

Text Books:

1. Digital control engineering, M. Gopal, New Age Int. Ltd., 2014, 2nd Edition.
2. Discrete time control systems, K. Ogata, Pearson Education, 2006, 2nd Edition.

Reference Books:

1. Modern control Engineering, Katsuhiko Ogata, Pearson Education India, 2015, 5th Edition.
2. Digital Control Systems, B.C. Kuo, Oxford University Press, 2012, 2nd Edition.

Online Resources:

https://nptel.ac.in/courses/108/103/108103008/

EE5163	High Power Inverters	3 – 0 – 0	3 Credits

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

CO1	Analyze the Weighted THD and implement SVM based on instantaneous phase reference voltages
CO2	Implement level-shifted, phase-shifted, hybrid and Space Vector PWM schemes for Cascaded H-Bridge Multilevel Inverters
CO3	Develop PWM schemes to balance the neutral point, eliminate common mode voltage and reduce the switching power loss in diode clamped multilevel inverter
CO4	Develop reduced switch count MLIs and PWM current source inverters

Syllabus:

Introduction: Review of two-level inverters and their PWM schemes. Effect of dead-time and compensation in two-level inverters. Limitations of two-level inverters and introduction to multilevel inverters. Convectional multilevel inverter typologies.

Diode clamped multilevel inverter (DCMLI): 3, 4 and 5 level DCMLIs, level-shifted PWM, Neutral point voltage balance, SVM and discontinuous SVM, Elimination of common mode voltage, Active Neutral Point Clamped Inverter (ANPCI).

Cascade H-bridge (CHB) multilevel inverter (MLI): Symmetrical and asymmetrical topologies, level-shifted PWM, phase-shifted PWM, hybrid PWM and SVM. Concept of coupling transformer-less grid connected applications, Topologies of modular multilevel inverters (MMI).

Reduced switch count MLIs: Introduction, classification, operation of T-type, multilevel dc link, switched series parallel source and other topologies.

PWM current source inverters: Trapezoidal modulation, selective harmonic elimination and SVM, Load-commutated inverters (LCI).

Learning Resources:
Text Books:

1. High Power Converters and AC Drives, Bin Wu, Wiley-Inter science, 2017, 2nd Edition.
2. Pulse Width Modulation for Power Converters: Principles and Practice, D. Grahame Holmes and Thomas A. Lipo, IEEE Press, 2003.

References Books:

1. Research publications.

Online Resources:
https://nptel.ac.in/courses/108/102/108102157/

EE5201	ADVANCED COMPUTATIONAL METHODS IN POWER SYSTEMS	3-0-0: 3

Pre-Requisites:

Course Outcomes:

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

CO1	Develop mathematical models for load flow studies for Transmission and Distributionsystems and Fault analysis
CO2	Prepare the input data required for load flow analysis and fault calculations
CO3	Apply appropriate algorithms for load flow studies
CO4	Develop power system software /implementation of algorithm for static power systemstudies

Syllabus:

Introduction, Concept of incidence matrix, formation of A and Â matrices, list of other types of incidence matrices and their limitations. Representation of Generator, Transmission lines and Transformers, Primitive and Network matrices, Y_{bus} formation by Inspection method andits algorithm. Merits and Demerits of Y_{bus} and Z_{bus} matrices in Power System Analysis — Areas of application

Introduction to Load Flow Analysis - Y_{bus} based Power System Static Load Flow Equations. Gauss-Seidel (GS) method, PV-bus treatment, Gauss-Seidel load flow algorithm. Need of Sparsity technique for 'well-grown' power systems, Concept of Sparsity technique, Y_{bus} formation using Sparsity technique. GS with Sparsity technique, Merits and Demerits of GSmethod

Newton-Raphson (NR) load flow method and its algorithm. Merits and Demerits of NR method; Newton's Decoupled, Fast Decoupled equation, algorithm of Fast Decoupled (FDC)method. Merits and Demerits of FDC method; Areas of application of load flow study. AC/DCload flow solutions

Distribution system Load Flow methods-Vector based load flow method, Backward-Forward Sweep method and Current injection method

Load flow studies with Renewable Energy Sources –Solar and Wind Energy Sources. Need of short circuit studies – Assumptions in short circuit studies – Areas of application

Formation of Z_{bus} using step-by-step approach (Addition of a branch & Addition of a link). Modification of Z_{bus} elements for changes

Symmetrical Sequence Components, significance of symmetrical components, approximations, formation of primitive z^{abc}, y^{abc}, z^{012} and y^{012} for various types of faults

Formation of Z_{bus}^{012} by step-by-step algorithm. Derivation of relevant equations for E^{012} for LLLG and LG faults

Text Books:

1. Computer Methods in Power System Analysis, Stagg and El – Abiad , McGraw Hill, ISE, 1986
2. Computer techniques in Power System Analysis, M A Pai and Dr. Dheeman Chatterjee, McGraw hill, 2014, 3e

Reference Books:

1. Power System Analysis, Hadi Sadat, McGraw Hill – International Edition – 1999
2. Computer Modeling of Electrical Power Systems, J. Arrilaga and NR Watson, John Wiley and Sons, 2001, 1e

Online Resources:

1. Website reference links: https://www.engineeringonline.ncsu.edu/course/ece-753-computational-methods-for-power-systems/
2. https://www.youtube.com/playlist?list=PL36A60B630E8C7B56

https://www.youtube.com/playlist?list=PL-uxPiMl0_6GWFPGXgVapb1yjVAZs9YGz

5112	Power Quality Improvement Techniques	3 – 0 – 0	3 Credits

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

CO1	Identify power quality problems in distribution system
CO2	Evaluate power quality indices in distribution system
CO3	Develop mitigation techniques for compensating devices to improve power quality indistribution system
CO4	Suggest compensating devices to improve power quality in distribution system

Syllabus:

Power Quality: Significance of power quality, Power quality terms: Transients, Long- duration voltage variations, Short-duration voltage variations, Voltage imbalance,Waveform distortion, Voltage fluctuation, CBEMA and ITI curves. Devices for Overvoltage Protection: Surge arresters and transient voltage surge suppressors, Isolation transformers and Low-impedance power conditioners.
Waveform Distortion: Introduction, Voltage versus current distortion, Harmonics versus transients, Harmonics indices: Total Harmonics Distortion (THD) and Total Demand distortion (TDD); Harmonic standards; Harmonic analysis; Harmonic phase sequence; Triplen harmonics; Interharmonics.

Harmonic Sources: Introduction; Harmonics generated from electrical machines such as transformers and rotating machines; Arcing devices; Static power conversion: Phase controlled and uncontrolled rectifiers, AC voltage regulators, Cycloconverters, Pulse width modulated inverters; Converter fed ac and dc drives;

Effects of Harmonic Distortion: Introduction; Resonances; Effects of harmonics on rotating machines; Effect of harmonics on static power plant; Power assessment with distorted waveforms; Effect of harmonics on measuring instruments; Harmonic interference with ripple control systems; Harmonic interference with power system protection; Effect of harmonics on consumer equipment; Interference with communicationsystems.

Harmonic Elimination: Introduction; Passive power filters: Design, A Shunt active power filters: Configurations, State of the art, Design and control strategies. Three-phase four- wire shunt active power filters

Voltage Quality: Introduction; Sources of Sags, Swell, Unbalance and Flicker; Voltage quality standards; Effects of sags, Swell, Unbalance and Flicker; Voltage sag magnitude due to fault; Voltage sag magnitude calculation based on influence of cross section of conductor, transformer and fault levels; Critical distance for a voltage sag magnitude; Causes of phase-angle jumps in voltage; Classification of voltage sags, voltage sag transformation due to transformers.

Methods for improving Voltage Quality: Introduction; Dynamic Voltage Restorer (DVR): Operating principle, Configurations, State of the art, Design and control strategies. Three-phase four-wire DVR.

Unified Power Quality Conditioner (UPQC): Introduction; design and control; Three- phase three-wire UPQC and three-phase four-wire UPQC topologies, Multilevel inverters based UPQC topologies, Mitigation of Flicker

Learning Resources:

Text Books:

1. Power Quality: Problems andMitigation Techniques, Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Wiley, 2015.
2. Understanding power quality problems, Math H. J. Bollen, Wiley-IEEEPress, 2000, 1st Edition.
3. Power Quality Enhancement Using Custom Power Devices, Ghosh Arindam, Ledwich Gerard, Springer, 2009.

References Books:

1. InstantaneousPower Theory and Applications to Power Conditioning, Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, Wiley-IEEE Press, 2017.
2. Electrical Power Systems Quality, Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and H. Wayne Beaty, McGraw Hill, 2012, 3rd Edition.
3. Power System Harmonics, J. Arrillaga, N.R. Watson, Wiley, 2003, 2nd Edition.

Online Resources:

1. https://nptel.ac.in/courses/108/107/108107157/
2. https://nptel.ac.in/courses/108/106/108106025/

EE5251	DIGITAL PROTECTION OF POWER SYSTEMS	3-0-0: 3

Pre-Requisites:

Course Outcomes:

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

CO1	Recognize the advantages of digital relays over conventional relay
CO2	Apply the suitable signal processing techniques for protection
CO3	Understand the adaptive criterion for relay decision making
CO4	Identify the new developments in protective relaying and applications

Syllabus:

Overview of Static relays, Transmission line protection, Transformer protection, Need for digital protection

Digital Relays- Basic elements of a digital relay and their functions, signal conditioning subsystem, conversion subsystem, digital relay subsystem

Signal processing techniques– Sinusoidal based algorithms, Fourier analysis based algorithms, Least squares based algorithm, Discrete Fourier Transforms, Wavelet Transforms, Kalman Filtering

Travelling Wave Protection scheme, Digital Protection of Transformers, Infinite Impulse Response Filters, Finite Impulse Response filters

Correction of errors introduced by Instrument Transformers- PTs and CTs, detection of unsaturated fragment of wave shape, CT saturation correction procedure

Decision making in Protective Relays – Deterministic decision making, Statistical Hypothesistesting, Decision making with multiple criterion, Adaptive decision schemes, Adaptive Differential protective scheme

Applications of Fuzzy Logic and ANN for power system protection, Fault location algorithm, Wide Area Monitoring and Protection

Learning Resources:

Text Books:

1. Computer Relaying for Power Systems, A.G.Phadke, James S.Thorp, John-Wiley and sons, 2009, 2/e
2. Digital Signal Processing inPower System Protection and Control, Waldemar Rebizant, Janusz Szafran, Andrzej Wiszniewski, Springer Publication, 2011, 1/e

Reference Books:

1. Digital Protection for Power Systems, A.T.Johns and S.K.Salman, IEE Power Series 15, 1997
2. Digital Power System Protection, Singh, Prentice-Hall of India Pvt. Limited, 2007, 1/e
3. Understanding Digital Signal Processing, Orhan Gazi, Springer, 2017, 2/e
4. Fundamentals of Power System Protection, Paithankar Y.G, PHI, 2010, 2/e

5. Protective Relays-their Theory and Practice, A R C Warrington, Chapman & Hall Ltd., 1968

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ee73/preview
2. NPTEL :: Electrical Engineering - Power System Protection (web contents)
3. NPTEL :: Electrical Engineering - NOC:Power System Protection and Switchgear (video lectures)