NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL



RULES AND REGULATIONS

SCHEME OF INSTRUCTION AND SYLLABI

for B.Tech. 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.

B.Tech. – Electrical and Electronics Engineering

Program Educational Objectives

PEO-1	Design and develop innovative products and services in the field of electrical and electronics engineering and allied engineering disciplines
PEO-2	Apply the knowledge of electrical and electronics engineering to solve problems of social relevance, pursue higher education and research
PEO-3	Work effectively as individuals and as team members in multidisciplinary projects.
PEO-4	Engage in lifelong learning, career enhancement and adopt to changing professional and societal needs

Program Articulation Matrix

PEO / Mission Statements	PEO1	PEO2	PEO3	PEO4
Impart quality education to produce globally competent electrical engineers capable of extending technological services	3	3	2	2
Engage in research & development in cutting edge and sustainable technologies.	1	2	1	3
Nurture scientific temperament, professional ethics and industrial collaboration	3	3	2	2
Impart quality education to produce globally competent electrical engineers capable of extending technological services	3	3	2	2

1-Slightly; 2-Moderately; 3-Substantially

SCHEME OF INSTRUCTION

B.Tech.- Minor Program – Electrical Engineering

S. No.	Course Code		L	T	P	Credits	Sem.
1	EEM01	Electrical Circuits & Energy Conversion Systems	3	0	0	3	III
2	EEM02	Electrical Measurement Technique	3	0	0	3	IV
3	EEM03	Elements of Electrical Power Systems	3	0	0	3	V
4	EEM04	Industrial Applications of Electrical Energy	3	0	0	3	VI
5	EEM05	Power Converters and Applications	3	0	0	3	VII
6	EEM06	Energy Conservation & Audit	3	0	0	3	VIII
		Total	**18**	**0**	**0**	**18**	

DETAILED SYLLABUS

B.Tech. Minor – Electrical Engineering

EEM01	ELECTRIC CIRCUITS & ENERGY CONVERSION SYSTEMS	3-0-0: 3

Pre-Requisites: None

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

CO1	Analyze the given electric and magnetic circuits to solve for unknown parameters
CO2	Understand the principles of Electro-mechanical Energy conversion
CO3	Identify the type and rating of rotating machines and transformers for given application.
CO4	Evaluate the performance of DC machines and AC machines.

Syllabus:

Electrical Circuits: DC Circuits-Kirchoff's voltage and current laws, AC circuits- complex representation of impedance, phasor diagrams, power & power factor, solution of single-phase series and parallel circuits.

Magnetically Coupled Circuits & Energy Conversion: Review of basic concepts, leakage and magnetizing inductance. Principles of energy flow, concept of field energy and co-energy.

DC Machines: Constructional details, classification, EMF and torque equation, characteristics of generators and motors. Speed torque characteristics, Speed control methods, applications of D.C. motors, losses and efficiency.

Single Phase Transformers: Construction, principle of operation, EMF equation, Equivalent circuit, determination of equivalent circuit parameters, Losses, calculation of efficiency and regulation by direct methods.

Three-Phase Induction Motor: Constructional details, types, production of rotating magnetic field-principle of operation and ratings of induction motors. Analysis of Induction Motors: equivalent circuit, Torque-slip characteristics and applications. Speed control methods.

Synchronous Machines: Construction, types of synchronous machines (generators & motors), principle of operation and method of starting synchronous motor, principle of operation, rating of synchronous generator, production of emf and applications.

Learning Resources:

Text Books:

1. Electrical & Electronic Technology, Edward Hughes, Pearson Education, 2016, 12th Edition.
2. Electrical Machinery - Theory, Performance & Applications, P.S. Bimhbra, Khanna Publishers 2014, 7th edition.
3. Basic Electrical Engineering, V N Mittle and Arvind Mittal, Tata McGraw Hill, 2005, 2nd Edition.

Reference Books:

1. Electrical Machines, A Fitzgerald, Charles Kingsley, Stephen Umans, McGraw Hill Education, 2017, 6th edition.
2. The Performance and Design of Alternating Current Machines, M.G. Say, CBS Publishers and Distributors Pvt Ltd; 2005, First Edition.
3. Electric Machinery, Stephen.J.Chapman, McGraw Hill International Edn., 2017, 4th edition.

Online Resources:

1. https://nptel.ac.in/courses/108/108/108108076/

EEM02	ELECTRICAL MEASUREMENT TECHNIQUES	3-0-0: 3

Pre-Requisites: None

Course Outcomes:

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

CO1	Evaluate the performance of PMMC, MI, dynamometer & induction type measuring instruments.
CO2	Determine the circuit parameters using AC and DC bridges.
CO3	Compute the errors in CTs and PTs.
CO4	Select transducers to measure temperature, displacement, strain, angular velocity.

Syllabus:

Introduction: Definitions: Accuracy, tolerance, sensitivity, reproducibility, absolute and secondary measuring instruments, recording instruments**.**

Analog Ammeters and Voltmeters: PMMC and MI instruments: construction, torque equation, range extension, advantages and disadvantages.

Analog Wattmeter and Power Factor Meters: Electrodynamometer type wattmeter and power factor meter: construction, working, torque equation, advantages and disadvantages; Measurement of active and reactive power in single phase; Measurement in three phase.

Analog Energy Meter: Single phase induction type energy meters, construction, working, lag adjustments, errors; Maximum demand indicators.

Electrical Bridges: DC bridges: Wheatstone, Kelvin's, Kelvin's double bridge, Megger, Earth resistance measurement; AC bridges: Maxwell's, Anderson, Schering; Applications and limitations.

Instrument Transformers: Construction, working, testing & applications of current transformer and potential transformer.

Transducers: Thermistor, RTD, thermocouple, LVDT, strain gauge, piezoelectric transducers, digital shaft encoders, tachometer, Hall Effect sensors.

Electronic Instruments: Digital voltmeters, Digital Energy Meter, CRO, measurement of voltage and frequency, Lissajous patterns, wave analyzers, harmonic distortion analyzer, LCRQ-meter.

Learning Resources:

Text Books:

1. A Course in Electrical Measurements, Electronic Measurements and Instrumentation, A. K. Sawhney, Dhanpat Rai and Co., 2015.
2. Modern Electronic instrumentation and Measurements Techniques, William D. Cooper, Albert D. Helfrick, Prentice Hall of India Pvt. Ltd. 2002.
3. Electrical and Electronics Measurements and Instrumentation, Prithwiraj Purkait, Budhaditya Biswas, Santanu Das, Chiranjib Koley, McGraw Hill Education (India) Private Limited, 2013.

Reference Books:

1. Electrical Measurements and Measuring Instruments, E.W. Golding, F.C. Widdis, Reem Publications, 2011.
2. Measurement Systems-Applications and Design, Ernest O. Doebelin, McGraw-Hill College,

4th edition, 1989.

Online Resources:

1. https://nptel.ac.in/courses/108/105/108105153/

EEM03	ELEMENTS OF ELECTRICAL POWER SYSTEMS	3-0-0: 3

Pre-Requisites: Electric Circuits & Energy conversion Systems.

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

CO1	Understand the operation of conventional generating stations and renewable sources of electrical power
CO2	Analyze the power economics and power tariff methods.
CO3	Identify the types of insulators and its working
CO4	Evaluate power system sustainability and reliability

Syllabus:

Introduction: Typical Layout of an Electrical Power System Present Power Scenario in India.

Generation of Electric Power (Qualitative): Conventional Sources: Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant. **Renewable energy Sources:** Wind Energy, Fuel Cells, and Solar Energy, Tidal

Economics of Generation: Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants. Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.

AC Distribution: Introduction, single line diagram of a typical power system, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site and layout of substation,

Overhead Line Insulators: Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators.

Insulated Cables: Introduction, insulation, insulating materials, Extra high voltage cables, grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cables, Overhead lines versus underground cables, types of cables.

Sustainability of Power System: environmental sustainability, economic sustainability, social sustainability, concept of power system reliability

Technology Drivers (Qualitative): Technologies associated with Distributed energy Resources (e.g. Fuel cells, Microturbines, Solar PV)

Learning Resources
Text Books:

1. Generation, Distribution and Utilization of Electrical Energy, C.L. Wadhwa, New-Age International, Second Edition, 2009.
2. Electrical Power Systems, C.L. Wadhwa, New-Age International, Fifth Edition, 2009.
3. Elements of Power System Analysis, W.D.Stevenson, McGraw Hill, Fourth Edition, 1984.

Reference Books:

1. Sustainable Power Systems, Nava Raj Karki, Rajesh Karki, Ajit Kumar Verma, Jaeseok Choi, Springer Singapore, 2017.
2. Modeling and Control of Sustainable Power Systems, Lingfeng Wang, Springer-Verlag Berlin Heidelberg, 2012.
3. Elements of Electrical Power Station Design, M.V.Deshpande, Wheeler Pub., Third Edition, 1998.

Online Resources:

1. https://www.coursera.org/learn/electric-power-systems
2. https://onlinecourses.nptel.ac.in/noc19_ee62/preview

EEM04	INDUSTRIAL APPLICATIONS OF ELECTRICAL ENERGY	3-0-0: 3

Pre-Requisites: none

Course Outcomes:

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

CO1	Understand basic principles of electric heating and welding.
CO2	Determine the lighting requirements for flood lighting, household and industrial needs
CO3	Estimate heat developed in induction furnace.
CO4	Evaluate power requirement in electrolytic processes & speed time curves for traction.

Syllabus:

Illumination Science: Laws of illumination, coefficient of Utilization and depreciation, Polar curves, photometry, integrating sphere, sources of light, fluorescent lamps, compact fluorescent lamps, LED lamps discharge lamps, mercury vapour lamps, sodium vapour lamps and neon lamps, comparison between tungsten filament lamps and fluorescent tubes. Basic principles of light control, Types and design of lighting scheme, lighting calculations, factory lighting, street lighting and flood lighting.

Electric Heating: Principles of Electric Heating, Various Schemes and methods of Resistance heating-Direct and Indirect heating, Induction heating, Dielectric heating and Microwave heating. Applications of Heating and modern heating methods. Simple problems.

Electric Arc Welding: Electric welding equipment, resistance welding and arc welding, comparison between AC and DC welding.

Electrolytic Process: Basic principles, Faraday's law of Electrolysis, Electro deposition, Extraction and refining of metals, Power supply of Electrolytic processes.

Electric Traction: Systems of electric traction and track electrification- DC system, single phase and 3-phase low frequency and high frequency system, composite system, kando system, comparison between AC and DC systems, problems of single-phase traction with current unbalance and voltage unbalance. Systems of train lighting, special requirements of train lighting, methods of obtaining unidirectional polarity constant output- single battery system, Double battery parallel block system, coach wiring, lighting by making use of 25 kV AC supply, Speed control of Traction motors(DC Series motors) series-Parallel connection, Shunt Transition, Bridge Transition. Problems on series-parallel control.

Learning Resources:

Text Books:

1. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons, 2017.
2. Modern Electric Traction, H. Partab, Dhanpat Rai & Co, 2017.
3. Utilisation of Electric Energy, E. Openahaw Taylor, Orient Longman, 1971.

Reference Books:

1. Generation Distribution and Utilization of Electrical Energy, C.L. Wadhwa, New Age International Publishers, 3rd Edition, 2017.
2. Utilisation of Electrical power including Electric drives and Electric Traction, N.V. Suryanarayana, New Age Publishers, Second Edition, 2017.

Online Resources:

1. https://nptel.ac.in/courses/108/105/108105060/
2. https://www.youtube.com/watch?v=mX8k3xrOXwg

EEM05	POWER CONVERTERS AND APPLICATIONS	3-0-0: 3

Course Outcomes:

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

CO1	Select switching devices for a given power converter.
CO2	Evaluate the performance of phase-controlled rectifiers.
CO3	Identify and design DC-DC converter for a given application.
CO4	Analyze & evaluate the Inverters and ac voltage controllers for a given application.

Syllabus:

Introduction: Concept of power electronics, scope and applications, types of power converters, power semiconductor switches and V-I characteristics: Diodes, SCR, TRIAC, power MOSFET, IGBT devices and applications. Line commutation of SCR, gate drive circuit.

Phase-Controlled Rectifiers: Principles of single-phase full- & half-controlled converter with R, RL, and RLE load, Principles of three- phase fully controlled converter operation with RLE load, and applications.

DC-DC Converters: Introduction, chopper classification of choppers, Basic principles of step-down and step-up operation, study of Buck, Boost and Buck-Boost converters and applications.

Inverters: Introduction, principle of operation, performance parameters, single phase bridge inverters with R, RL and RLC loads, 3-phase bridge inverters-180 and 120 degrees mode of operation, voltage control of single phase inverters-single pulse width modulation, sinusoidal pulse width modulation and applications.

A.C. Voltage Controllers: Introduction, principle of operation of single-phase voltage controllers for R, R-L & R-L-E loads and applications.

Learning Resources:

Text Books:

1. Power Electronics - Circuits, Devices and Applications, M.H.Rashid, Pearson Education; Fourth edition, 28 November 2017.
2. Power Electronics: Essentials & Applications, L. Umanand, Wiley publishers, Kindle Edition, 1 January 2009.

Reference Books:

1. Elements of Power Electronics, Philip T. Krein, Oxford University Press, Indian Edition, Second edition, 1 November 2017.
2. Power Electronics - Converters, Applications and Design, Mohan Undeland Robin, John Wiley & Sons, 2006.

Online Resources :

1. https://nptel.ac.in/courses/108/101/108101038/

EEM06	ENERGY CONSERVATION AND AUDIT	3-0-0: 3

Course Outcomes:

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

CO1	Assess energy conservation opportunities in electrical system
CO2	Applying energy conservation techniques in power transmission and distribution system
CO3	Identify energy conservation opportunities in thermal system
CO4	Know energy auditing procedure and reporting

Syllabus:

Module I: Basics of energy Conservation

Potential areas in the Power Industries for energy saving. Energy Saving methods with typical examples and exercises for power stations. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load Scheduling-Case studies

Module II: Energy Conservation in Power transmission and Distribution

Ways to minimize losses in power transmission & distribution system, Components of the System That Contribute to Losses – transformer, transmission system conductors, distribution stations, voltage regulators, distribution lines. reducing line losses, power factor and reactive power, Demand response program in managing line losses.

Module III: Energy conservation in power plants

Waste Heat areas and their utilization, Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler.

Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.

Module V: Energy audit (Through Course project)

Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants - Case study. Computer aided energy management,

Module VI: Energy audit execution and reporting (Through course project)

Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach,

Learning Resources:

Text Books:

1. Introduction to Energy Conservation and Management, M Jayaraju and Premlet, Phasor Books, 2008.
2. Optimizing Energy Efficiencies in Industry, G.G. Rajan, Tata McGraw Hill, Pub. Co., 2001.
3. Energy Audit and Management, Volume-I, IECC Press
4. Energy Efficiency in Electrical Systems, Volume-II, IECC Press

Reference Books:

1. Handbook of Energy Audits, Albert Thumann, William J. Younger, CRC Press, 2003.
2. Industrial energy conservation, Charles M. Gottschalk, John Wiley & Sons, 1996.
3. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988

Online Resources:

1. https://beeindia.gov.in/
2. http://nptel.ac.in/
3. https://lbre.stanford.edu/sem/energy_conservation