# INFORMATION BROCHURE

Master of Technology in Power System and Control

 (An Accredited Post Graduate Programme by National Board of Accreditation, India)



National Institute of Technology Raipur

**Address:**

Department of Electrical Engineering, National Institute of Technology Raipur

G.E. Road, Raipur, Chhattisgarh 492010, INDIA.

Website: nitrr.ac.in

# ABOUT THE INSTITUTION

In view of the fact of a young nation and also with an aim of harnessing the ample mineral resources of the region, this institute, presently recognized as NIT Raipur, was set-up on 1st May 1956 as Government College of Mining and Metallurgy. The first President of independent India honorable Dr. Rajendra Prasad laid the Foundation stone of the college building on 14th September 1956.

The construction work was completed in 1962 and on 14th March 1963, India's first Prime Minister Pt. Jawaharlal Nehru performed the inauguration. The first session of the college commenced from 1st July 1956 with the admission of 15 students each in Mining and Metallurgy Engineering. In 1958-59 with the commencement of additional courses in Civil, Mechanical and Electrical Engineering the college came to be known as Government College of Engineering and Technology. Later graduate courses in Chemical Engineering (1965), Architecture (1984), Electronics (1985), Information Technology, Computer Science and Technology (2000), Biotechnology, Biomedical Engineering (2003) were also started. In view of its great past with 50 years old record of excellence and several strengths, the institute has been declared as National Institute of Technology (NIT) by the Central Government on 1st Dec. 2005.

National Institute of Technology, Raipur (NITRR), hence formed in the year 2006,

is an Institute of national importance and presently runs academic courses in 12 disciplines in the form of graduate and post graduate courses. The institute also inducts regular and part-time scholars for PhD courses. In addition to this, the institute intends to provide continuing education in a very broad spectrum keeping in view the needs of industries, academic institutions, research organizations and, last but not least, the society. The institute is committed to the challenging task of development of technical education by preparing seasoned graduates in highly sophisticated fields of engineering and technology. Development of India as an emerging industrial power is a demanding exercise as it involves the combination of cost effectiveness and efficiency along with producing world-class technology at the cutting edge. For about five decades we have been doing it with utmost sincerity and commitment at NIT Raipur

# ABOUT THE DEPARTMENT

Established in the year 1958, today the department offers undergraduate program (B. Tech.) in Electrical Engineering and Postgraduate program (M. Tech.) in Power System and control. It is one of the largest departments of the institute with intake of

115 students for undergraduate course and 25 students through GATE (and non-GATE in Special round) and 5 sponsored for post graduate course. Department also offers Ph.D. program in all relevant discipline of Electrical Engineering.

#### Vision: -

* Electrical Engineering Department aims at imparting the state of the art know ledge and skills to the students, thus, developing them into excellent Electrical Engineers, Entrepreneurs, Scientists, and Academicians.

#### Mission: - The mission of Department of Electrical Engineering is;

* To provide students with a conducive environment that facilitates learning the fundamental concepts in Electrical Engineering
* To provide excellence in learning through dedicated teaching and innovative industrial projects
* To impart the necessary skills and state-of-the-art knowledge in the relevant fields of Electrical Engineering
* To imbibe self learning attitude and professional ethics
* To prepare students to face the challenges in the emerging areas of Engineering and Technology

***Programme Educational Objectives (PEOs): -***

Under the MTech programme in Power System and Control, the objectives aim to produce qualified Electrical Engineering Post-graduates who will:

* Be successful professionals in resulting domains with proven expertise.
* Contribute to society as responsible, educated, expressive and ethical citizens.
* Achieve appraising peer-recognition; as an individual or in a team.
* Thrive to pursue life-long reflective learning to fulfill their goals.

**ABOUT THE PROGRAMME: M.TECH. IN POWER SYSTEM AND CONTROL**

***PROGRAMME COORDINATOR:* Dr. Sachin Jain**

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Under the MTech programme in Power System and Control, the objectives aim to produce qualified Electrical Engineering Post-graduates who will:

* Be successful professionals in resulting domains with proven expertise.
* Contribute to society as responsible, educated, expressive and ethical citizens.
* Achieve appraising peer-recognition; as an individual or in a team.
* Thrive to pursue life-long reflective learning to fulfill their goals.

## PROGRAMME OUTCOMES (Pos):

**✓ PO1:** An ability to apply attained knowledge;

1. identify, critically analyze, formulate and solve engineering problems,
2. select modern engineering tools and techniques and use them with dexterity,
3. design a system and process to meet desired needs within realistic constraints,
4. contribute by research and innovation to solve engineering problems,
5. devise and conduct experiments, interpret data and provide conclusions.

**✓ PO2:** An ability to understand the impact of engineering solutions;

1. in a contemporary, global, economic, environmental and societal context,
2. for sustainable development.

**✓ PO3:** An ability to function professionally with ethical responsibility;

1. as an individual as well as in multidisciplinary teams with positive attitude,
2. an ability to communicate effectively.

**✓ PO4:** An ability to appreciate;

1. the importance of goal setting. to recognize the need for life-long reflective learning.



# FACULTY OF POWER SYSTEM AND CONTROL

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| --- | --- | --- | --- |
| **NAME** | **DESIGNATION** | **EDUCATION** | **AREA OF INTEREST** |
| [Dr. (Mrs.) S. Gupta](http://www.nitrr.ac.in/viewdetails.php?q=ee.sgupta) | Professor | B.E., M.Tech (VNIT Nagpur), Ph.D. (Pt.RSU Raipur) | Power System & Power Quality/ Power Quality, Power Electronics & Electrical Machines |
| [Dr. P. D. Dewangan](http://www.nitrr.ac.in/viewdetails.php?q=ee.pddewangan) | Associate Professor | B.E., M.Tech (VNIT Nagpur), Ph.D (NIT ,Raipur) | Model Order Reduction, Interval system,Power System |
| [Dr. Anamika Yadav](http://www.nitrr.ac.in/viewdetails.php?q=ee.ayadav) | Associate Professor | B.E., M.Tech (VNIT Nagpur) Ph.D (CSVTU Bhilai:- NIT Raipur as Research Centre) | Power System Protection, Smart Grid, Microgrid, FACTS, HVDC, Power Electronics, Artificial Intelligence, Soft Computing Techniques etc. |
| [Dr. N. D. Londhe](http://www.nitrr.ac.in/viewdetails.php?q=ee.ndlondhe) | Associate Professor | B.E., M.Tech &  PhD (IIT Roorkee) | Measurement & Instrumentation/Signal & Image Processing, Medical Instrumentation, Speech Signal Processing, Machine Learning |
| [Dr. S. Ghosh](http://www.nitrr.ac.in/viewdetails.php?q=ee.sghosh) | Associate Professor | B.E., M.E. (BIT Meshra) Ph.D. (IIT Kharagpur) | Control System & Signal Processing/ Control System, Soft Computing, Biomedical Engg. Pattern Recognition |
| [Dr. R N Patel](http://www.nitrr.ac.in/viewdetails.php?q=ee.rnpatel) | Associate Professor | B.Tech, M.Tech & Ph.D (IIT Delhi) | Power and Energy Systems, Renewable Energy |
| [Dr. Sachin Jain](http://www.nitrr.ac.in/viewdetails.php?q=ee.sjain) | Associate Professor | B.Tech, M.Tech (VNIT Nagpur), Ph.D (IIT Bombay) |  Grid-Tie PV Inverters Design and optimization of power conditioning circuits for DC-DC converters and inverters  |
| [Dr. Ebha Koley](http://www.nitrr.ac.in/viewdetails.php?q=ee.ekoley) | Associate Professor | B.E., M.E. (SATI Vidisha), Ph.D (NIT Raipur) | Power System Protection, Soft Computing Techniques, Electrical Machine & Drives |
| [Dr. S. Patnaik](http://www.nitrr.ac.in/viewdetails.php?q=ee.spatnaik) | Associate Professor | B.E., M.Tech & Ph.D (NIT Rourkela) | Power Electronics, Converters for Renewable energy application, Electrification of transportation, Switch mode power supplies |
| [Dr. B. Shaw](http://www.nitrr.ac.in/viewdetails.php?q=ee.bshaw) | Assistant Professor | B.E. M.Tech (CU)Ph.D (ISM Dhanbad) | Power System/Artificial Intelligence Techniques to Power System |
| [Dr.(Mrs.) Varsha Singh](http://www.nitrr.ac.in/viewdetails.php?q=ee.vsingh) | Assistant Professor | B.E., M.Tech & Ph.D (NIT Raipur) | Multilevel Inverters, DC-DCconverters, ACDrives, Softcomputing techniques inpower electronics. |
| [Dr. M. Biswal](http://www.nitrr.ac.in/viewdetails.php?q=ee.mbiswal) | Assistant Professor | B. E. M.Tech Ph.D (Sambalpur University) | Smart Grid Protection,Microgrid Protection,FACTS devices,Adaptive Relaying, |
| [Dr. Lalit Kumar  Sahu](http://www.nitrr.ac.in/viewdetails.php?q=ee.lkumar) | Assistant Professor | B.E., M.Tech & Ph.D (MANIT Bhopal) | Power Electronics & Drives/Vehicular Electrification, Power Electronics Converters, Multilevel Inverters |
| [Dr. K Chandrasekaran](http://www.nitrr.ac.in/viewdetails.php?q=ee.kchandrasekaran) | Assistant Professor | B.E., M.E. (Anna University), Ph.D (NITK Surathkal) | High Voltage Engineering (Lightning),Lightning, LEMF, Coupling Computation, Application of GA in High Voltage |
| Dr.B. N. Bag | Assistant Professor | B.Tech., M.Tech & Ph.D (MANIT Bhopal) | Network planning and Management (Power System), V-Var-W control |
| [Dr. Sonti Venu](http://www.nitrr.ac.in/viewdetails.php?q=ee.svenu) | Assistant Professor | B.Tech(KLCE)M.Tech(NIT Warangal)PhD (NIT Warangal) | Multilevel Inverters, PWM Techniques, Renewable Energy |
| [Dr. Ramya Selvaraj](http://www.nitrr.ac.in/viewdetails.php?q=ee.rselvaraj) | Assistant Professor |  Ph.D. | Chemical and industrial gas sensing, IR spectroscopy, TDLAS, Photoacoustic spectroscopy, Breath gas analysis  |
| [Dr. D. Suresh](http://www.nitrr.ac.in/viewdetails.php?q=ee.dsuresh) | Assistant Professor | B.Tech, M.Tech, Ph.D (IIT Roorkee) | Electrical drives and power electronics |
|  [Dr. Hari priya Vemuganti](http://www.nitrr.ac.in/viewdetails.php?q=ee.hpvemugant) | Assistant Professor | B.Tech, M.Tech, Ph.D (NIT Warangal) | Multilevel inverters, Active front converters  |

## COURSE STRUCTURE/ SYLLABUS

**SEMESTER- I**

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| **NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR(CHHATTISGARH)** |
| **Department of Electrical Engineering** |
| **M.Tech in Power System & Control** |
| **Course of Study** | **M.Tech: First Semester** |
| **Sn.** | **Board of Studies** | **Subject Code** | **Subject Name** | **Periods/****Week** | **Examination Schemes** | Total Marks | Credits L+(T+P)/2 |
| L | T | P | TA | FE | SE | ESE | PRACTESE |
| 1 | Electrical | EL 41111EL | Modern Control Theory | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 2 | Electrical | EL 41112EL | Flexible AC Transmission System | 3 |  | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 3 | Electrical | EL 41113EL | Electrical Drives | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 4 | Electrical | \* | Elective-I | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 5 | Electrical | \* | Elective-II | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 6 | Electrical | EL 41121EL | Power System Laboratory-I | - | - | 3 | 75 | - | - | - | 50 | 125 | 2 |
| 7 | Electrical | EL 41122EL | Electrical Dives Laboratory | - | - | 3 | 75 | - | - | - | 50 | 125 | 2 |
| **Total** | **15** | **5** | **6** | **250** | **75** | **75** | **500** | **100** | **1000** | **24** |

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| **List of Electives for First Semester** |
| **S.no.** | **Subject Code\*** | **Subject Name** |
| 1 | EL41131EL | Extra High Voltage AC |
| 2 | EL41132EL | High Voltage DC |
| 3 | EL41133EL | System Identification |
| 4 | EL41134EL | Advanced Power Electronic |
| 5 | EL41135EL | Smart Grid Technology |
| 6 | EL41136EL | Power System Dynamics and Control |
| 7 | EL41137EL | Computer Aided Power System Analysis |
| 8 | EL41138EL | Energy Management System |

**SEMESTER –II**

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| **NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR(CHHATTISGARH)** |
| **Department of Electrical Engineering** |
| **M.Tech in Power System & Control** |
| **Course of Study** | **M.Tech: Second Semester** |
| **Sn.** | **Board of Studies** | **Subject Code** | **Subject Name** | **Periods/****Week** | **Examination Schemes** | **Total Marks** | **Credits L+(T+P)/2** |
| L | T | P | TA | FE | SE | ESE | PRACT ESE |
| 1 | Electrical | EL 41211EL | Optimization in Engineering design | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 2 | Electrical | EL 41212EL | Advanced Power System Protection | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 3 | Electrical | EL 41213EL | Soft Computing Techniques | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 4 | Electrical | \*\* | Elective –III | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 5 | Electrical | \*\* | Elective-IV | 3 | 1 | - | 20 | 15 | 15 | 100 | - | 150 | 4 |
| 6 | Electrical | EL 41221EL | Control System Laboratory | - | - | 3 | 75 | - | - | - | 50 | 125 | 2 |
| 7 | Electrical | EL 41222EL | Power System Laboratory-II | - | - | 3 | 75 | - | - | - | 50 | 125 | 2 |
| **Total** | **15** | **5** | **6** | **250** | **75** | **75** | **500** | **100** | **1000** | **24** |

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| **List Of Electives for Second Semester** |
| **S.no** | **Subject Code\*\*** | **Subject Name** |
| 1 | EL41231EL | Digital Techniques of Power System & Electric Drives |
| 2 | EL41232EL | Advanced Electric Drives |
| 3 | EL41233EL | Power System Modeling |
| 4 | EL41234EL | Power Quality |
| 5 | EL41235EL | Renewable and Non-Conventional Energy System |
| 6 | EL41236EL | Advanced Instrumentation |
| 7 | EL41237EL | Nonlinear and Digital Control System |
| 8 | EL41238EL | Optimal Control System |

***SEMESTER-III***

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| **NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR(CHHATTISGARH)** |
| **Department of Electrical Engineering** |
| **M.Tech in Power System & Control** |
| **Course of Study** | **M.Tech: Third Semester** |
| **Sn.** | **Board of Studies** | **Subject Code** | **Subject Name** | **Periods/****Week** | **Examination Schemes** | **Total Marks** | **Credits L+(T+P)/2** |
| L | T | P | TA | FE | SE | ESE | PRACTESE |
| 1 | Electrical | EL 41321EL | Preliminary work on dissertation | - | - | 24 | 100 | - | - | - | 200 |  300 | 12 |
| 2 | Electrical | EL 41322EL | Comprehensive VivaVoce & Seminar | - | - | - | - | - | - | - |  200 |  200 | 4 |
| **Total** | **0** | **0** | **24** | **100** | **0** | **0** | **0** | **400** | **500** | **16** |

## SEMESTER-IV

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| **NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR(CHHATTISGARH)** |
| **Department of Electrical Engineering** |
| **M.Tech in Power System & Control** |
| **Course of Study** | **M.Tech: Fourth Semester** |
| **Sn.** | **Board of Studies** | **Subject Code** | **Subject Name** | **Periods/Week** | **Examination Schemes** | **Total Marks** | **Credits L+(T+P)/2** |
| L | T | P | TA | FE | SE | ESE | PRACTESE |
| 1 | Electrical | EL 41421EL | Dissertation | - | - | 32 | 200 | - | - | - | 300 | 500 | 16 |
| **Total** | **0** | **0** | **32** | **200** | **0** | **0** | **0** | **300** | **500** | **16** |

**SEMESTER - I**

**Course Title: MODERN CONTROL THEORY**

1. **State Variable Modelling and Analysis**

State Equations (continuous and discrete time), solution of state equations, system equivalence, Canonical forms, Stability , Linearization, MIMO(multi-input multi-output) system **.**

1. **Controllability & Observability**

Concept of controllability & observability, Grammian, controllability and observability tests for continuous -time systems, controllability and observability of discrete-time systems, canonical forms of state models.

1. **State models and input-output descriptions**

Input-output maps from state model and vice-versa, transfer matrix, output controllability, reducibility, Liapunov stability analysis.

1. **State feedback control**

Introduction, Effect of state feedback on controllability and observability, pole placement by state feedback; Integral state feedback, Full order observers, Reduced-order observers; constrained observer design.

1. **Introduction to Robust Control**

Modeling, Uncertainty and Robustness, Co-prime factorization, System Stabilities, Sensitivity function, General regulator problem, Small-gain theorem

1. **Fractional Order Controller**

Fractional order calculus, Fractional order transfer function modelling, Frequency domain analysis of fractional order controller, Time domain analysis of time domain controller.

**Course Title: FLEXIBLE AC TRANSMISSION SYSTEM**

Power flow analysis in ac systems, meshed system, concept of FACTS, dynamic stability consideration, basic types of FACTS controllers, voltage source converter, current source converters, objectives of shunt compensation, static shunt compensators - SVC & STATCOM - methods of controllable var generation- TCR, TSC, FC-TCR, TSC-TCR, switching converter type var generators-basic operating principle, STACOM, Hybrid Controllers, objectives of series compensation, static series compensators, variable impedance type series compensators:- GCSC, TSSC, TCSC, switching converter type var generators :SSSC, Combined series and shunt Controller: Unified power flow controller (UPFC).

**Course Title: ELECTRICAL DRIVES**

Basic concept of electric drives, classification of electric drives, Requirement of electric drives, fundamental torque equation, speed torque conventions and multi quadrant operation, steady state stability of electrical drives

Speed control and, closed loop control of drives, current limit control, closed loop torque control, closed loop speed control, closed loop speed control of multi motor drives, phase locked loop controller (PLL), closed loop position control.

Speed torque characteristics of dc and induction motors,

Starting and speed control of Direct Current motors and induction motors

Breaking of industrial motors

Bidirectional Electric drive system and four quadrant Electrical drive systems

Single phase induction motors

**Course Title: EXTR HIGH VOLATGE A.C. TRANSMISSION**

E.H.V. A.C. Transmission trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses. Calculation of line resistance, inductance and capacitance calculation. Generation of High voltage AC, Impulse Volatge. Corona in EHV lines, corona loss formula, attenuation of travelling waves due to corona, Audio noise due to corona and characteristics. Power Frequency voltage control : Problems at power frequency, generalized constants, No load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components : Shunt and series compensation, sub synchronous resonance in series capacitor compensated lines.

**Course Title: - HIGH VOLATGE DC TRANSMISSION**

H.V.D.C. Transmission: General considerations, DC Versus AC transmission, power handling capabilities of HVDC lines, basic conversion principles, static converter configuration: 3-pulse, 6-pulse and 12-pulse converters, converter station and terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter, control of HVDC Converters and systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, Multi-terminal DC links and systems; series, parallel and series parallel systems, their operation and control.

**Course Title: - SYSTEM IDENTIFICATION**

Introduction to system identification, Parameter estimation using input-output data, Least squares algorithm, Generalized, weighted and recursive least squares. Precision of parameter estimates, Cramer-Rao bound, Instrumental variable method, Autoregressive modelling (linear and nonlinear), Kalman filter, extended Kalman filter, LMS based adaptive filter, Likelihood functions and maximum likelihood estimation (MLE); Singular value decomposition (SVD); Stochastic approximation algorithm (STA); Order and structure determination, Yule-Walker equation; Multi-variable system representation, controllability and observability indices; Feedback system identification, Spectral estimation: parametric and non-parametric approaches, Use of optimization techniques in parameter estimation and system identification, Nonlinear system identification using soft computing techniques.

**Course Title: - ADVANCED POWER ELECTRONICS**

Solid State Power Semi-conducting Devices: Review of the thyristors, traic, GTO, transistor MOSFET, IGBT and other modem power devices, characteristics, ratings, commutation methods, protection and requirement of firing circuits.

Review of Phase Controlled Converters: Single and three-phase controlled converters, power factor improvement techniques.

Basic concepts of Switched Mode power converters. Analysis and design of DC to DC converters- Control of DC-DC converters. Isolated and non isolated DC-DC converter.

Single phase and Three phase inverters, Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters. PWM techniques.

Single phase and three phase Cyclo-converters. Reduction in Output Harmonics. Matrix Converter Multilevel Inverters and PWM modulation techniques

**Course Title: - SMART GRID TECHNOLOGY**

**Introduction to Smart Grid**: Evolution of Electric Grid, Concept, Definitions, Need and Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid

**Smart Grid Technologies**: Smart Meters, Plug in Hybrid Electric Vehicles (PHEV), Smart Sensors, Home & Building Automation, Smart Substations, Substation Automation, Feeder Automation. Smart storage like Battery, SMES

**Micro Grids and Distributed Energy Resources**: Concept of micro grid, need & applications of micro grid, formation of micro grid, protection & control of micro grid.

**Information and Communication Technology for Smart Grid**: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN) Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols.

**Course Title: - POWER SYSTEM DYNAMICS AND CONTROL**

Introduction to Power System Stability: Power System Operation and Control, Stability Problems faced by Power Systems, Impact on Power System Operation and Control.

Analysis of Dynamical Systems: Concept of Equilibria, Small and Large Disturbance Stability, Example: Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using Numerical Integration Techniques, Issues in Modeling: Slow and Fast Transients, Stiff Systems.

Stability Issues in Interconnected Power Systems: Single Machine Infinite Bus System, Multi-machine Systems, Stability of Relative Motion, Frequency Stability: Centre of Inertia Motion, Concept of Load Sharing: Governors, Single Machine Load Bus System: Voltage Stability, Torsional Oscillations.

Power System Stability Analysis Tools: Transient Stability Program, Small Signal Analysis Program, EMTP Programs, Real-Time Simulators.

Enhancing System Stability: Planning Measures, Stabilizing Controllers (Power System Stabilizers), Operational Measures- Preventive Control, Emergency Control.

**Course Title: - COMPUTER AIDED POWER SYSTEM ANALYSIS**

Load Flow Analysis (AC/DC), Y-Bus Formulation, Sparse Matrix Techniques, Optimal Power Flow Analysis, Z - matrix for Short Circuit Studies, State estimation, Security and contingency studies, Load Frequency Control

**Course Title: - ENERGY MANAGEMENT SYSTEMS (EMS)**

Energy Efficiency, Optimization, Forecasting, Modeling and Analysis

Energy Efficiency in Industrial Utilities,

Energy Management Centers and Their Functions, Architectures, recent Developments Characteristics of Power Generating Units and Economic Dispatch.

Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints); Solution techniques of Unit Commitment. Generation Scheduling with Limited Energy.

Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations. Interchange Evaluation for Regional Operations, Types of Interchanges

Exchange Costing Techniques.

Methodology Development for a Comprehensive and Cost-Effective Energy Management in Industrial Plants, Energy Demand Analysis and Forecast

### LAB: DRIVES LAB

* + To study the operation of bridge type single phase fully controlled converter with motor /lamp load.
	+ To study the operation of single-phase semi-controlled converter with motor/lamp load.
	+ To perform the speed control of single-phase induction motor using single-phase step down cycloconverter
	+ To perform the speed control of ac motor in open loop and close loop using AC regulator
	+ To measure the following DC Motor Parameter using WARD LEONARD set up

a) Armature resistance measurement

b) Armature inductance measurement

c) Field resistance measurement

d) Field inductance measurement

e) Back emf constant/torque constant

* + To investigate the characteristics and performance of

a) Separately excited DC motor.

b) DC shunt motor.

c) DC series motor

* + To study and perform the speed control and braking of three phase induction motor under

a) Open loop condition.

 b) Close loop condition

* + To study and perform the speed control of slip-ring induction motor using static Kramer drive.
	+ To study and perform speed control of induction motor drive using variable voltage and variable frequency control under

a) Open loop condition.

b) Close loop condition.

* + To study and perform speed control of permanent magnet synchronous motor drive
	+ To study and perform speed control of switched reluctance motor drive

### LAB: POWER SYSTEM LABORATORY –I

* + Simulation of various faults using MATLAB.
	+ To check voltage and current condition for unsymmetrical and symmetrical fault in short, medium, and long transmission lineusing microcontroller based three phase fault analyser (VPL 87)
	+ Location of cable faults using Varley Loop test.
	+ To study the gas actuated Buchholz relay for transformer.
	+ To perform CT polarity test and study the operating principle of current differential relay.
	+ To study the operating principle of Microcontroller based differential relay.
	+ To study the operating principle of underfrequency relay.
	+ To study the operating principle of motor protection relay.
	+ To study the operating principle of Reverse Power relay (Model No: RW 12).
	+ Study of single-phase Directional Overcurrent relay (Model No: JRP 011)
	+ To verify the operating principle of air circuit breaker.

**SEMESTER-II**

**Course Title: OPTIMIZATION IN ENGINEERING DESIGN**

**Module - 1**

**INTRODUCTION**

Convex sets and functions, Least-squares, linear, and quadratic optimization, Formulation of objective function, Incorporating constraints in objective function.

**Module -2**

**DYNAMIC PROGRAMMING**

Discrete and Dynamic Programming with case studies

**Module - 3**

**SINGLE-VARIABLE OPTIMIZATION ALGORITHM**

Bracketing methods, Region elimination methods; Interval halving method, Fibonacci search method, Point-estimation method; Successive quadratic estimation method. Gradient-based methods : Newton-Raphson method, Bisection method, Secant method, Computer programmes.

**Module - 4**

**MULTIVARIABLE OPTIMIZATION ALGORITHM**

Optimality criteria, Unidirectional search, Direct search methods: Evolutionary optimization method, Simplex search method, Hooke-Jeeves pattern search method.

**Module -5**

**CONSTRAINED OPTIMIZATION ALGORITHM**

Kuhn Tucker Condition, Rosen’s Gradient projection method, Penalty function method.

**Module - 6**

**NONTRADITIONAL AND EVOLUTIONARY OPTIMIZATION ALGORITHMS**

Genetic Algorithm, Differential Evolution and Particle Swarm Optimization. Application of evolutionary optimization algorithms in power systems and power electronics.

**Module-7**

**MULTIOBJECTIVE OPTIMIZATION**

Formulation of optimization problem with multiple objectives, Pareto Optimality, NSGA (Non-sorted genetic algorithm).

**Course Title: ADVANCED POWER SYSTEM PROTECTION**

Digital Protection: Overcurrent, Fault Detection, Directional Relaying, Fault Classification, Differential and Distance Protection, Fault Location. Sequence networks & short circuit analysis; Relay coordination, Introduction to Current Transformer & Potential transformer; Introduction to computer aided relaying, Aliasing, Anti Aliasing, Phasor Estimation: Discrete Fourier transform (DFT), Half Cycle DFT, Full Cycle DFT, Least Square, Frequency Estimation, Transformer & Bus Bar Protection; Out-of-Step Relaying Introduction to adaptive relaying & wide area measurements. Numerical algorithms, Simulation of Transients, electromagnetic transient program (EMTP).

**Course Title: SOFT COMPUTING TECHNIQUES AND ITS APPLICATIONS**

Introduction of soft computing techniques, Artificial Neural Network: Introduction to Biological neural network and Artificial Neural Network: Evolution of ANN, Basic neuron modeling , comparison between ANN and human brain, characteristics, neuron models/ Architectures, activation functions, Learning (Supervised & Unsupervised) strategies, Back propagation network, Kohonen’s Self organization map, competitive network, Applications of Neural network. Fuzzy Logic: Introduction to classical sets and operations, Fuzzy set theory and operations, Membership functions, Fuzzy rule base, fuzzification and defuzzification methods, fuzzy inference systems, Applications of fuzzy logic,. Genetic algorithm: Introduction, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modelling: Significance of Genetic operators, cross over, mutation, GA optimization problems.

**Course Title: DIGITAL TECHNIQUES TO POWER SYSTEM AND ELECTRIC DRIVES**

**Review of basic microprocessors**: Architecture and instruction set of 8085 microprocessor Evolution of advanced microprocessors: Introduction to 16, 32 and 64 bit microprocessors. architecture, working and applications of 8086 microprocessor.

**Microcontrollers**: Evolution of micro-controllers, comparison between micro processor and micro-controllers,Overview of various microcontroller architectures (e.g.8051, 8096 and PIC Serie) and their suitability for diverse applications.

Typical applications in the control of power electronic converters for power supplies and electric motor drive. PWM implementation, Implementation of P, PI and PID controllers. Implementation of digital controllers and filters, Power quality/power factor correction, Solar Power Conditioning (MPPT), microprocessor-based distribution relay applications etc.

**Course Title: ADVANCE ELECTRIC DRIVES**

Generalized theory of synchronous machines : The ideal theory of synchronous machine, synchronous machine inductance, transformation to direct and quadrature axis variables, basic machine relation id dq0 variables, steady state analysis using dq0, transient analysis, three-phase short circuit, transient power angle characteristics. Generalized theory of Inductance machines: The ideal induction machine, transformation to dqvariables, basic machine relation in dqvariables, steady state analysis using dq0, electrical transients in induction machine, power invariance. Modelling of electrical machines , reference frame theory. Control of Induction Motor Drive: Scalar control of induction motor, Principle of vector control and field orientation

**Course Title: POWER SYSTEM MODELLING**

Synchronous Machines Modelling: Per unit system and normalization, Park’s transformation, Flux –linkage equation , Voltage and current equations , Formulation of state space equations , Equivalent circuit , Sub-transient and transient inductance and time constant, Simplified models of synchronous machines.

Steady state equations and phasor diagram, Determination of machine parameters from manufacturer’s data. Linear model of single machine infinite bus system.

Load modelling of different types of load, transmission line modelling, modelling of Excitation and Prime movers controllers

**Course Title: POWER QUALITY**

**Power Quality**: What is power quality, power quality, voltage quality, and overview of power quality phenomena, - IEC and IEEE definitions, EMC standards, terms and definitions.

**Voltage Sag and Interruptions**: Motor –starting sags

**Transient Overvoltage**: Sources of transient overvoltage, principles of overvoltage protection, utility capacitor-switching transients, utility system lightning protection

**Fundamentals of Harmonics**: Harmonic distortion, harmonics versus transients, harmonic indices harmonic sources, effects of harmonic distortion, inter-harmonics, Standards of harmonics.

**Long-Duration Voltage Variations**: Principles of regulating the voltage, devices for voltage regulation. Flicker: sources and mitigation.

**Power Quality Monitoring**: Power quality monitoring standards

**Course Title: RENEWABLE AND NON-CONVENTIONAL ENERGY SYSTEM**

World energy use – Reserves of energy resources – Environmental aspects of energy utilisation – Renewable energy scenario in India – Potentials – Achievements – Applications. Introduction to renewable energy sources, wind, solar, hydrogen etc.

Wind Energy: Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, Various aspects of wind turbine design, Wind Turbine Generators: Induction, Synchronous machine, constant V & F and variable V & F generations, Reactive power compensation Site selection, planning of wind farms - maintenance and operation - environmental assessment

Solar Energy & Environment, Present & Future Scope of Solar energy. Solar radiation - photo voltaic effect - types of PV cells. electrical properties . equivalent circuit - cell characteristics - effects of temperature variation, insolation level and tilt angle . peak power point operation - PV cell model - PV module, Grid connected systems: Technical and non-technical considerations – system size and module choice Stand-alone systems: Modules .Batteries . charge controllers, stand-alone inverters- sizing of PV arrays .

Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles. Hydrogen Production: Direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production. Storage of Hydrogen. Fuel cell – Principle of working, construction and applications.

Hybrid energy system, Hybrid wind energy systems - wind + diesel power, wind + conventional grid, wind + Photovoltaic system + fuel cell etc.

**Course Title: ADVANCED INSTRUMENTATION**

**Measurement of force torque, velocity**

Electric balance – different types of load cells – magnets – elastics load cell-strain gauge load cell-different methods of torque measurement, strain gauge, relative regular twist-speed measurement-revaluation counter- capacitive tacho-drag up type tacho D.C and A.C tacho generators – stroboscope.

**Measurement of acceleration, vibration and density**

Accelerometers – LVDT, piezo- electric, strain gauge and variable reluctance type accelerometers – mechanical type vibration instruments – seismic instrument as an accelerometer and vibrometer – calibration of vibration pick ups – units of density, specific gravity and viscosity used in industries – Baume scale API scale – pressure head type densitometer – float type densitometer – ultrasonic densitometer Bridge type gas densitometer.

**Pressure measurement**

Units of pressure – manometers – different types – elastic type pressure gauges – Bourde type bellows – diaphragms – Electrical methods – elastic elements with LVDT and strain gauges – capacitive type pressure gauge – piezo resistive pressure sensor – resonator pressure sensor – measurement of vacuum – McLeod gauge – thermal conductivity gauges – Ionization gauge cold cathode and hot cathode types – testing and calibration of pressure gauges – dead weight tester.

**Temperature measurement**

Definitions and standards – primary and secondary fixed points – calibration of thermometers different types of filled in system thermometer – sources of errors in filled in systems and their compensation – Bimetallic thermometers – Electrical methods of temperature measurement – signal conditioning of industrial RTDs and their characteristics –3 lead and 4 lead RTDs, Thermocouples and pyrometers.

**Measurement of viscosity, humidity and moisture**

Viscosity terms – say bolt viscometer – rotameter type viscometer – industrial consistency meters – humidity terms – dry and wet bulb psychrometers – hot wire electrode type hygrometer – dew cell – electrolysis type hygrometer – commercial type dew point meter – moisture terms – different methods of moisture measurement – moisture measurement in granular materials, solid penetrable materials like wood, web type material.

**Electrical type flow meter**

Principle and constructional details of electromagnetic flow meter – different types of excitation – schemes used – different types of ultrasonic flow meters – laser doppler anemometer systems – rortex shedding flow meter – target flow meter – solid flow rate measurement – guidelines for selection of flow meter.

**Level measurement**

Gauge glass technique coupled with photo electric readout system – float type level indication – different schemes – level switches level measurement using displacer and torque tube – bubbler system. Boiler drum level measurement – differential pressure method – hydra step systems – electrical types of level gauges using resistance, capacitance, nuclear radiation and ultrasonic sensors.

**Course Title: NON LINEAR AND DIGITAL CONTROL SYSTEM**

Introduction to digital control: Introduction, Discrete time system representation, Mathematical modelling of sampling process, Data reconstruction. Modelling of discrete time systems by pulse transfer function: Revising z-transform, Mapping of s-plane into z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph. Stability analysis of discrete time systems: Jury stability test, Stability analysis using bilinear transformation. Time response of discrete-time systems: Transient and steady state responses, Time response parameters of a prototype second order system. Design of sampled data systems: Root locus method, Controller using root locus, Nyquist stability criterion, Bode plot, and Lead, Lag, and Lag-lead compensator design using Bode plot. Deadbeat response design: Design of digital control systems with deadbeat response, Practical issues with deadbeat response design, Sampled data control systems with deadbeat response. Discrete space state model: Introduction of state variable model, Various canonical forms, Characteristic equation, State transition matrix, Solution of discrete state equation, and controllability, observability and stability of discrete state space models. State feedback design: Pole placement design, Full order tracking controller, Reduced-order observer. Output feedback design: Theory and applications.

### LAB: CONTROL SYSTEM LABORATORY

* + To derive the parameters of second order network from the transient response.
	+ To study the digital control of a system using 8-bit microprocessor. Examine the effect on response of the system for (i) time delay (ii) variation in the parameters of PID controller.
	+ To determine the transfer function of a circuit using input-output data.
	+ For the motor control system, design a proportional controller using root locus.
	+ Design a state feedback controller for improving the system response.
	+ Design an Observer-based state feedback controller.
	+ Study the characteristics of magnetic amplifier for series connection.
	+ Design of lead-lag compensator.
	+ To study the characteristics of small ac servo motor and determine its transfer function.
	+ Genetic algorithm based PID controller design.

### LAB: POWER SYSTEM LABORATORY –II

* + Modelling, Simulation and testing of Instantaneous, IDMT, Very Inverse, Extreme Inverse over current relays using MATLAB software. .
	+ Modelling, Simulation and testing of Impedance relay for protection of transmission line using MATLAB software. .
	+ Design of fuzzy logic based impedance relay for protection of transmission line using fuzzy logic tool box and simulink tool box of MATLAB software..
	+ To write a MATLAB program to calculate power input that can be applied to generator without loss of synchronism using equal area criterion..
	+ To write MATLAB program to analyse transient shunt fault at various point in a power system using Equal Area Criterion..
	+ To write a MATLAB program to determine the parameter of equivalent circuit of transformer.
	+ Study of Introduction to 100 kV ac set and to determine the breakdown characteristics of air under the influence of uniform ac field using sphere-sphere gap apparatus.
	+ To determine the breakdown characteristics and study the effect of polarity of the high voltage dc in the breakdown strength of air using sphere- sphere gap apparatus.
	+ To study the components, control and operation of 150kv, 1.2/50µs, 225j impulse generator.
	+ To determine the String efficiency of suspension insulators.

***On/Off Campus Placement of students of M.Tech. Power System and Control***

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| **M.Tech Power System and Control (Batch 2014-2016)** |
| **S.No.** | **Students Name** | **Name of the Employer** |
| 1 | ANKITA NAG | Master of Science: Computer Information Systems and Information Technology, University of Central Missouri (UCM) – Warrensburg, MO |
| 2 | GARIMA NETAM | Assistant Engineer at CSPTCL Gudhiyari Raipur |
| 3 | Vishnu Nair M. T. | KPTCL |
| 4 | Arun Hirani | Power Grid |

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| **M.Tech Power System and Control (Batch 2015-2017)** |
| S.No. | **Students Name** | **Name of the Employer** |
| 1 | ATUL SONI | Pursuing PhD in IIT Kanpur |
| 2 | CHITRARTH RANGARI | CGPSC |
| 3 | THARA JOSE | Assistant Professor, Albertian Institute of Science and Technology |

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| **M.Tech Power System and Control (Batch 2016-2018)** |
| **S.No.** | **Students Name** | **Name of the Employer** |
| 1 | MAHITOSH BANAFER | Pursuing PhD in IIT BHU |

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| **M.Tech Power System and Control (Batch 2017-2019)** |
| S.No. | **Students Name** | **Name of the Employer** |
| 1 | RUCHI CHANDRAKAR | Pursuing PhD in IIT Delhi through PMRF |
| 2 | SUPRIYA NAIK | Pursuing PhD in NIT Raipur |
| 3 | POOJA RANI | CSEB, JE, Janjgir |
| 4 | SOM JAIRAJ ANKAR | Pursuing PhD under Prime Minister’s Research Fellow (PMRF) for Doctoral Studies at National Institute of Technology, Tiruchirappalli. |

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| **M.Tech Power System and Control (Batch 2018-2020)** |
| **S.No.** | **Students Name** | **Name of the Employer** |
| 1 | SHUBHAM GHORE | CSEB, Junior Engineer, Raipur |
| 2 | UPMA SAHU | CSEB, Junior Engineer, Raipur |

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| **M.Tech Power System and Control (Batch 2019-2021)** |
| **S.No.** |  **Students Name** |  **Name of the Employer** |
| 1 | VIJAY KUMAR | Teaching |
| 2 | ASHAKTI CHANDRAKAR | TCS |
| 3 | BHUMIKA SHYAM AGARKAR | BioUrja |

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| **M.Tech Power System and Control (Batch 2020-2022)** |
| **S.No.** |  **Students Name** |  **Name of the Employer** |
| 1 | MOUNIKA BURIDI | KEC International Company, Mumbai |
| 2 | AMIT KUMAR | Infosys |
| 3 | VAGULAGIRI SRINIVASAN S | Factspan |
| 4 | MONIKA TANJAY | Larsens & Turbo, Post Graduate Engineer Trainee |
| 5 | AJAY SIVA KUMAR NUJELLA | PharmaAce Innovations Pvt Ltd, Data Engineer |
| 6 | AMIREDDY SAINATH REDDY | Assistant Engineer, TSSPDCL |
| 7 | DEWESH BHARDWAJ | GE Aviation (General Electric) |
| 8 | GODVIN JOSEPH | Oracle Server Technology, Member Technical Staff  |
| 9 | KAILASH MESHRAM | DRDO |
| 10 | KOLLU JOSHUA | Delta Technology, Hyderabad, Full stack developer |
| 11 | SANJEEV KUMAR SUMAN | CSIR- Central Institute of Mining and Fuel Research, Project Associate |
| 12 | SOUMYA SHASTRY | Junior Engineer, Chhattisgarh State Power Generation Company (CSPGCL) |

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| **M.Tech Power System and Control (Batch 2021-2023)** |
| **S.No.** |  **Students Name** |  **Name of the Employer** |
| 1 | SHASHANK DEV RATREY | GreyB Patent Private Limited, India |
| 2 | RAVI SEN | Reliance industries limited, India |
| 3 | PRACHI AGRAWAL | Mercedes Benz, Post Graduate Engineer Trainee |
| 4 | MATU SHREE KOCHAR | Larsens & Turbo, Post Graduate Engineer Trainee |
| 5 | KANAPARTI BHAVYA SRI | Pradan, Development Apprentice |
| 6 | NIKITA MISHRA | Tata Consulting Engineers Limited |
| 7 | PANKAJ PRASAD | Jindal Stainless limited, India |

Faculty Publications in Last 5 Years

Sponsored Projects in Last 5 Years

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **2022-23**  | **2021-22**  | **2020-21**  | **2019-20**  | **2018-19**  |
| **Amount in Lakhs** | **78.35** | **141.58**  | **130.98**  | **97.71**  | **109.14**  |

Published Patent Details

|  |  |  |
| --- | --- | --- |
| **S.No.**  | **Patent Title**  | **Faculty**  |
| **1**  | Development of Piezo wheel for electric vehicle | Dr. S. Pattnaik |
| **2**  | System and Method for Generation of and Matching of Biometric Templates. | Dr. N.D. Londhe |
| **3**  | Method for locating faults at single location or multiple locations in power transmission lines | Dr. (Ms.) A. Yadav |
| **4**  | System and method for detecting, classifying and communicating fault in power transmission lines | Dr. S Ghosh & Dr. (Mrs.) E. Koley |
| **5.**  | Fault tolerant Single Phase Multilevel Inverter (Mli) Topology | Dr. Lalit Ku SahuDr. Shubhrata Gupta |
| **6**  | Highly Resilient Fault Tolerant Topology of Single Phase MLI | Dr. Lalit Ku SahuDr. Shubhrata Gupta |
| **7**  | Switched-Capacitors based Circuit for Multilevel DC-to-AC and AC-to-DC Power Conversion | Dr. Lalit Kumar Sahu |
| **8**  | Method And System For A Dual Character Visual Eeg Speller | Dr. Narendra D Londhe |
| **9**  | MODULAR MULTI- INPUT HYBRID CONVERTER (MIHC) FOR AC-DC FED SYSTEMS | Dr. Lalit Kumar Sahu |
| **10**  | MODULAR MULTI- INPUT AND MULTI-OUTPUT DC-DC CONVERTER | Dr. Lalit Kumar Sahu |
| **11**  | BIDIRECTIONAL VOLTAGE CONVERTER WITH VOLTAGE BALANCING CAPABILITY | Dr. Lalit Kumar Sahu |
| **12** | ASYMMETRICAL FAULT TOLERANT MULTILEVEL INVERTER (MLI) TOPOLOGY | Dr. Lalit Kumar Sahu |
| **13** | CONTROLLER BASED SMART REPLACEABLE BATTERY FOR ALL TYPE OF ELECTRIC VEHICLE | Dr. Lalit Kumar Sahu |
| **14** | SMART SYSTEM FOR SAFETY OF FIREFIGHTERS | Dr. Lalit Kumar Sahu |
| **15** | IOT BASED DATAACQUISITIO N SYSTEM RENEWABLE ENERGY GRID | Dr. Lalit Kumar Sahu & Dr. Binod Kumar Shaw |