# INDIAN INSTITUTE OF TECHNOLOGY GANDHINAGAR

## Norms for e-Masters Programme in Energy Policy and Regulation

(As approved by the Senate in its 61st meeting held on 15th November 2022)

**Overall Structure of the Programme:**

[Approx. 10 full course equivalents of 4 credits, 1 credit equivalent to 10 hrs.]
[Min. 400 hrs of engagement required for e-Master's degree]

| S. No | Course Title | Total Engagement (hrs.) |
|---|---|---|
| 1 | Power Sector Reforms & Regulations- Fundamentals, Institutions & Evolution | 40 |
| 2 | Electricity Regulations - Legal & Regulatory Frameworks | 40 |
| 3 | Power System Operations & Electricity Market | 40 |
| 4 | Economics of Power Sector- Tariff Philosophy, Principles & Regulations | 40 |
| 5 | Renewable Energy Market, Regulations & Sustainable Energy Future | 40 |
| 6 | Tariff Regulations - Generation, Transmission, Distribution & Retail Business | 40 |
| 7 | Smart Grid, Ancillary Services & Grid Flexibility | 40 |
| 8 | Demand Side Management and Energy Efficiency | 40 |
| 9 | Environmental Regulations, Carbon Pricing & Green Hydrogen | 40 |
| 10 | Distribution Reforms, Good Governance & Effective Regulators | 40 |
| 11 | Regulatory Capstone Project-1 | 40 |
| 12 | Regulatory Capstone Project-2 | 40 |
| 13 | Writing/Leadership | 40 |
| | Total | 520 |

**Break-up of courses:**

| Course Type | List of Courses from the Programme Structure | Total engagement (hrs.) |
|---|---|---|
| Foundation | 1. Power Sector Reforms & Regulations- Fundamentals, Institutions & Evolution<br>2. Electricity Regulations - Legal & Regulatory Frameworks<br>3. Power System Operations & Electricity Market<br>4. Economics of Power Sector- Tariff Philosophy, Principles & Regulations | **160** |
| Core | 1. Renewable Energy Market, Regulations & Sustainable Energy Future<br>2. Tariff Regulations - Generation, Transmission, Distribution & Retail Business<br>3. Smart Grid, Ancillary Services & Grid Flexibility<br>4. Demand Side Management and Energy Efficiency<br>5. Environmental Regulations, Carbon Pricing & Green Hydrogen<br>6. Distribution Reforms, Good Governance & Effective Regulations | **240** |

| | | |
|---|---|---|
| Regulatory Capstone Project 1 | Suitable Topics relevant with the Program will be decided with mutual consultation. | **40** |
| Regulatory Capstone Project 2 | Suitable Topics relevant with the Program will be decided with mutual consultation. | **40** |
| Writing/Leadership | To be added | **40** |
| **Total engagement (hrs.)** | | **520** |

**Programme Course Contents:**

1. **Power Sector Reforms & Regulations - Fundamentals, Institutions & Evolution [40 Hrs]**

   **Course objectives:**
   The module helps participants to get an overview of the Indian power sector and its evolution through pre & post Reforms. The module provides participants an understanding of the fundamentals Principles of Regulations, Institutions and functioning of Regulatory bodies.
   **Course contents**

   Scope, Significance, and need of Regulations in India, Overview of Indian Power Sector, Generation (Different Fuel), Renewable Energy (all types) Transmission, Distribution, Retail Market, System Operator, Energy Exchange, Evolution of Indian power sector pre-independence, Post-independence, and Reforms and Restructuring of Power Sector, Growth of Renewable Energy, Wind, Solar, Hybrid RE, Waste to Energy and other types of RE, Regulatory Authorities in the power sector, its power and function, Structure of Regulatory bodies, appointment Process, required skills, selection process, terms, Attributes of Regulators, Regulatory Reforms and Good Governance issues Case Study & Group Exercise- Privatization of Distribution in Orissa – Lessons Learnt
   **Mode of conduct:** Interactive sessions with academic and Industry experts, there will be continuous assessment through multiple quizzes, problem solving exercises, viva voce & presentation on the assigned case study.
   **Textbooks/References**
   1. Ignacio J Perez Arriago - *Regulation of the Power Sector*
   2. Deo P, Sushanta K Chatterjee, Shrikant Modak- *Renewable Energy in India: Economics & Market Dynamics*
   3. Alok Kumar and Sushanta K Chaterjee*, "Electricity Sector in India- Policy & Regulations*

2. **Electricity Regulations - Legal & Regulatory Framework [40 Hrs]**

   **Course objectives**:
   The module helps participants understand the legal, policies, statutory & regulatory frameworks of electricity regulation in India. The participants will also understand the process of framing different types of regulations and their significance which are necessary for sustainable development of the power & energy sector.

**Course contents**:

Electricity Act 2003, All Rules notified under the EA2003, National Electricity Policy, National Tariff Policy, Rural Electrification Policy, Competitive Guidelines for procurement of electricity Tariff based competitive bidding guidelines of Transmission services, Mega Power Project Policy, Hydro Policy, Guidelines for taking Renovation and Modernisation of Power Plants, Deen Dayal Gramin Vidyutikaran Yojna- DDUJY, Electricity (Rights of Consumers) Rule, National Policies on Market Development, Solar Policy, Brief on CPC, IPC & Company Law relating to Electricity Regulations, Framework and important Regulations like Conduct of Business Regulations, Fees & Fines Regulation, Staff Recruitment Regulation, etc, Process of framing Regulation, Multi-year Tariff Regulations, Licensing, Power Purchase Agreement, Redressal of Grievances, type of authorities to address consumer's complaints- 2 Case Studies

**Mode of conduct:** Interactive sessions with academic and industry experts. Important case laws of Indian power sector. There will be a continuous assessment based on quizzes, and presentations on an assigned case study on the constraints in present legal/regulatory framework in India in the or small project on challenges in the energy transitions in India.

**Textbooks/References**

1. Kumar Alok and Sushanta K Chaterjee- *Electricity Sector in India-Policy and Regulations*
2. Dubash N K and D Narsimimha, *The Practice and Politics of Regulations- Regulatory Governance in Indian Electricity*
3. Asquer A- *Regulations of Infrastructure and Utilities, Public Policy and management issues*

### 3. Power System Operations & Electricity Market [40 Hrs]

**Course objectives**:

The module helps students understand the concepts of AC circuits, basic structure of power system and its operation, electricity market & power exchanges in India. It will also help them to understand the role & functioning of system operators (national/regional/state load dispatches) in the energy transition in India.

**Course contents**:

Fundamental of AC circuits – balanced/unbalanced 3-phase system, understanding of complex power, active power, reactive power and power factor; Basic structure of power systems - generation, transmission and distribution, fundamentals on economic dispatch, power flow problems and power system stability; Introduction to deregulation and restructuring of power system - Open access & competitive power market, Inter-State and Intra-State Open Access (Short Term/ Medium Term Open Access) regulations, role of system operator/NLDC/RLDC/SLDC and operation guidelines, grid operation and congestion management, Security constrained economic dispatch (SCED), Available Transmission Capability (ATC) determination, Transmission pricing, Open Access charges and requirement of National Tariff Policy, Power Exchange (PX) structure and energy trading process, Day-ahead market (DAM) and real-time market (RTM), operation and related Regulations and Energy Accounting- Procedure & Methodology, Demand forecasting, Deviation settlement mechanism (DSM), Group exercises on generation

scheduling, availability, and deviation settlement.

**Mode of conduct:** Interactive sessions with academic and industry experts. There will be continuous assessment of participants through quizzes, problem-solving exercises, presentations on the assigned case study or projects on power system operations and grid management in best performing States in India and abroad.

**Textbooks/References**

1. Mohammad Shahidehpour and M. Alomoush, Restructured Electrical Power Systems: Operation, Trading, and Volatility, CRC Press, 2001
2. Fried I Denny & David Dismukes - *Power System Operations & Electricity Market*
3. Barrie Murray- *Power Market & Economics*

**4. Economics of Power Sector - Tariff Philosophy, Principles & Regulations [40 Hrs]**

**Course objectives**:

The module covers fundamental principles of regulatory economics and helps participants understand different approaches to the Price Regulations. The module also helps participants understand the economic rationale for regulation and an understanding of tariff setting.

**Course contents**

Fundamental Principles of Economics in the Power Sector, Cost of Producing Electricity, Fixed and Variable Cost, Average & Marginal Cost, Generation, Transmission, Distribution, and Supply Cost, Other Costs of the Power Sector, Economies of Scale-Monopoly to Competitions, The behavior of the Consumer and Demand Curve, The behavior of Supplier and Supply Curve, Law of Supply & Demand, Market Structure, Theory of Market and different forms of Markets, The practice of Tariff Setting in India, Tariff Regulations- Cost Plus Vs Price/Revenue Cap & Hybrid Tariff, Determination of Annual Revenue Requirement (ARR), Multi-Year Tariff Regulations & its Analysis, Case Studies: Approval of Retail Tariff by Regulatory Authorities .

**Mode of conduct:** Interactive sessions with academic and Industry experts. There will be continuous assessment of participants based on quizzes, problem-solving exercises, viva voce, presentation on the assigned case study or project on tariff cases in India and Abroad.

**Textbooks/References**

1. Christopher Decker – *Modern Economic Regulation- An introduction to Theory and Practice*
2. Nancy L. Rose- *Economic Regulation and its Reform*
3. Ignacio J Perez Arriago **-** *Regulation of the Power Sector*

**5. Renewable Energy Market, Regulations & Sustainable Energy Future [40 Hrs]**

**Course objectives**:

The module provides an overview of the Renewable Energy (RE) Policies, Regulations and RE Market in India. It shall help participants understand Central and State regulations on setting of renewable energy tariff and other technical & commercial aspects.

**Course contents**

Legal Provisions & Statutory Policies, Renewable Purchase Obligation (RPO) & State wise position, Present status of RE & Global commitments, RE Tariff and Competitive bidding, Step by Step Method of Tariff Setting of Wind, Solar & Small Hydro, Net & Gross Metering Regulations for Solar Roof Top, CERC Tariff Regulation of RE, Connectivity of RE & Transmission System, Emerging Role of System Operator, Renewable Energy Certificate (REC) Mechanism, The framework of the Market for RE, Standalone System and Microgrid, Green Energy Corridor- Institutional Arrangements & Implementation Strategy, International Solar Alliance, Net Zero, Potential use of RE for EV charging, Policy and Regulatory Framework for EV Charging infrastructure. Case Study-& Group Exercise: 1. Solar Suryashakti Kisan Yojna (SKY) 2. Approval of RPPA at Regulator Level

**Mode of conduct:** Interactive sessions with academic and Industry experts. There will be continuous assessment of participants based on quizzes, problem-solving exercises, Projects on international experiences on EV, Green Hydrogen, Carbon Trading, etc.

**Textbooks/References**

1. Kumar Alok & Sushanta K Chaterjee**-** *Electricity Sector in India-Policy and Regulations*
2. Deo P, Sushanta K Chatterjee, Shrikant Modak**-** *Renewable Energy in India: Economics & Market Dynamics*

## 6. Tariff Regulations - Generation, Transmission, Distribution & Retail Business [40 Hrs]

**Course objectives**:

The module helps participants gain in-depth knowledge to understand the existing Regulatory framework including Multi Year Tariff (MYT) Regulations in generation, transmission, distribution, and retail supply tariff. It helps partici[pants to examine & analyze the Aggregate Revenue Requirement (ARR) & Tariff Proposals of different stakeholders and work out tariff for them.

**Course contents**

Generation- Statutory Provisions and Multi Year Tariff (MYT) Regulations, Fuel Supply Agreement, Power Purchase Agreement (PPA), Determination of Generation Tariff – U/S 62- Tariff Regulations, Step by Step Procedure for ARR & Tariff Setting for Thermal Plant, Availability Based Tariff Regulation, Case Study & Group Exercise on Tariff Setting of Coal Plant in India and its Regulatory approval, Transmission-Statutory Provisions and Regulations, Competitive Bidding for Transmission- Policy & Guidelines, Determination of Transmission Tariff – U/S 62- & as per Tariff Regulations for Transmission, Determination of SLDC (State Load Dispatch Centre) Tariff – U/S 62- & as per Tariff Regulations for SLDC, Step by Step Procedure for ARR & Tariff Setting for Transmission Tariff, Case Study & Group Exercise for Approval of Transmission & SLDC Tariff Distribution & Supply-Statutory Provisions and Regulations, Power Procurement Guidelines & State ERC Regulations, Competitive Bidding for Procurement of Power -Policy & Guidelines, Determination of Distribution Tariff – U/S 62- Tariff Regulations for Distribution, Determination of Retail Tariff – U/S 62- Tariff Regulations for Retail Supply, Step by Step Procedure for ARR & Tariff Setting for Distribution & Retail Tariff, Case Study & Group Exercise for Approval of Distribution & Retail Tariff

**Mode of conduct:** Interactive sessions with academic and Industry experts. There will be continuous assessment of participants based on quizzes, problem-solving exercises,

Projects on preparing appropriate business models in the Competition in the retail businesses in India and abroad and viva voce.

**Textbooks/References**

1. Christopher Decker – *Modern Economic Regulation- An introduction to Theory and Practice*
2. Ignacio J Perez Arriago **-** *Regulation of the Power Sector*
3. CERC*/SERC MYT Tariff Regulations*

## 7. Smart Grid, Ancillary Services & Grid Flexibility [40 Hrs]

**Course objectives**:

The module covers smart grid technologies and the concept of flexibility in all activities of the power system covering generation (Conventional & Renewable energy) transmission, distribution, & at consumer's end. It helps participants to understand the pressing need of ancillary services & related regulations.

**Course contents**:

The architecture of Smart Grid & Technologies, Advanced Metering Infrastructure, Elements & Technologies of Smart Grid, Distributed Energy Resources, Energy Management, Design of Smart grid and Practical Smart Grid case study, international experience of smart grid, Micro/Mini Grid, Computational tools for energy data analytics. Basic Concepts & Fundamentals of the requirement of Flexibility in Renewable Energy integration. Regulations and other Standards to deal with the Flexibility, Ancillary Service Regulations, Indian Electricity Grid Code, Intra-State ABT Mechanism & Deviation Settlement Mechanism (DSM), Flexibility in Thermal Generation, Flexibility in the Indian power system, Flexibility in System operation, Demand Side Flexibility. Role of Energy Storage in grid management.

**Mode of conduct:** Interactive sessions with academic and industry experts. There will be continuous assessment of participants through assignments, viva voce and presentations on the assigned case study or assigned projects on smart grid/Metering.

**Textbooks/References**

1. Jahangir Hossain Apel Mahmud, *Renewable Energy Integration*, Springer
2. Ignacio J Perez- Arriga, *Regulation of the power sector*
3. Subir Sen , Rajesh Kumar, D P Kothari, *Smart Grid : Fundamentals & Applications*

## 8. Demand Side Management & Energy Efficiency [40 Hrs]

**Course objectives**:

The module shall cover the concept of Demand Side Management in a Distribution company as well as the need of self-regulation from the consumer side to manage its demand through application of new technology, energy efficiency, smart meters, and demand response program. The module helps participants understand the implementation and technologies involved to integrate and optimize distributed energy resources (DER) to achieve an efficient and reliable grid management.

**Course contents**:

Concept of Demand Side Management, Energy Efficiency & Demand Response (DR) program, Significance and need of Demand Side Management in India, Need of Demand

Response and Energy efficiency to conserve energy, DR in India and International experience of USA/UK Planning & Implementation Strategies & Monitoring, Assessment of the market, program selection, Cost-benefit analysis, Various types of Schemes & Energy Efficiency equipment, All types of Load curves and shapes, Demand Response, Demand Forecasting. The framework of Regulations in Demand Side Management, governing laws & framework and important Regulations, Bureau of Energy Efficiency (BEE) and their functions Baseline data definition, Energy Efficiency and types of energy saving devices, Monitoring and Reporting for Demand Side Management Program. Targets, Guidelines of programs, Cost-Effectiveness Assessment of programs and Monitoring, Reporting, Plans and programs. Demand side management cell in Distribution companies. Power Quality Monitoring & Management.

**Mode of conduct:** Interactive sessions with academic and industry experts. There will be continuous assessment of participants through quizzes, problem solving exercises, presentation on the assigned case study.

**Textbooks/References**

1. C. W. Gellings, John H. Chamberlin, *Demand Side Management - Concepts & Methods*
2. SERC Regulations on Energy Efficiency & Demand Side Management

**9. Environmental Regulations, Carbon Pricing & Green Hydrogen [40 Hrs]**

**Course objectives**:

This module describes a set of regulations and statutory laws that address the effects of emission of greenhouse gasses from various activities in the power sector on the environment. In addition, it will cover the use of different strategies to regulate carbon emission by carbon trading, carbon pricing, creation of market, and the need for a balanced regulation. Participants will also understand the importance of green hydrogen and related policy frameworks in India.

**Course contents**:

Statutory Provisions for Carbon Reductions, Energy Conservation Act, Policy & Regulatory Framework, Concept of Carbon Pricing, Effective Mechanism for Carbon Pricing, Strengths Explicit Carbon Pricing, Carbon Pricing for Sustainable Development, Role of Effective Carbon Pricing as a good climate Policy, Carbon Trading & Market, Status of Carbon Pricing- International Studies & Indian State of Affairs, Vision for Green Hydrogen Economy in India, Green Hydrogen Status, Drivers, and Challenges, Types of Hydrogen and its cost, Important Elements for making Effective Policy for Green Hydrogen Policy, Priorities and National goals to support green hydrogen, Production Processes and Cost & Benefits Analysis.

**Mode of conduct:** Interactive sessions with academic and industry experts. Quizzes, problem-solving exercises, Continuous assessment of participants through case studies on carbon trading, carbon market etc.& presentations/viva voce.

**Textbooks/References**

1. Leela krishnan, *Environmental Law in India*
2. John Smith, *The Possibility of a Hydrogen Economy: Renewable Energy Future*

**10. Distribution Reforms, Good Governance & Effective Regulators [40 Hrs]**

**Course objectives**:
The module aims to conceptualize learnings from best practices from national & international experience. Participants shall understand the need of effective regulations, good governance, role of regulators &, their attributes.

**Course contents**:
Financial health of Distribution Utilities- Present Status & future trends, Distribution losses & Aggregate Technical Commercial Losses, Policy Initiatives and trend of loss reductions in India, Regulatory Role & Response, Tariff Rationalization and Introduction of incentives and penalties in Tariff structure, Regulation of Public-Private Distribution Utilities & introduction of Good Governance, Energy Accounting, Metering & Energy Audit, Accurate Load Forecasting, Use of digital Technology- AI & ML, Real-Time asset management, and effective power Procurement, Analysis of Effective Regulations in India, Attributes of Effective Regulator. Case Study: Best Practices of top 5 Public & Private Distribution Companies in India
**Mode of conduct:** Interactive sessions with academic and industry experts. There will be continuous assessment of participants through multiple quizzes, case studies, viva voce and presentations on the projects on the best practices in distribution businesses in India and abroad.
**Textbooks/References**

1. Scott Hempling, Preside or Lead?
2. Pratik Biswas & Sukanya Mondal, *Indian Electricity Sector under Regulatory Regime*

**11. Two Capstone Projects on Regulation in Power Sector, Electricity Market, Renewable Energy and Emerging Technologies [Long Engagement: 80 Hrs]**

**Course objectives**:
The project course will expose the student to solving some small problems by applying the fundamentals covered in various courses. It may require data generation/data collection, modeling, analysis, and hypothesis validation.

**Course contents**:
Students will work on various regulatory, technology related topics and present at the semester's or module's end. They will meet faculty members separately during the semester for their project course. Students will also be encouraged to use some lab facilities during their visit to the IITGN campus.

**Mode of conduct:** The student should be connected with faculty members for regular progress of the project through multiple discussion session throughout the semester. They should present the progress and get evaluated during mid semester as well as end semester. In addition to the presentation, student should prepare a project report and submit the it before end semester evaluation.