# FACULTY OF ENGINEERING & TECHNOLOGY

## Effective from Academic Batch:  2022-23

**Programme:**      **Bachelor of Technology (Electrical Engineering)**

**Semester:**      **VIII**

**Course Code:**      **202050807**

**Course Title:**      **Optimization of Power System**

**Course Group:**       **Professional Elective Course-VI**

**Course Objectives:**  It is necessary to operate the power system with minimum cost and maximum reliability due to continuously increasing power demand. To introduce fundamentals of optimization theory to students with specific focus on applications for power systems.

**Teaching & Examination Scheme:**

| Contact hours per week | | | Course Credits | Examination Marks (Maximum / Passing) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | J/V/P* | | Total |
| Lecture | Tutorial | Practical | | Internal | External | Internal | External | |
| 3 | 0 | 2 | 4 | 50 / 18 | 50 / 17 | 25/9 | 25/9 | 150/ 53 |

\* **J**: Jury; **V**: Viva; **P**: Practical

**Detailed Syllabus:**

| Sr. | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Optimization** <br> Engineering applications of optimization, Statement of an optimization Problem, Classification of optimization problems, Optimization techniques, Solution of optimization problems using MATLAB, OpenSolver etc. | 05 |
| 2 | **Classical Optimization Techniques** <br> Single-Variable optimization, Multivariable Optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints, Convex programming problem. | 07 |

| 3 | **Linear Programming**<br>Applications of linear programming, Standard form of a linear programming problem, Geometry of linear programming problems, Definitions and theorems, Solution of a system of linear simultaneous equations, Pivotal reduction of a general system of equations, Motivation of the simplex method, Simplex algorithm, Two phases of the simplex method, MATLAB Solution of LP Problems. | **07** |
|---|---|---|
| 4 | **Economic Load Dispatch of Thermal Generating Units**<br>Generator operating cost, Economic dispatch problem on a bus-bar, Optimal Generation Scheduling, Economic dispatch using Newton-Raphson method, Classical method to calculate loss coefficients, Loss coefficient calculation using YBUS, Loss coefficient calculation using sensitivity factors, Transmission loss coefficients, Transmission loss formula as a function of generation and loads, economic load dispatch using exact loss formula, economic load dispatch using loss formula as a function of real and reactive power, economic dispatch for active and reactive power balance. | **08** |
| 5 | **Infrastructure Planning**<br>Nodal placement and sizing, Problem types and greedy algorithms, Power sources, Multiple scenarios, Energy storage, Transmission expansion, Basic approach, Linearized models, Branch flow approximation, Relaxations, Feasibility issues. | **07** |
| 6 | **Power System Economics**<br>Background, Lagrangian duality, Pricing and the welfare theorems, Game theory, Electricity markets, Nodal pricing, Multi-period and dynamic pricing, Transmission cost allocation, Pricing under non-convexity, Market power, Supply function equilibrium, Complementarity models, Capacitated price competition. | **08** |

**List of Practicals / Tutorials:**

| 1 | Introduction to Optimization. |
|---|---|
| 2 | Introduction to MATLAB for optimization. |
| 3 | Classical Optimization Techniques. |
| 4 | Unconstrained Optimization: Elimination Methods. |
| 5 | Single-Variable optimization using MATLAB. |
| 6 | Multi-Variable optimization with no constraints using MATLAB. |
| 7 | Multi-Variable optimization with constraints using MATLAB. |
| 8 | Linear programming using MATLAB. |
| 9 | To study optimal generation scheduling. |
| 10 | Loss coefficient calculation using $Y_{bus}$ |
| 11 | Loss coefficient calculation using sensitivity factors. |
| 12 | Transmission loss formula as a function of generation and loads using MATLAB. |

| 13 | To study economic load dispatch using loss formula as a function of real and reactive power using MATLAB. |
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**Reference Books:**

| 1 | Singiresu S. Rao, "Engineering Optimization: Theory and Practice", 3rd Edition, New Age International, 2013. |
|---|---|
| 2 | D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2nd Edition, PHI Learning Private Ltd., 2011. |
| 3 | Joshua Adam Taylor, "Convex Optimization of Power Systems", Cambridge University Press, 2015. |
| 4 | Jizhong Zhu, "Optimization of Power System Operation", 2nd Edition, John Wiley and Sons, 2009. |

**Supplementary learning Material:**

| 1 | https://electrical-engineering-portal.com |
|---|---|
| 2 | https://www.electrical4u.com |
| 3 | https://onlinecourses.nptel.ac.in |
| 4 | https://electrical-engineering-portal.com |

**Pedagogy:**
- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

**Internal Evaluation:** The internal evaluation comprised of written exam (40% weightage) along with combination of various components such as Certification courses, Assignments, Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance, Achievements etc. where individual component weightage should not exceed 20%.

**Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):**

| Distribution of Theory Marks in % | | | | | | R: Remembering; U: Understanding; A: Applying; N: Analyzing; E: Evaluating; C: Creating |
|------|------|------|------|------|------|---|
| R | U | A | N | E | C | |
| 15% | 30% | 20% | 25% | 10% | 0% | |

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Course Outcomes (CO):**

| Sr. | Course Outcome Statements | %weightage |
|---|---|---|
| CO-1 | Comprehend the engineering applications of optimization. | 10 |
| CO-2 | Understand and analyze the classical optimization techniques. | 15 |
| CO-3 | Apply optimization theory to the power system domain. | 25 |
| CO-4 | Formulate and solve optimization problems for economic load dispatch of thermal generating units. | 25 |
| CO-5 | Formulate and solve optimization problem for infrastructural planning problems of power system and Formulate and solve optimization problem for power system economics problems | 25 |

| Curriculum Revision: | |
|---|---|
| Version: | 2.0 |
| Drafted on (Month-Year): | June-2022 |
| Last Reviewed on (Month-Year): | |
| Next Review on (Month-Year): | June-2025 |