# Dr. Babasaheb Ambedkar Technological University, Lonere.

**Dr. Babasaheb Ambedkar Technological University**

**(Established as a University of Technology in the State of Maharashtra)**

**(under Maharashtra Act No. XXIX of 2014)**

**P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra**

**Telephone and Fax. : 02140 -275142**

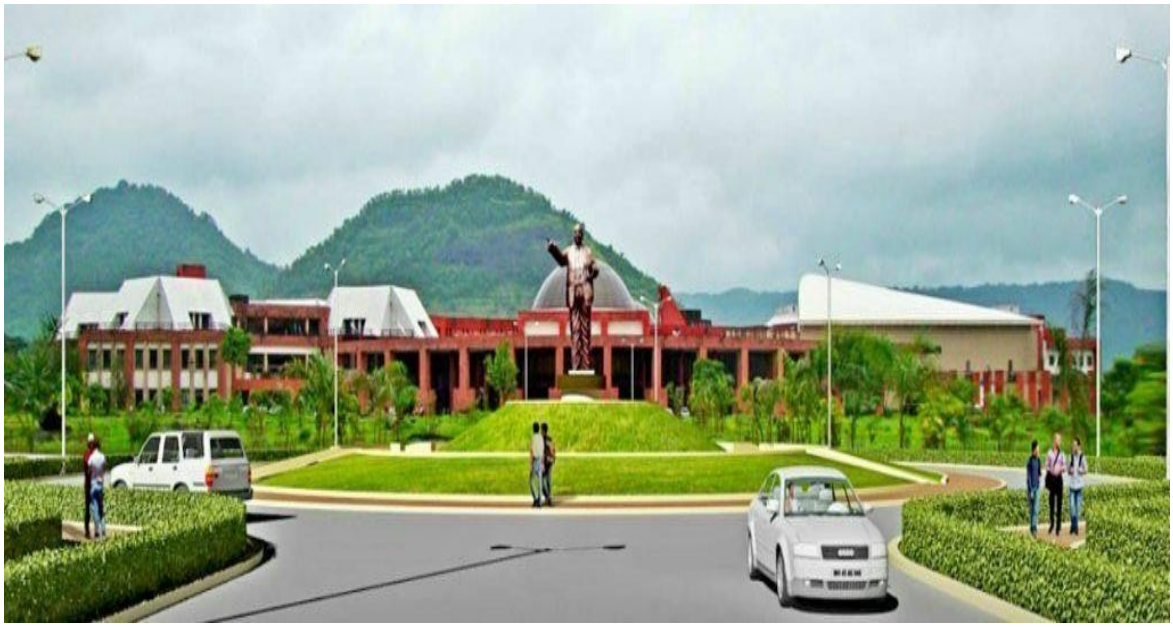
**www.dbatu.ac.in**

# COURSE STRUCTURE AND SYLLABUS

For

## Final Year Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering

## With effect from the Academic Year 2023-2024



# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

| **Basic Sciences Courses(BSC)** | | |
|---|---|---|
| BTBS101 | Engineering Mathematics - I | (3-1-0)4 |
| BTBS102 | Engineering Physics | (3-1-0)4 |
| BTBS107L | Engineering Physics Lab | (0-0-2)1 |
| BTBS201 | Engineering Mathematics - II | (3-1-0)4 |
| BTBS202 | Engineering Chemistry | (3-1-0)4 |
| BTBS207L | Engineering Chemistry Lab | (0-0-2)1 |
| BTBS301 | Engineering Mathematics-III | (3-1-0)4 |
| BTBS404 | Analog and Digital Electronics | (3-0-0)3 |
| BTBSL409 | Analog and Digital Electronics Lab | (0-0-2)1 |

| **Engineering Sciences Courses(BSC)** | | |
|---|---|---|
| BTES103 | Engineering Graphics | (2-0-0)2 |
| BTES105 | Energy and Environment Engineering | (2-0-0)2 |
| BTES106 | Basic Civil and Mechanical Engineering | (2-0-0) |
| BTES108L | Engineering Graphics Lab | (0-0-4)2 |
| BTES203 | Engineering Mechanics | (2-1-0)3 |
| BTES204 | Computer Programming | (3-0-0)3 |
| BTES205 | Workshop Practice | (0-0-4)2 |
| BTES206 | Basic Electrical and Electronics Engineering | (2-0-0) |
| BTES208L | Engineering Mechanics Lab | (0-0-2)1 |
| BTES305 | Engineering Material Science | (3-0-0) |

| **Humanities and Social Science Including Management Courses(HSSMC)** | | |
|---|---|---|
| BTHM104 | Communication Skills | (2-0-0)2 |
| BTHM109L | Communication Skills Lab | (0-0-2)1 |
| BTHM304 | Basic Human Rights | Audit |
| BTHM506 | Foreign Languages<br>(A) Japanese Language<br>(B) German Language | Audit |
| BTHM706 | Engineering Operations and Project Management | Audit |

| **Professional Core Course (PCC)** | | |
|---|---|---|
| BTEEC302 | Electrical Machines-I | (3-1-0)4 |
| BTEEC303 | Electrical and Electronics Measurement | (3-1-0)4 |
| BTEEL306 | Electrical Machines Lab | (0-0-2)1 |
| BTEEL307 | Electrical and Electronics Measurement Lab | (0-0-2)1 |
| BTEEC401 | Network Theory | (3-1-0)4 |
| BTEEC402 | Power System | (3-1-0)4 |
| BTEEC403 | Electrical Machines-II | (3-1-0)4 |
| BTEEL406 | Network Theory Lab | (0-0-2)1 |
| BTEEL407 | Power System Lab | (0-0-2)1 |
| BTEEL408 | Electrical Machines-II Lab | (0-0-2)1 |
| BTEEC501 | Power System Analysis | (3-1-0)4 |
| BTEEC502 | Microprocessor and Microcontroller | (3-0-0)3 |
| BTEEC503 | Power Electronics | (3-1-0)4 |
| BTEEL507 | Power System Analysis Lab | (0-0-2)1 |
| BTEEL508 | Microprocessor and Microcontroller Lab | (0-0-2)1 |
| BTEEL509 | Power Electronics Lab | (0-0-2)1 |
| BTEEC601 | Switchgear Protection | (3-0-0)3 |
| BTEEC602 | Electrical Machine Design | (3-1-0)4 |
| BTEEC603 | Control System Engineering | (3-1-0)4 |

| | | |
|---|---|---|
| BTEEL606 | Switchgear Protection Lab | (0-0-2)1 |
| BTEEL607 | Electrical Machine Design Lab | (0-0-2)1 |
| BTEEL608 | Control System Engineering Lab | (0-0-2)1 |
| BTEEC701 | High Voltage Engineering | (3-1-0)4 |
| BTEEC702 | Power System Operation and Control | (3-1-0)4 |
| BTEEL707 | High Voltage Engineering Lab | (0-0-2)1 |

| **Professional Elective Course (PEC)** | | |
|---|---|---|
| BTEEPE405 | (A)Electromagnetic Field Theory | (3-0-0)3 |
| | **(B)Signals and System** | |
| | ©Advance Renewable Energy Sources | |
| | (D)Electronic Devices and Circuits | |
| BTEEPE504 | (A)Industrial Automation | (3-0-0)3 |
| | (B)Power Quality Issues | |
| | ©HVDC | |
| BTEEPE604 | **(A)Application of Power Electronics in Power System** | (3-0-0)3 |
| | (B)Smart Grid Technology | |
| | ©Modeling, Simulation and Control of Electric Drives | |
| BTEEPE703 | (A)Energy Audit and Conservation | (3-0-0)3 |
| | (B)Electrical System Design for Building | |
| | ©Flexible AC Transmission System | |
| | (D)Electrical Utilization | |

| **Open Elective Course (OEC)** | | |
|---|---|---|
| BTEEOE505 | (A)Embedded System | (3-0-0)3 |
| | (B)Electrical Safety | |
| | ©Condition Monitoring of Electric Apparatus | |
| BTEEOE605 | **(A)E-waste Management** | (3-0-0)3 |
| | **(B)Power Plant Engineering** | |
| | ©Sensor Technology | |
| | (D)Lightning Interaction with Power System | |
| BTEEOE704 | (A)Process Control Instrumentation | (3-0-0)3 |
| | (B)Biomedical Instrumentation | |
| | ©Mechatronics | |
| BTEEOE705 | (A)Testing, Maintenance and Commissioning of Electrical Equipment | (3-0-0)3 |
| | (B)Electric and Hybrid Electric Vehicles | |
| | ©Internet of Things (IoT) | |

| **Seminar / Mini Project / Internship** | | |
|---|---|---|
| BTES209S | Seminar | (0-0-2)1 |
| BTES211P | (Internship – I) Field Training / Internship/Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in at one time). | 1 |
| BTEEM308 | Miniproject-I | (0-0-4)2 |
| BTEEP410 | (Internship – II) | 1 |
| BTEEM509 | Miniproject-II | (0-0-2)1 |
| BTEES609 | Seminar | (0-0-4)2 |
| BTEEP610 | (Internship – III) | |
| BTEEM708 | In house project-I / Mini project-III | (0-0-4)2 |

| **Project(MP)** | | |
|---|---|---|
| BTEEP802 | In house project-I / Internship & Project in Industry | (0-0-26) 13 |

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

**Plan of Study:**

| No.of Courses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | I | II | III | IV | V | VI | VII | VIII |
| 2 | BTBS101 | BTBS201 | BTBS301 | BTEEC401 | BTEEC501 | BTEEC601 | BTEEC701 | BTEEPE801 |
| 3 | BTBS102 | BTBS202 | BTEEC302 | BTEEC402 | BTEEC502 | BTEEC602 | BTEEC702 | BTEEP802 |
| 4 | BTES103 | BTES203 | BTEEC303 | BTEEC403 | BTEEC503 | BTEEC603 | BTEEPE703 | |
| 5 | BTHM104 | BTES204 | BTHM304 | BTBS404 | BTEEPLE504 | BTEEPE604 | BTEEOE704 | |
| 6 | BTES105 | BTES205 | BTES305 | BTEEPE405 | BTEEOE505 | BTEEOE605 | BTEEOE705 | |
| 7 | BTES106 | BTES206 | BTEEL306 | BTEEL406 | BTHM506 | BTEEL606 | BTHM706 | |
| 8 | BTBS107L | BTBS207L | BTEEL307 | BTEEL407 | BTEEL507 | BTEEL607 | BTEEL707 | |
| 9 | BTES108L | BTES208L | BTEEP308 | BTEEL408 | BTEEL508 | BTEEM608 | BTEEM708 | |
| 10 | BTHM109L | BTES209S | BTES211P | BTEEL409 | BTEEPE509 | BTEEP609 | BTEEP609 | |
| 11 | | BTES211 | | BTEEP410 | BTEEP409 | | | |

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

## A. Program Educational Objectives (PEOs)

Graduates will able to–

1.To equip graduates with a strong foundation in engineering sciences and Electrical Engineering fundamentals to become effective collaborators, researchers and real-time problem solver with technical competencies.

2.Perceive the limitation and impact of engineering solutions in social, legal, environmental, economical and multidisciplinary contexts.

3.Excel in Industry/technical profession, higher studies, and entrepreneurship exhibiting global competitiveness.

## B. Program Outcomes (POs)

Engineering Graduate will be able to –

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

### Curriculum for Semester VII

| Course Category | Course Code | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | Total | |
| PCC10 | BTEEC701 | High Voltage Engineering | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC11 | BTEEC702 | Power System Operation & Control | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PEC4 | BTEEPE703 | Group F | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| OEC3 | BTEEOE704 | Group G | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| OEC4 | BTEEOE705 | Group H | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| HSSMC | BTHM706 | Engineering Operations and Project Management | - | - | - | - | - | - | - | Audit |
| LC | BTEEL707 | High Voltage Engineering Lab | - | - | 2 | 60 | - | 40 | 100 | 1 |
| Project | BTEEM708 | Inhouse Project Part-I /Miniproject-III | - | - | 4 | 60 | - | 40 | 100 | 2 |
| Internship | BTEEP609 | Internship-III Evaluation | - | - | - | - | - | 50 | 50 | 1 |
| | | **Total** | **15** | **2** | **10** | **340** | **100** | **510** | **950** | **21** |

### Semester VIII

| Course Category | Course Code | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | Total | |
| PEC5 | BTEEPE801 | NPTEL online courses | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| Project/Internship | BTEEP802 | Inhouse Project Part-II /Internship in Industry. | - | - | 26 | 60 | - | 40 | 100 | 12 |
| | | **Total** | | | | | | | | 15 |

BSC= Basic Science Course, ESC= Engineering Science Course, PCC= Professional Core Course, PEC= Professional Elective Course, OEC= Open Elective Course, LC= Laboratory Course, HSSMC= Humanities and Social Science including Management Course

**Important Note: Minimum Eight Experiment to perform based on the syllabus for the laboratory subject.**

### Semester VII

| BTEEPE703 Professional Elective (Group F) | BTEEOE704 Open Elective (Group G) | BTEEOE705 Open Elective (Group H) |
|---|---|---|
| (A) Energy Audit and Conservation | (A) Process Control Instrumentation | (A) Testing, Maintenance and Commissioning of Electrical Equipment |
| (B) Electrical System Design for Building | (B) Biomedical Instrumentation | (B) Electric and Hybrid Electric Vehicles |
| (C) Applications of Power Electronics in Power System | (C) Mechatronics | (C) Internet of Things (IoT) |
| (D) Electrical Utilization | | |

## Mapping of Courses with MOOCs Platform SWYAM / NPTEL

| S.N. | Course Name | Duration | Name of Professor | Institute offering Course |
|---|---|---|---|---|
| 1 | Power Management Integrated Circuits | 12 Weeks | Prof. Qadeer Ahmad Khan | IITM |
| 2 | DC Power Transmission Systems | 12 Weeks | Prof. Krishna S | IITM |
| 3 | High Power Multilevel Converters | 12 Weeks | Prof. Anandarup Das | IITD |
| 4 | Fuzzy Sets, Logic and Systems & Applications | 12 Weeks | Prof. Nishchal Kumar Verma | IITK |
| 5 | The Joy of Computing using Python | 12 Weeks | Prof. Sudarshan Iyengar Prof. Yayati Gupta | IIT Ropar |
| 6 | Introduction to Industry 4.0 and Industrial Internet of Things | 12 Weeks | Prof. Sudip Misra | IIT KGP |
| 7 | Entrepreneurship Essentials | 12 Weeks | Prof. Manoj Kumar Mondal | IIT KGP |

## BTEEC701 HIGH VOLTAGE ENGINEERING 04 credits

**UNIT 1: Introduction to High Voltage Engineering (02 hours)**

Electric Field Stresses,Poisson's equation, Estimation and Control of Electric Stress, Surge Voltages, their distribution and control.

**UNIT 2: Conduction & breakdown in gases (06 hours)**

Gases as insulation media, ionization processes, Townsend's current growth equation, current growth in presence of secondary processes, Townsend's criterion for breakdown in electronegative gases, time lags for breakdown, Streamers theory, Paschen's law, breakdown in non-uniform fields and corona discharge, corona under positive & negative polarities, glow & arc discharge, considerations in using gases for insulation purpose.

**UNIT 3: Breakdown in Dielectric Materials (08 hours)**

Conduction & breakdown in liquid dielectrics: Pure and commercial liquids, breakdown in pure and commercial liquids, theories of breakdown in liquids. Breakdown in solid dielectrics: Intrinsic, electromechanical& thermal breakdown, chemical, electrochemical deterioration, treeing, tracking, internal discharges, breakdown in composite insulation, properties of solid insulators & other materials used in practice. Insulating materials: In power transformers, rotating machines, circuit breakers, cables, power capacitors & other equipment.

**UNIT 4: Over voltage due to lightening phenomenon: (08 hours)**

Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, propagation of lightning voltage & current waves on transmission lines, reflection & transmission of traveling wave at junction, system control of over voltage due to switching protection of transmission lines against over voltage. Insulation co-ordination, surge diverters, equipment insulation level & co-ordination of substations.

**UNIT 5: Generation& Measurement of high voltages & currents: (10 hours)**

Generation of a) high d. c voltage b) power frequency high alternating voltage c) high frequency a. c. d) impulse voltages Standard impulse waves shapes and it's equation, multistage impulse generator, marx circuit, generation of switching surges, tripping & control of impulse generators, generation of impulse currents.

Measurement of High Direct Current voltages, Abraham Voltmeter Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements

**UNIT 6: Non Destructive Testing** **(06 hours)**

I. E. C. & IS codes for high voltage tests on electrical appliances & power apparatus &electrical motors, non- destructive testing, testing of insulators, bushings, isolators, circuit breakers, cables, transformers, surge diverter, layout of high voltage laboratories & test facilities.

**Reference Books:**


1. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition
2. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995.
3. High Voltage Engineering, Theory and Practice by Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, RoshdyRadwan, Marcel Dekker


**Text Books:**


1. Kamaraju V. & Naidu M. S., 'High Voltage Engineering', Tata-McGraw Hill
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Pvt. Ltd

## BTEEC702 POWER SYSTEM OPERATION AND CONTROL 4 Credits

**Unit 1: Reactive Power Management** **6 Hours**

Necessity of reactive power control, production and absorption of reactive power, methods of voltage control, shunt reactors, series capacitors, shunt capacitors, synchronous condensers, Static VAR Systems

**Unit 2: Power System Stability** **6 Hours**

The stability problem-Steady state stability, transient stability and Dynamic stability, Swing equation. Equal area criterion of stability-Applications of Equal area criterion, Step by step solution of swing equation-Factors affecting transient stability, Methods to improve steady state and Transient stability

**Unit 3: Excitation Systems** **6 Hours**

Excitation Systems: Excitation System requirements, Elements of an excitation system Types of excitation systems. Control and protective functions of Excitation systems

**Unit 4: Load Frequency Control** **7 Hours**

Introduction, LFC control of a single-area system, Two-Area Load Frequency Control,Automatic voltage Control, Speed governing mechanism and modelling, Speed Governor Dead band and its effect on Automatic Generation Control

**Unit 5: Economic Operation of Power System** **10 Hours**

Distribution of load between units within a plant, Economic division of load between units in a plant, transmission loss as function of plant generation, calculation of loss-coefficient, numerical Unit Commitment, Constraints on Economic operation of power system, optimum scheduling of hydro-thermal system, long term hydro scheduling in a hydro-thermal system, short term hydro-thermal scheduling, computer approach to solve the short-term hydro-thermal scheduling problem

**Text/References Books:**


1. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 1993.
2. I. J. Nagrath and D. P. Kothari, Modern Power System Analysis, TMH, 2003
3. A Chakrabarti and S. Halder, Power System Analysis: Operation and Control, PHI, 2006.
4. W. D. Stevenson, Elements of Power system analysis, Mcgraw Hill, Digitized on Dec., 2007.
5. C.L.Wadhwa, Electrical Power Systems, 3rd Edn, New Age International Publishing Co., 2001
6. T. K. Nagsarkar and M. S. Sukhija, Power System Analysis, Oxford University Press, 2007

**BTEEPE703A Energy Conservation and Audit** **03 Credits**

**Unit 1: Sources of Energy and International Agreements** **7 Hours**

Energy resources, Stored & running resources, Non-conventional energy sources, Necessity of conserving resources. United Nation Framework Convention on Climate Change. International Agreements – History and Current Agreements – Paris Agreement.

**UNIT 2 Energy In Industries** **7 Hours**

Energy inputs in industry, Comparison of various energy inputs, Use of electric energy in industries for motive power, Heating (Space, Furnace, Water), Lighting, Air conditioning, Welding, Energy efficiency of the apparatus in above energy conversion processes, Energy efficient design of above processes.

**UNIT 3 Energy in Non-industrial Sector** **7 Hours**

Different forms of energy used in agricultural, commercial, domestic & municipal sectors.

**UNIT 4 Energy Audit** **7 Hours**

Audit, A prerequisite for energy conservation, Principles of energy audit, Measurement & measuring devices, Analysis of data, Audit Case Studies.

**UNIT 5 Energy Conservation in Utilities and Energy Investment** **8 Hours**

Energy conservation in generation, transmission, distribution & utilization, Demand side energy management, Energy efficient lighting system, Energy efficient drives-Critical study & analysis of certain case studies.Planning, Implementation & monitoring of energy conservation project, Time Value of money, Financial Investment.All calculations and numerical interpretation.

**Texts/References Books**:


1. Charles M Gottschalk , “Industrial Energy Conservation” , John Willey and Sons
2. Keth & Fecher, “Energy Efficiency Handbook”, CRC Publication
3. Paul O Callagham,“Energy Management”, Tata Mc Grawhill
4. S Rao and B Parulekar ,“Energy Technology”, Khanna Publisher

## BTEEC703B ELECTRICAL SYSTEM DESIGN FOR BUILDING 3 Credits

**Unit 1 System planning** **7 Hours**

Preparation of estimate of quantity of material required for wiring of a house (typical plan of house including electric layout is to be given). Drawing of electrical circuit for such electrification. Conductor size, calculations for internal domestic wiring, Permissible voltage drops for lighting and industrial load, Numerical, Conductor size calculation for underground cables: General considerations, Numerical, Basic design considerations.

**Unit 2: Study of different types of components in electrical distribution system** **8 Hours**

Review of Insulated Wires: Types: Rubber covered taped and compounded or VIR, Lead alloy sheathed, Tough rubber sheathed, Weather proof, Flexible wire splicing, Termination (Twist splicing, Married joint, Tap joint, Pig tail joint) Different Types of Switches: Tumbler, flush, pull, grid, architrave, rotary snap, Push button, Iron clad water proof, Quick break knife switch. Ceiling roses, Mounting blocks, Socket outlets plugs, Main switches, Distribution fuse boards, MCB (Miniature Circuit Breakers)

**Unit 3 Cable size selection and Substation** **7 Hours**

Load Details Calculation, Cable type and Construction features, Site Installation Conditions, Cable Selection Based on Current Rating of feeder, Introduction, Design consideration of Electrical installation. Introduction, Types of substation, Equipment and Accessories, Outdoor substation- pole mounting type and their SLD & estimation, Indoor substation- floor mounting type and their SLD & estimation.

**Unit 4 Protection** **7 Hours**

Protection devices such as fuse, Earthing and requirements such as Soil Resistivity, Electrode, Types of earthing, Single phase and three phase installation for residential load, Busbar and Busbar chambers, Mounting of CTs and PTs.

Light Source: Incandescent lamp, Quartz lamps, Fluorescent lamps- General characteristics, Fluorescent lamps types, HID Lamps, Mercury vapour lamps, Metal halide lamps, high pressure sodium lamps, induction lamps.

**Unit 5 Electrical Planning** **7 Hours**

Procedure in wiring planning, computer used in Electrical Design, the architecture-Electrical plan, Residential Electrical criteria.

**Texts/References Books:**


1. Electrical Wiring - Estimating & Costing By S.L. Uppal, Khanna Publishers.
2. Electrical Installation Estimating & Costing By J.B. Gupta, S.K. Kataria & Sons Publishers.
3. Electrical Design Estimating And Costing by K.B. Raina, S.K. Bhattacharya, New Age international LTD Publishers.
4. Residential, Commercial and Industrial Electrical Systems by Hemant Joshi, Tata Mcgraw-Hill Publishers.


**Reference:** Manual of Auto CAD.

**BTEEC703CAPPLICATION OF POWER ELECTRONICS IN POWER SYSTEM 3 Credits**

**Unit 1: Introduction** **5 Hours**

Basics of Power Transmission Networks, Introduction to power electronics applications to power system:power generation, power transmission, power quality, active power filter.

**Unit 2: Flexible AC transmission systems (FACTS)** **9 Hours**

Basic realities & roles, Types of facts controller, Principles of series and shunt compensation Description of static var compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC).

**Unit 3: Modelling and Analysis of FACTS controllers** **7 Hours**

Modelling and analysis of various FACTS controllers (SVC,TCSC,SPS,STATCON and UPFC),Control strategies to improve system stability. Power Quality problems in distribution systems.

**Unit 4: Harmonics** **7 Hours**

Generation of Harmonics, Harmonics creating loads, modelling, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, active filters, and passive filters.

**Unit 5: Active filters** **7 Hours**

Shunt, series hybrid filters, voltage sags & swells, voltage flicker. Mitigation of power quality problems using power electronic conditioners. IEEE standards

Text/References Books:

1. R.M. Mathur and R. K. Varma, ―Thyristor-Based FACTS Controllers for Electrical Power Systems‖, IEEE Press and John Wiley, 2002

2. Understanding of FACTs., Hingorani, N. G.; IEEE Press 1996.

3. Power Quality;Heydt G.T.; Stars in a Circle Publications , Indiana, 1991.

4. Static Reactive Power Compensation.; Miller T.J.E.; John Wiley & Sons, New York, 1982

5. Flexible AC Transmission System. (FACTs).; Yong Hua Song.; IEE 1999

6. Recent Publications on IEEE Journals

## BTEEC703D ELECTRICAL UTILIZATION 3 Credits

### Unit 1: Electrical Heating 7 Hours

Advantages of electrical heating, Resistance heating, Design of heating element in resistance oven, Control of temperature in resistance oven, Electric arc furnaces, Induction furnaces, Dielectric heating. Electric Welding: Electric arc welding & Resistance welding, Modern welding techniques like Ultrasonic & Laser welding.

### Unit 2: Electrolytic Processes 6 Hours

Faradays laws of electrolysis, Application of electrolysis, Like Electroplating, Anodizing electrical polishing & electroextraction, Accumulators & cell, Types & construction, Charging & discharging, recent trends in manufacturing of batteries.

### Unit 3: Illumination 7 Hours

Requirement of good lighting, Classification of light fitting & luminaries, Factor to be considered for design of indoor & outdoor lighting scheme, Design procedure for factory lighting, flood lighting & street lighting. Design of illumination scheme-Factors to be considered for design of illumination scheme, Calculation of illumination at different points, considerations involved in simple design problems for indoor installation, illumination schemes, standard illumination level.

### Unit 4: Electric Traction System: 8 Hours

Electrical transmission: Electrical transmission system employing D.C. generator D.C. series motor, Electrical transmission system employing 3 phase alternator supplying D.C. traction motors, electrical transmission employing 3 phase alternator supplying induction motors, Choice of traction system-battery drive, hybrid drive, flywheel drive, tramways, trolley bus. Traction Motors: Characteristics of traction motors, straight D.C. series motor, suitability of series motor for traction duty, constructional details of D.C. Traction Motors.

### Unit 5: Train Movement and Braking: 7 Hours

Speed time curve, its analysis and construction, schedule speed and factors affecting it, train resistance and its components. Tractive effort calculations, average acceleration and speed, energy output and consumption.

**Braking:** Mechanical versus electric breaking, rheostatic braking, Regenerative braking, method and energy saved in the process, Magnetic track brakes.

**REFERENCE BOOKS:**


1) Utilization of Electrical Power and Electic Traction by J.B. Gupta. (Katson Book publisher)
2) H. Partab: Modern Electric Traction, Dhanpat Rai & sons.
3) Upadhayay J. & Mahindra S.N., Electric Traction, Allied Publishers Ltd., 1st Ed.
4) Rao P.S., Principle of 25 KV Overhead Equipments. R. (Nasik) Printpack Pvt Ltd,, 1st Ed.
5) Electric Traction for Railway Trains, by Edward P. Burch. McGraw Hill Book Co. Inc.
6) Electrical Wiring - Estimating & Costing By S.L. Uppal, Khanna Publishers.

## BTEEOE704A PROCESS CONTROL INSTRUMENTATION 3 Credits

**Unit 1: Introduction to Process Control** **7 Hours**

Mathematical Modeling, Development of mathematical models. Modeling considerations for control purposes

**Unit 2: Dynamic Behavior of Chemical Processes** **7 Hours**

Computer simulation and the linearization of nonlinear systems, Brief of Laplace transforms, Transfer functions and the input-output models, Dynamics and analysis of first, second and higher order systems.

**Unit 3: Feedback Control Schemes** **7 Hours**

Concept of feedback control, Dynamics and analysis of feedback-controlled processes, Stability analysis, Controller design, Frequency response analysis and its applications

**Unit 4: Advanced Control Schemes** **7 Hours**

Feedback control of systems with dead time or inverse response, Control systems with multiple loops, Feed forward and ratio control.

**Unit 5: Instrumentation** **7 Hours**

Final control elements, measuring devices for flow, temperature, pressure and level Mathematical modeling: Development of mathematical models, modeling consideration for control purpose.

**Text /Reference Book:**

1. Stephanopoulos, G. (1984). "Chemical process control: an introduction to theory and practice," Prentice-Hall, New Delhi.

2. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A. (2003). "Process dynamics and control," Wiley, New York.

3. Smith, C.A. and Corripio, A.B. (1997). "Principles and practice of automatic process control," Wiley, New York.

4. Johnson, C.D. (2006). "Process control instrumentation technology," Prentice-Hall, New Delhi.

**BTEEOE704B BIOMEDICAL INSTRUMENTATION 03 Credits**

**Unit 1: Fundamentals of Biomedical Engineering 7 Hours**

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals - Basic components of a biomedical system- Cardiovascular systems- Respiratory systems -Kidney and blood flow – Biomechanics of bone - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs -Physiological signals and transducers - Transducers – selection criteria – Piezo electric, ultrasonic transducers - Temperature measurements - Fiber optic temperature sensors.

**Unit 2: Non-Electrical Parameters Measurement and Diagnostic Procedures 7 Hours**

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers, pH of blood –measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements.

**Unit 3: Electrical Parameters Acquisition and Analysis 7 Hours**

Electrodes – Limb electrodes –floating electrodes – Pregelled disposable electrodes - Micro, needle and surface electrodes – Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier - ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment‘s.

**Unit 4: Imaging Modalities and Analysis 7 Hours**

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography –Different types of biotelemetry systems - Retinal Imaging - Imaging application in Biometric systems - Analysis of digital images.

**Unit 5: Life Assisting, Therapeutic and Robotic Devices 7 Hours**

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy - ICCU patient monitoring system: Nano Robots - Robotic surgery – Advanced 3D surgical techniques- Orthopedic prostheses fixation.

**Text /Reference Books:**

1. Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
2. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication.
3. Medical Instrumentation Application and Design by J. G. Webster, Wiley Publication.

**BTEEOE704C MECHATRONICS** **03 Credits**

**Unit 1: Introduction to Mechatronics and its Systems** **4 Hours**

Evolution, Scope, Measurement Systems, Control Systems, Open and Close Loop Systems, Sequential Controllers, Microprocessor based Controllers, Mechatronics approach.

**Unit 2: Sensors and Transducers** **8 Hours**

Introduction to Sensors and measurement systems, Displacement and Position Sensors, Proximity Sensors (Capacitive and Inductive Sensor), Ultrasonic Sensors, Temperature and Light Sensors, Velocity and Motion Sensors, Force and Pressure Sensors, Level and Flow Sensors, Magnetic Sensors (Reed Switch), pH Sensor, Humidity Sensors, Selection of Sensors, Signal Conditioning Devices.

**Unit 3: Mechanical Actuation Systems** **8 Hours**

Mechanical systems, Types of motion, Kinematics Chains, Cams, Gear Trains, Ratchet and Pawl, Belt and Chain drives, Bearings, Mechanical aspectsof motor selection.

Pneumatic and Hydraulic Actuation Systems: Actuation systems, Pneumatic and Hydraulic systems, Components and Symbols, Directional Control Valves, Pressure Control Valves, Cylinders, Rotary Actuators, Application.

**Unit 4: Microprocessors** **7 Hours**

Digital logic: Basics of Digital Technology Number System, Boolean algebra, Logic Functions, Karnaugh Maps, Timing Diagrams, Flip-Flops. Microprocessors: Introduction, Architecture, Pin Configuration, Instruction set, Programming of Microprocessors using 8085 instructions, Interfacing input and output devices-Interfacing D/A converters and A/D converters, Applications, Temperature control, Stepper motor control, Traffic light controller.

**Unit 5: Programmable Logic Controller** **8 Hours**

Introduction, Basic structure, Input/ Output Processing, Programming, Mnemonics, Timers, Internal relays and counters, Data handling, Analog and Digital Input/Output, Selection of a PLC, Applications.

**Robotics:** Introduction, Types of Robots, Robotic Control, Robot Drive Systems Robot End Effectors, Selection Parameters of a Robot, Applications.

**Text Books/Reference Books:**


1. Bolton W., “Mechatronics”, Pearson, Sixth Edition, 2015.
2. Robert H. Bishop, “Mechatronic Systems, Sensors, And Actuators”, CRC Press.

3. David G. Alciatore & Michael B. Histand, “Introduction to Mechatronics & Measurement Systems”, McGraw Hill, 2003.
4. Nitaigour P. Mahalik, “Mechatronics: Principles, Concepts and Applications”, McGraw Hill, 2003.
5. HMT Limited, “Mechatronics”, Tata McGraw-Hill Publishing Co Ltd, 2002.
6. K.P. Ramachandran, G.K. Vijayaraghavan & M.S. Balasundaram, “Mechatronics: Integrated Mechanical Electronic Systems”, Wiley India, 2008.
7. Gordon M. Mair, “Industrial Robotics”, Prentice Hall, 1998.
8. C. D. Johnson, “Process Control Instrumentation Technology”, PHI.
9. W. Bolton, “Programmable Logic Controllers”, Elsevier.
10. John W. Webb & Ronald A. Reis, “Programmable Logic Controllers”, PHI.

**BTEEOE 705A TESTING, MAINTENANC AND COMMISSIONING OF ELECTRICAL EQUIPMENT** **3 Credits**

**Unit 1: Maintenance and Condition Monitoring** **7 Hours**

Importance and necessity of maintenance, different maintenance strategies like Breakdown maintenance, planned maintenance and condition based maintenance. Planned and preventive maintenance of transformer, induction motor and alternators. Insulation stressing factors, insulation deterioration, polarization index, dielectric absorption ratio. Concept of condition monitoring of electrical equipments. Advanced tools and techniques of condition monitoring (Only theory)

**Unit 2: Condition Monitoring of Transformers** **7 Hours**

Testing and condition monitoring of oil as per the IS/IEC standards. Filtration/reconditioning of insulating oil. Failure modes of transformer. Condition monitoring of transformer bushings, On load tap changer, dissolved gas analysis, degree of polymerization. IS/Specifications for testing of transformer bushing and oil.

**Unit 3: Condition Monitoring of Induction Motors** **7 Hours**

Parameters of induction motors, Induction motor fault diagnostic methods, the induction motor fault monitoring method and Remedies

**Unit 4: Testing of Electrical Equipments** **7 Hours**

Testing of Power cables – Causes of cable failure, fault location methods and Remedial actions, Testing of Transformer - Type tests, Routine tests and Special tests. Various abnormal conditions, trouble shooting, faults, causes and remedies, Testing of Induction motor – Various abnormal conditions, trouble shooting, faults, causes and remedies, Testing of Capacitor banks

**Unit 5: Special Tests for Faults Finding and Earthing** **7 Hours**

Industrial Sonography (ultra sonic tests) to detect internal mechanical faults, Industrial X ray /Radiography, Megger, Heat Run Test, High voltage withstand Tests.

Substation earthing system i) Types of earthing (Equipment and Neutral), Maintenance free earthing system. ii) Different electrode configuration (Plate and Pipe Electrode) iii) Tolerable step and Touch Voltages. Methods of testing earth resistance.

**Text Books/Reference Books:**

1. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.

2. Hand book of condition monitoring by B.K.N.Rao, Elsevier Advance Tech.,Oxford(UK)

3. S.L.Uppal - Electrical Power - Khanna Publishers Delhi

4. S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House

5. B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication

## BTEEOE 705B ELECTRIC AND HYBRID ELECTRIC VEHICLES 3 credits

**Unit 1: Introduction to Hybrid Electric Vehicles** **7 Hours**

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

**Unit 2: Hybrid Electric Drive-trains** **7 Hours**

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

**Unit 3: Electric Propulsion unit** **7 Hours**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of-DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives, drive system efficiency. Power converters in EV.

**Unit 4: Energy Storage** **7 Hours**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor and Flywheel used for energy storage, Hybridization of different energy storage devices

**Unit 5: Sizing the drive system** **7 Hours**

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology Communications, supporting subsystems: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

**Text/Reference Books:**


1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003
2. James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”,

**BTEEOE705C - INTERNET OF THINGS** **03 Credits**

**Unit 1: Internet in general and internet of things** **7 Hours**

Layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia

**Unit 2: Transport services** **7 Hours**

TCP, UDP, socket programming, Network layer: forwarding & routing algorithms (Link, DV), IP-addresses, DNS, NAT, and routers

**Unit 3: Local area network** **7 Hours**

MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular Internet access, and Machine-to-machine. Mobile networking: Roaming and handoffs, mobile IP, and ad hoc and infrastructure less networks.

**Unit 4: Real time networking** **7 Hours**

Soft and real time, quality of service/information, resource reservation and scheduling, and performance measurements

**Unit 5: IOT definitions** **7 Hours**

Overview, applications, potential & challenges, and architecture, IoT examples; case studies e.g sensor body area network and control of smart home

**Text Books/Reference Books:**

1. Kurose, James F.; Ross, Keith W. Computer networking: a top-down approach, 5th ed., international ed.:Boston, Mass.:Pearson,cop.2010

## BTHM706 ENGINEERING OPERATIONS AND PROJECT MANAGEMENT AUDIT COURSE

**Unit 1: Operations Planning Concepts** **7 Hours**

Introduction, Operations Functions in Organizations, Historical development, Framework for managing operations, The trend: Information and Non-manufacturing systems, Operations management, Factors affecting productivity, International dimensions of productivity, The environment of operations, Production systems decisions- a look ahead.

**Unit 2: Operations Decision Making** **7 Hours**

Introduction, Management as a science, Characteristics of decisions, Framework for decision making, Decision methodology. (Problems on decision trees)

**Unit 3: System Design and Capacity** **7 Hours**

Introduction, Manufacturing and service systems, Design and systems capacity, Capacity planning. Forecasting Demand: Forecasting objectives and uses, forecasting variables, Opinion and Judgmental methods, Time series methods, Moving Average methods, Exponential smoothing, Trend adjusted Exponential Smoothing, Regression and correlation methods, Application and control of forecasts-Mean Absolute Deviation, BIAS, and Tracking Signal.

**Unit 4: Aggregate Planning and Master Scheduling** **7 Hours**

Introduction- planning and scheduling, Objectives of aggregate planning, Three Pure Strategies, Aggregate planning methods, Master scheduling objectives, Master scheduling methods. Material and Capacity Requirements Planning: Overview: MRP and CRP, MRP: Underlying concepts, System parameters, MRP logic, System refinements, Capacity management, and CRP activities.

**Unit 5: Scheduling and Controlling Production Activities** **7 Hours**

Introduction, PAC, Objectives and Data requirements, Loading –Finite and Infinite Scheduling methodology, priority sequencing, capacity control. Single Machine Scheduling: Concept, measures of performance, SPT rule, Weighted SPT rule, EDD rule. Flow –Shop Scheduling: Introduction, Johnson‘s rule for ‗n‘ jobs on 2 and 3 machines, CDS heuristic. Job-Shop Scheduling: Types of schedules, Heuristic procedure, scheduling 2 jobs on ‗m‘ machines.

Lean Systems: Seven Wastes in Lean, Characteristics of Just-in-Time operations, Pull method of materials flow, consistently high quality, small lot sizes, Uniform workstation loads, Standardized components and work methods, close supplier Ties, Flexible workforce, Line flows, Automated production, preventive maintenance, continuous improvement, The Kanban system, General operating rules, Determining the number of containers, Other Kanban Signals, JIT II, Lean Systems in Services, Strategic Implications of Lean systems, Competitive Priorities, Flows, Operational Benefits Implementation Issues, Organizational Consideration, Process considerations, Inventory and scheduling, Lean system across the organization.

**Text /Reference Books:**

2. Monks, J.G., Operations Management, McGraw-Hill International Editions, 1987.

3. Pannerselvam. R., Production and Operations Management, PHI, 2012. (Unit-IV scheduling-single machine, flow shop and job shop scheduling)

4. Lee J Karjewski and Larry P Ritzman, Operations Management – strategy and Analysis, 6th Edn, Pearson Education Asia ,2009(Unit-V)

5. Buffa, Modern Production/Operations Management, Wiely Eastern Ltd, 8e, 2003.

6. Chary, S.N., Production and Operations Management, Tata-McGraw Hill, 5th edition, 2012.

7. Chase Jacobs Aquilano, Operations Management for Competitive Advantages, 10th Edition, 2012, TMH

**BTEEL707 HIGH VOLTAGE ENGINEERING LAB** **1 credit**

**List of Experiments: Perform minimum eight experiments from given list**

1) Study of Faraday Cage for HV labs.
2) Study of Standard HV Laboratory layouts.
3) One min. (1-min.) DC high voltage withstand test on Equipment. (Max. up to 10 KV).
4) Effect of gap length on liquid insulating material.
5) Breakdown Strength of composite dielectric material.
6) Study of impulse generator.
7) High voltage withstand test on cables/safety gloves/shoes, as per IS. (Max. 2.25 KV DC)
8) Horn gap arrangement as surge diverter.
9) Measurement audible and visible corona inception and extinction voltage.
10) Development of tracks and trees on polymeric insulation.
11) Study of Effect of EHV field on Human, Animals & Plants.

## BTEEM708 INHOUSE PROJECT PART-I /MINIPROJECT-III 2 credits

**Inhouse Project Part-I**

It is the phase –I of in house project, for the students those are not doing Internship in the Industry, such students can do project work in the dept. It is expected that students should finalize objective of the work, tools and techniques, and literature survey of the work. Assessment will be based on the work carried out by the student, report submitted and presentation.

**Miniproject-III**

Student, who wanted to opt for internship in industry in VIII semester, should do the miniproject, preferably based on hardware. Assessment will be based on the work carried out by the student, report submitted and presentation.

## BTEEP802 INHOUSE PROJECT PART-II /INTERNSHIP IN INDUSTRY .

**In House Project Part-II**

In phase-II of In-house project, work should consist of detailed report for chosen topic and output of work proposed in VIIth semester, in addition to the contents specified in semester VII. Assessment will be based on the work carried out by the student, report submitted and presentation.

**Internship in Industry**

In this course, students should go to industry for internship for one semester and do assigned work. After, completion of the Internship student should submit the report to the department. Assessment will be based on the work carried out by the student, report submitted and presentation, in consultation with the Industry guide.

# Dr. Babasaheb Ambedkar Technological University, Lonere.

**Dr. Babasaheb Ambedkar Technological University**

**(Established as a University of Technology in the State of Maharashtra)**

**(underMaharashtra Act No. XXIX of 2014)**

**P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra**

**Telephone and Fax. : 02140 -275142**

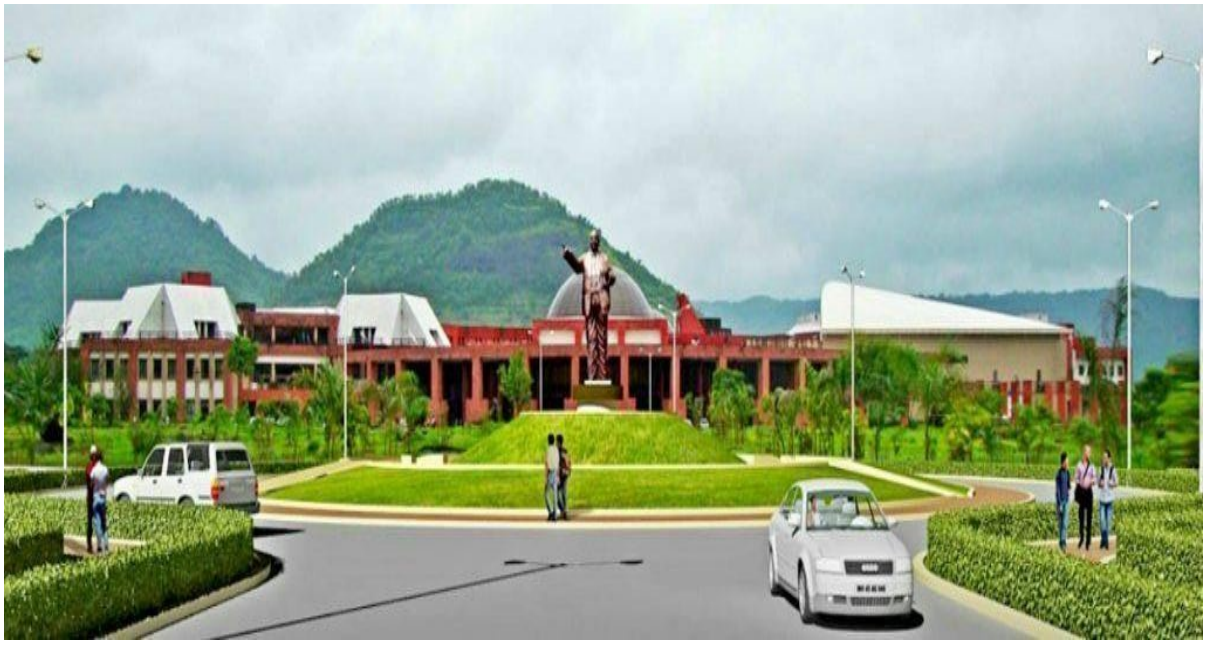
www.dbatu.ac.in

# COURSE STRUCTURE AND SYLLABUS

for

## Third Year B. Tech. Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering

## With effect from the Academic Year2022-2023



# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

| **Basic Sciences Courses(BSC)** | | |
|---|---|---|
| BTBS101 | Engineering Mathematics - I | (3-1-0)4 |
| BTBS102 | Engineering Physics | (3-1-0)4 |
| BTBS107 L | Engineering Physics Lab | (0-0-2)1 |
| BTBS201 | Engineering Mathematics - II | (3-1-0)4 |
| BTBS202 | Engineering Chemistry | (3-1-0)4 |
| BTBS207 L | Engineering Chemistry Lab | (0-0-2)1 |
| BTBS301 | Engineering Mathematics-III | (3-1-0)4 |
| BTBS404 | Analog and Digital Electronics | (3-0-0)3 |
| BTBSL40 9 | Analog and Digital Electronics Lab | (0-0-2)1 |

| **Engineering Sciences Courses(BSC)** | | |
|---|---|---|
| BTES103 | Engineering Graphics | (2-0-0)2 |
| BTES105 | Energy and Environment Engineering | (2-0-0)2 |
| BTES106 | Basic Civil and Mechanical Engineering | (2-0-0) |
| BTES108L | Engineering Graphics Lab | (0-0-4)2 |
| BTES203 | Engineering Mechanics | (2-1-0)3 |
| BTES204 | Computer Programming | (3-0-0)3 |
| BTES205 | Workshop Practice | (0-0-4)2 |
| BTES206 | Basic Electrical and Electronics Engineering | (2-0-0) |
| BTES208L | Engineering Mechanics Lab | (0-0-2)1 |
| BTES305 | Engineering Material Science | (3-0-0) |

| **Humanities and Social Science Including Management Courses(HSSMC)** | | |
|---|---|---|
| BTHM104 | Communication | (2-0-0)2 |
| | Skills | |
| BTHM109 L | Communication Skills Lab | (0-0-2)1 |
| BTHM304 | Basic Human Rights | Audit |
| BTHM506 | Foreign Languages<br>(A) Japanese Language<br>(B) German Language | Audit |
| BTHM706 | Engineering Operations and Project Management | Audit |

| **Professional Core Course (PCC)** | | |
|---|---|---|
| BTEEC302 | Electrical Machines-I | (3-1-0)4 |
| BTEEC303 | Electrical and Electronics Measurement | (3-1-0)4 |
| BTEEL306 | Electrical Machines Lab | (0-0-2)1 |
| BTEEL307 | Electrical and Electronics Measurement Lab | (0-0-2)1 |
| BTEEC401 | Network Theory | (3-1-0)4 |
| BTEEC402 | Power System | (3-1-0)4 |
| BTEEC403 | Electrical Machines-II | (3-1-0)4 |
| BTEEL406 | Network Theory Lab | (0-0-2)1 |
| BTEEL407 | Power System Lab | (0-0-2)1 |
| BTEEL408 | Electrical Machines-II Lab | (0-0-2)1 |
| BTEEC501 | Power System Analysis | (3-1-0)4 |
| BTEEC502 | Microprocessor and Microcontroller | (3-0-0)3 |
| BTEEC503 | Power Electronics | (3-1-0)4 |
| BTEEL507 | Power System Analysis Lab | (0-0-2)1 |
| BTEEL508 | Microprocessor and Microcontroller Lab | (0-0-2)1 |
| BTEEL509 | Power Electronics Lab | (0-0-2)1 |
| BTEEC601 | Switchgear Protection | (3-0-0)3 |
| BTEEC602 | Electrical Machine Design | (3-1-0)4 |
| BTEEC603 | Control System | (3-1-0)4 |

| | | |
|---|---|---|
| | Engineering | |
| BTEEL606 | Switchgear Protection Lab | (0-0-2)1 |
| BTEEL607 | Electrical Machine Design Lab | (0-0-2)1 |
| BTEEL608 | Control System Engineering Lab | (0-0-2)1 |
| BTEEC701 | High Voltage Engineering | (3-1-0)4 |
| BTEEC702 | Power System Operation and Control | (3-1-0)4 |
| BTEEL707 | High Voltage Engineering Lab | (0-0-2)1 |

| **Professional Elective Course (PEC)** | | |
|---|---|---|
| BTEEPE405 | (A)Electromagnetic Field Theory | (3-0-0)3 |
| | (B)Signals and System | |
| | ©Advance Renewable Energy Sources | |
| | (D)Electronic Devices and Circuits | |
| BTEEPE504 | (A)Industrial Automation | (3-0-0)3 |
| | (B)Power Quality Issues | |
| | ©HVDC | |
| BTEEPE604 | (A)Application of Power Electronics in Power System | (3-0-0)3 |
| | (B)Smart Grid Technology | |
| | ©Modeling, Simulation and Control of Electric Drives | |
| BTEEPE703 | (A)Energy Audit and Conservation | (3-0-0)3 |
| | (B)Electrical System Design for Building | |
| | ©Flexible AC Transmission System | |
| | (D)Electrical Utilization | |

| **Open Elective Course (OEC)** | | |
|---|---|---|
| BTEEOE50 | (A)Embedded System | (3-0-0)3 |
| | (B)Electrical Safety | |
| | ©Condition Monitoring of Electric Apparatus | |
| BTEEOE605 | (A)E-waste Management | (3-0-0)3 |
| | (B)Power Plant Engineering | |
| | ©Sensor Technology | |
| | (D)Lightning Interaction with Power System | |
| BTEEOE704 | (A)Process Control Instrumentation | (3-0-0)3 |
| | (B)Biomedical Instrumentation | |
| | ©Mechatronics | |
| BTEEOE705 | (A)Testing, Maintenance and Commissioning of Electrical Equipment | (3-0-0)3 |
| | (B)Electric and Hybrid Electric Vehicles | |
| | ©Internet of Things (IoT) | |

| **Seminar / Mini Project / Internship** | | |
|---|---|---|
| BTES209S | Seminar | (0-0-2)1 |
| BTES211P | (Internship – I) Field Training / Internship/Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in at one time). | 1 |
| BTEEM308 | Miniproject-I | (0-0-4)2 |
| BTEEP410 | (Internship – II) | 1 |
| BTEEM509 | Miniproject-II | (0-0-2)1 |
| BTEES609 | Seminar | (0-0-4)2 |
| BTEEP610 | (Internship – III) | |
| BTEEM708 | In house project-I / Mini project-III | (0-0-4)2 |

| **Project(MP)** |
|---|

| | | |
|---|---|---|
| BTEEP802 | In house project-I / Internship & Project in Industry | (0-0-26) 13 |

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

**Plan of Study:**

| No.of Courses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | I | II | III | IV | V | VI | VII | VIII |
| 2 | BTBS101 | BTBS201 | BTBS301 | BTEEC401 | BTEEC501 | BTEEC601 | BTEEC701 | BTEEPE801 |
| 3 | BTBS102 | BTBS202 | BTEEC302 | BTEEC402 | BTEEC502 | BTEEC602 | BTEEC702 | BTEEP802 |
| 4 | BTES103 | BTES203 | BTEEC303 | BTEEC403 | BTEEC503 | BTEEC603 | BTEEPE703 | |
| 5 | BTHM104 | BTES204 | BTHM304 | BTBS404 | BTEEPLE504 | BTEEPE604 | BTEEOE704 | |
| 6 | BTES105 | BTES205 | BTES305 | BTEEPE405 | BTEEOE505 | BTEEOE605 | BTEEOE705 | |
| 7 | BTES106 | BTES206 | BTEEL306 | BTEEL406 | BTHM506 | BTEEL606 | BTHM706 | |
| 8 | BTBS107L | BTBS207L | BTEEL307 | BTEEL407 | BTEEL507 | BTEEL607 | BTEEL707 | |
| 9 | BTES108L | BTES208L | BTEEP308 | BTEEL408 | BTEEL508 | BTEEM608 | BTEEM708 | |
| 10 | BTHM109L | BTES209S | BTES211P | BTEEL409 | BTEEPE509 | BTEEP609 | BTEEP609 | |
| 11 | | BTES211 | | BTEEP410 | BTEEP409 | | | |

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

## A. Program Educational Objectives (PEOs)

Graduates will able to–

1.To equip graduates with a strong foundation in engineering sciences and Electrical Engineering fundamentals to become effective collaborators, researchers and real-time problem solver with technical competencies.

2.Perceive the limitation and impact of engineering solutions in social, legal, environmental, economical and multidisciplinary contexts.

3.Excel in Industry/technical profession, higher studies, and entrepreneurship exhibiting global competitiveness.

## B. Program Outcomes (POs)

Engineering Graduate will be able to –

1. **Engineering knowledge**:Apply the knowledge of mathematics, science,engineering fundamentals, and anengineering specialization to the solution ofcomplex engineering problems.
2. **Problem analysis**:Identify, formulate, review research literature, and analyzecomplex engineering problems reaching substantiated conclusions using firstprinciples of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**:Design solutions for complex engineeringproblems and design systemcomponents or processes that meet the specifiedneeds with appropriate consideration for the public health and safety, and thecultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:**Use research-based knowledgeand research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:**Create, select, and apply appropriate techniques, resources,and modern engineering and IT tools including prediction and modeling to complexengineering activities with an understanding of the limitations.
6. **The engineer and society:**Apply reasoning informed by the contextualknowledge to assess societal, health, safety, legal and cultural issues and theconsequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:**Understand the impact of the professionalengineering solutions in societal and environmental contexts, and demonstrate theknowledge of, and need for sustainable development.
8. **Ethics:**Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:**Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively oncomplex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effective reports anddesign documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering andmanagement principles and apply these to one's own work, as a member and leader in a team, to manageprojects and in multidisciplinary environments.
12. **Life-long learning:**Recognize the need for, and have the preparation and ability to engage in independentand life-long learning in the broadest context of technological change.

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

### Curriculum for Semester V

| Course Category | Course Code | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | Total | |
| PCC4 | BTEEC501 | Power System Analysis | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC5 | BTEEC502 | Microprocessor and Microcontroller | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| PCC6 | BTEEC503 | Power Electronics | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC2 | BTEEPLE504 | Group B | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| OEC1 | BTEEOE505 | Group C | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| HSSMC | BTHM506 | Foreign Language # | - | - | - | - | - | - | - | Audit |
| LC | BTEEL507 | Power System Analysis Lab | - | - | 2 | 60 | - | 40 | 100 | 1 |
| LC | BTEEL508 | Microprocessor and Microcontroller Lab | - | - | 2 | 60 | - | 40 | 100 | 1 |
| LC | BTEEL509 | Power Electronics Lab | - | - | 2 | 60 | - | 40 | 100 | 1 |
| Project | BTEEPE510 | Mini project-II | - | - | 2 | 60 | - | 40 | 100 | 1 |
| Internship | BTEEP410 | Internship-II Evaluation | - | - | - | - | - | 50 | 50 | 1 |
| | | **Total** | **15** | **2** | **10** | **340** | **100** | **510** | **950** | **22** |

### Semester VI

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| PCC7 | BTEEC601 | Switchgear and Protection | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| PCC8 | BTEEC602 | Electrical Machine Design | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PCC9 | BTEEC603 | Control System Engineering | 3 | 1 | - | 20 | 20 | 60 | 100 | 4 |
| PEC3 | BTEEPE604 | Group D | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| OEC2 | BTEEOE605 | Group E | 3 | - | - | 20 | 20 | 60 | 100 | 3 |
| LC | BTEEL606 | Switchgear and Protection Lab | - | - | 2 | 60 | | 40 | 100 | 1 |
| LC | BTEEL607 | Electrical Machine Design Lab | - | - | 2 | 60 | | 40 | 100 | 1 |
| LC | BTEEL608 | Control System Engineering Lab | - | - | 2 | 60 | | 40 | 100 | 1 |
| Seminar | BTEEM609 | Seminar | - | - | 4 | 60 | | 40 | 100 | 2 |
| Internship | BTEEP610 | Internship-III (minimum of 4 weeks which can be completed partially in third or fourth semester or in at one time) | - | - | - | - | - | - | - | Credits to be evaluated in VII sem. |
| | | **Total** | **15** | **2** | **10** | **340** | **100** | **460** | **900** | **22** |

BSC= Basic Science Course, ESC= Engineering Science Course, PCC= Professional Core Course, PEC= Professional Elective Course, OEC= Open Elective Course, LC= Laboratory Course, HSSMC= Humanities and Social Science including Management Course

**# Online NPTEL Course**

## Semester V

| BTEEPE504 Professional Elective (Group B) | BTEEOE505 Open Elective (Group C) |
|---|---|
| (A)HVDC | (A) Embedded System |
| (B) Power Quality Issues | (B) Electrical Safety |
| (C) Industrial Automation | (C) Condition Monitoring of Electric Apparatus |

| BTHM506 Foreign Language |
|---|
| (A) Japanese Language |
| (B)German Language |

## Semester VI

| BTEEPE604 Professional Elective (Group D) | BTEEOE605 Open Elective (Group E) |
|---|---|
| (A) Flexible AC Transmission System | (A) E-waste Management |
| (B) Smart Grid Technology | (B) Power Plant Engineering |
| (C) Modeling, Simulation and Control of Electric Drives | (C) Sensor Technology |
| | (D) Lightning Interaction with Power System |

## Semester V

**BTEEC501 POWER SYSTEM ANALYSIS** **4 Credits**

**Unit 1: Modeling of Power System** **7 Hours**

Complex power flow, balanced and reactance diagrams of a power system, per unit system per unit representation of transformers, synchronous machines, representation of loads. Graph theory and its applications for formation of primitive network and Z and Y matrices, incidence matrices, Y-bus and Z-bus matrices.

**Unit 2: Load Flow Studies:** **7 Hours**

Introduction, network model formulation, formation of Y-bus by singular transformation, load flow problem, Iterative methods of load flow such as Gauss Gauss-Seidel, Newton-Raphson method, decoupled load flow and fast decoupled load flow, Automatic Generation control.

**Unit 3: Symmetrical Fault Analysis:** **7 Hours**

Transients on a transmission line, short circuit of a synchronous machine on no load and on load. Short circuit current computation on no load and on load, selection of circuit breakers, Z-bus formulation, algorithm of short circuit studies.

**Unit 4: Symmetrical Components:** **7 Hours**

Fundamentals of symmetrical components, sequence impedance and sequence network of star connected loads, transmission lines, synchronous machines and transformer sequence network of a loaded generator.

**Unit 5: Unsymmetrical Faults Analysis** **7 Hours**

single line to ground (l-g), Line to line (L-L), double line to ground (L-L-G) faults analysis of above faults using bus impedance matrix, bus voltage and line current during faults. open conductor faults.

**Unit 6: Security Analysis** **7 Hours**

Basic Concepts, Security analysis, Load Dispatch centre, Contingency Analysis, preventive and emergency control, Electrical Power Quality, causes, affects and mitigation methods.

**Text books:**

1. I.J. Nagrath& D.P. Kothari, “Modern System Analysis”, Tata McGraw- Hill

2. Stevenson W.D “Elements of Power System Analysis”, McGraw- Hill Wadhawa C.L “Elements Power System”, John Wiley & sons.

**Reference Books:**

1. “Power System Analysis”, T.K. Nagsarkar, M.S. Sukhiya. (OXFERD U. P.)
2. Stevenson W.D. and Grainger J.J. “Power System Analysis” McGraw- Hill
3. A.R. Bergen and Vijay Vittal, Power Systems Analysis, Pearson Education Asia, 2001.
4. Stagg W.D. & EI-AbiadA.H.,”Computer Method in Power System Analysis”, McGraw- Hill
5. H.Saadat “Power System analysis”, McGraw- Hill
6. Elgred O.I. electrical Energy System Theory”, McGraw-Hill.

7. J.D. Glover, M. Sarma and T.J. Overbye, Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.

**BTEEC502 MICROPROCESSOR AND MICROCONTROLLER 04 Credits**

**Unit 1: Microprocessor architecture 7 Hours**

8085 architecture, functional block diagram, Arithmetic Logic Unit (ALU), Timing and control Unit, Registers, Data and Address bus, Interface unit, 8085 instructions, Instruction word size: one byte, two byte and three byte instructions, addressing modes of 8085, assembly language programming Timing and control signals, Fetch operations, Execution operations, Machine cycle and state, Instruction and data flow, System timing diagram– interrupts.

**Unit 2: Memory interfacing 7 Hours**

Types of main memories, Compatibility between memory and system BUS, Address space, Partitioning of address space, Special chips for address decoding, ROM and RAM interfacing, i/o interfacing: memory map i/o, i/o map i/o scheme. Programmable peripheral interface. Data transfer techniques and their implementation: Programmed data transfer, DMA mode of transfer, I/O port, Device polling in interrupt driven mode of data transfer, DMA controller and data transfer in DMA mode, Serial mode of data transfer

**Unit 3: Applications of microprocessors 7Hours**

Interfacing of A/D converters, interfacing of D/A converter, wave generator, multiplex seven segment LED display system, measurement of frequency, phase angle and power factor. Traffic light controller and stepper motor controller.

**Unit 4: 8051 Microcontroller 8 Hours**

Intel 8051 architecture, memory organization, flags, stack, and special function registers, I/O, ports - connecting external memory, counters and timers, serial data I/O, Interrupts. Microcontroller instructions - addressing modes, moving data, logical operations, arithmetic operations, jump and call instructions – subroutines - Interrupts and returns.

**Unit 5: Microcontroller programming 8 Hours**

Assembly Language Programming, timer and counter programming, connection to RS 232 and RS 485, Interrupt programming. Peripherals and interfacing - Serial and parallel I/O (8251 and 8255), Programmable DMA controller, Programmable interrupt controller, ADC/DAC interfacing.

**Text/Reference Books:**

1. Systems and Microprocessors, John P. Hayes, Digital McGraw-Hill I.E.
2. Microprocessor Architecture, Programming and Applications, R.S.Gaonkar, Wiley Eastern.
3. Microprocessor and Interfacing: Programming and Hardware, D.V. Hall, McGraw-Hill I.E
4. Digital Systems and Microprocessors , John P. Hayes, McGraw-Hill I.E.

**BTEEC 503 POWER ELECTRONICS** **04 Credits**

**Unit 1: Introduction** **7 Hours**

Concept of Power Electronics, Different types of power electronics devices, converter systems, areas of application, recent developments. Device characteristics, protection and operation: Terminal characteristics of major power electronics devices(SCR, BJT, MOSFET, IGBT, GTO, TRIAC,), ratings, protection, heating, cooling and mounting, series and parallel operation, firing circuits, Snubber circuits

**Unit 2: Phase controlled rectifiers** **7 Hours**

Analysis and design of diode rectifier circuits and controlled rectifier circuits (for R, RL, RLE load), Phase control, power factor, DC load voltage, Polyphase rectifiers, Current and voltage waveforms analysis, Applications for DC motor drives. Effect of source impedance on the performance of converters, dual converters.

**Unit 3: Choppers** **7 Hours**

Principle of chopper operation, Control strategies, Types of chopper circuits and steady state analysis. Commutation in chopper circuits, buck, boost and buck-boost chopper, Discontinuous current analysis, Non-ideal effects and dynamic performance, Applications for DC motor drives. PWM control and operation

**Unit 4: Inverters** **7 Hours**

Classification of inverters, Single-phase and three-phase Voltage source Inverters, Methods of controlling output voltage, frequency and phase, Reduction of harmonics in the inverter output voltage, Current source inverters and operations. Applications for AC motor drives, Pulse Width Modulation (PWM): Types of PWM.

**Unit 5: AC Voltage Controller** **10 Hours**

Types of AC voltage controllers, Single phase voltage controllers, Sequence control of ac voltage controllers, 3-phase AC voltage controller operation Application of AC-AC Phase Control, Singlephase and poly phase control circuits, Applications for AC motor drives, Cycloconverters: Principles of cycloconverter operation, Methods of controlling output voltage and frequency in cases of: Single phase to single phase, three phases to single phase, three phases to three phase operation.

Applications: Power supply applications, few applications in residential and industrial systems, Electric utility.

Reference Books:

1. Power Electronics , P C Sen, TMH
2. Power Electronics, Dubey, TMH
3. Thyristorised Power Controllers, Dubey et. al., TMH
4. Power Electronics, Rashid Mohammed, PHI

5. Power Electronics & Drives, V. Subrahmanyam, New Age

**BTEEPE504A HVDC** **03 Credits**

**Unit 1: Introduction to HVDC transmission** **7 Hours**

Development of HVDC Technology, DC versus AC Transmission, DC System components and their functions, Converter configuration, Selection of Converter Configuration, Firing angle, Current and extinction angle control, DC link power control, Reactive power control and VAR sources, MTDC system types

**Unit 2: Bridge converters** **7 Hours**

Rectifier and inverter operation, equivalent circuit representation, power reversal, desired features of control and actual control characteristics.

**Unit 3: Basic HVDC controllers** **7 Hours**

Converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over voltage protection.

**Unit 4: Harmonics in HVDC** **7 Hours**

Characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters. Introduction to Hybrid HVDC and Off-shore wind power evacuation schemes .

**Unit 5: Component models for analysis of AC DC system** **7 Hours**

Power flow analysis Of AC DC system, transient stability analysis, dynamic stability analysis, advances in HVDC Transmission, application in wind power generation.

**Text/ Reference Books:**

1. K. R. Padiyar, ―HVDC power transmission system‖, Willey eastern limited, Second edition.

2. 2. E. W. Kimbark, ―direct current transmission‖, Wiley- inter science, NewYork.

**BTEEPE504B POWER QUALITY ISSUES** **03 Credits**

**Unit 1: Introduction** **7 Hours**

Definition of Power quality, Power Quality –Voltage & Current Quality, Importance of Power Quality, Power quality Evaluation. General Classes of Power quality Problems, Transients, Long-Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage fluctuation, Power Quality Terms, CBEMA and ITI Curves. Voltage Sags and Interruptions: Sources of Sags and Interruptions, estimating voltage Sag Performance, Fundamental Principles of Protection, Solution at the End-User Level, Motor –Starting Sags.

**Unit 2: Transient over Voltages** **7 Hours**

Sources of Transient Over voltages, Principles of Over voltage Protection, Devices for over voltageProtection, Utility Capacitor-Switching transients, Utility System Lightning Protection, ManagingFerro-resonance, Switching Transient Problems with Loads, Computer Tools for TransientsAnalysis.

**Unit 3: Fundamentals of Harmonics** **7 Hours**

Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, HarmonicIndexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads,Locating Harmonic Sources, Effects of Harmonic distortion, interharmonics, Harmonic distortionEvaluations, Principles for Controlling Harmonics, Harmonic Filter design: A Case Study,Standards of Harmonics.

**Unit 4: Long-Duration Voltage Variations** **7 Hours**

Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulatorapplication, Capacitors for Voltage Regulation, End-Users Capacitors Application, and RegulatingUtility Voltage with distributed Resources Flicker.

**Unit 5: Power Quality Monitoring** **7 Hours**

Monitoring considerations, Historical Perspective of Power quality Measuring Instruments, PowerQuality Measurement Equipment, Assessment of Power Quality Measurement Data, Application of intelligent Systems, Power Quality Monitoring Standards, Monitoring considerations.

**References/Books:**


1. Chattopadhyay, Surajit, Mitra, Electric Power Quality, Springer.
2. Haytt G. T., ―Electric Power Quality‖, Stars In Circle Publication.
3. NPTEL courses

**BTEEP504C INDUSTRIAL AUTOMATION 03 Credits**

**Unit 1: Introduction to Industrial Automation 6 Hours**

Architecture of Industrial Automation Systems, Elements of an Automated System, Functional hierarchy of an Industrial Automation system, Levels of Automation.

**Unit 2: Programmable Logic Controllers 8 Hours**

Introduction, Architecture of PLC, PLC Operation, **PLC Hardware Components-** Input-Output module (Discrete and Analog), **PLC Programming -** Ladder Logic, Functional Block Diagram (FBD), Ladder Logic Programming (NO-NC, Timer and Counter), PLC Communication, Application of PLCs.

**Unit 3: Industrial Drives Control 7 Hours**

Classification of Industrial Drives, DC Motor Drives, Induction Motor Drives, Variable Speed Drives, Servo Motor Drives, Step Motor Drives, BLDC Motor Drives, Control of Drives, Industrial Application of Drives.

**Unit 4: SCADA 8 Hours**

SCADA system Architecture, Elements of SCADA System, Human Machine Interface, Master Terminal Unit, Remote Terminal Unit. Alarm Handling and Trending, Access Control, Automation Logging, Archiving, Report Generation. Types of interfaces, SCADACommunication.SCADA Applications: Operation and control of interconnected power system, Automatic substation control, Electric Power Generation, Transmission and Distribution sector operation.

**Unit 5: Distributed Control System 7 Hours**

Introduction and Overview, System Architecture, System Elements, Difference between Centralized and Distributed Control System. Displays: Group Display, Overview Display, Detail Display, Data Highways, Field Buses, Multiplexers and Remote Sensing Terminal Units, I/O Hardware, Case study of any one DCS.

**Text Books/ Reference Books:**


1. C. D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall of India.
2. B. G. Liptak, Instrument Engineer's Handbook, Process Control, Chilton Book Company.
3. W. Bolton, “Programmable Logic Controllers”, Elsevier.
4 Hughes, “Programmable Controllers”, ISA Publications.
5 Frank D. Petruzella, “Programmable Logic Controllers”, McGraw-Hill Book Company.
6 John W. Webb and Ronald A. Reis, “Programmable Logic Controllers”, PHI.
7 Stuart A. Boyer “Supervisors Control and Data Acquisition”, ISA.

**BTEEOE505A EMBEDDED SYSTEM** **03 Credits**

**Unit 1: Embedded System Architectures** **7 Hours**

Introduction, Components of Embedded Systems ARM processor - architectural design -memory organization -data operation-bus configurations. System on-chip, scalable bus architectures, Design example: Alarm clock, hybrid architectures.

**Unit 2: Sensor and Actuator I/O 7 Hours**

ADC, DAC, timers, Servos, Relays, stepper motors, H-Bridge, port.

**Unit 3: Real time operating systems (RTOS)** **7 Hours**

real time kernel – OS tasks – task states – task scheduling –interrupt processing – clocking communication and synchronization – control blocks – memory requirements and control – kernel services.

**Unit 4: Embedded Networks** **7 Hours**

Distributed Embedded Architecture – Hardware and Software Architectures, Networks for embedded systems– I2C, CAN Bus, Ethernet, Internet, Network-based design–Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

**Unit 5: System Design** **7 Hours**

Specification, Requirements and Architectural design of PBX systems, Set-top box, Ink-jet printer, Laser printer, Personal digital Assistants.

Embedded Hardware : memory map, i/o map, interrupt map, processor family, external peripherals, memory- RAM , ROM, types of RAM and ROM, memory Testing, CRC, Flash memory.

**Text/ References Books:**


1. Sloss Andrew N, Symes Dominic, Wright Chris, ―ARM System Developer's Guide: Designing and Optimizing‖, Morgan Kaufman Publication,2004.
2. Raj Kamal,―Embedded Systems – Architecture: Programming and Design‖, Tata McGraw-Hill Education, 3rded.,2003.

**BTEEOE505B ELECTRICAL SAFETY** **03 Credits**

**Unit 1: Primary and secondary hazards arc** **7 Hours**

blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eyeprotection-rubber insulating equipment, hot sticks, insulated tools, barriersandsigns,safety tags,locking devices- voltage measuring instruments- proximity and contact testers-safety electricalone-line diagram- electrician ‘s safety kit.

**Unit 2: General requirements for grounding and bonding** **9 Hours**

definitions-grounding of electrical equipment bonding of electrically conducting materials andother equipment-connection of grounding and bonding equipment- system grounding- purpose ofsystem grounding- grounding electrode system grounding conductor connection to electrodes-useof grounded circuit conductor for grounding equipment- grounding of low voltage and highvoltage systems

The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system-lockout-tag out- flash hazard calculation and approach distances- calculating there required level of arc protection-safetyequipment, procedure for low, medium and high voltagesystems- the one-minute safety audit.

**Unit 3: Electrical safety programmer structure** **7 Hours**

development- company safety team- safety policy programme implementation- employee electrical safety teams-safety meetings- safety audit accident prevention- first aid- rescuetechniquesaccident investigation.

**Unit 4: Safety related case for electrical maintenance** **6 Hours**

reliability cantered maintenance (RCM) -eight step maintenance programme- frequency of maintenance- maintenance requirement for specific equipment and location.

**Unit 5: Regulatory bodies** **6 Hours**

National electrical safety code- standard for electrical safety in work place- occupational safety and health administration standards, Indian Electricity Acts related to Electrical Safety.

**Text / Reference Books:**


1. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, =Electrical SafetyHandbook ‘, McGraw-Hill Education, 4th Edition, 2012.
2. Maxwell Adams.J, =Electrical Safety- a guide to the causes and prevention of electrichazards ‘, The Institution of Electric Engineers, IET 1994.
3. Ray A. Jones, Jane G. Jones, =Electrical Safety in the Workplace ‘, Jones & BartlettLearning, 2000

**BTEEOE505C CONDITION MONITORING OF ELECTRICAL APPARATUS 3 Credits**

**Course Outcomes:**

By the end of the course, students will be able to

1. Understand the necessity of condition monitoring and reliability.
2. Have knowledge about the conventional and modern methodologies/techniques.
3. Develop basic functional models for condition monitoring system to different kind of power apparatus.
4. Determine life expectancy of the equipment

**Unit 1: Basic Considerations and Maintenance 07 Hours**

Basic definitions, terminologies, symbolic representation, Necessity from technical social, financial aspect, types of faults in electrical equipments {Electrical equipments such as transformer, CT/PT and rotating electrical machines, CBs, etc.}, maintenance strategies, breakdown maintenance, planned, preventative and condition based maintenance

**Unit 2: Testing of Electrical Equipments 6 Hours**

Cables, Transformers, Induction motor, Capacitor banks, conventional methods, Measurement of insulation resistance, Diagnostic Testing: Routine tests, type tests, special tests, offline tests, Causes of failure and remedies.

**Unit 3: Analysis tools 6 Hours**

Recent methods (offline), Dissolved Gas Analysis (DGA), Dissipation Factor (tan δ), Sweep Frequency Response Analysis (SFRA), Partial Discharge (PD), Time Domain Dielectric Response (TDDR), Frequency Domain Spectroscopy (FDS), Chemical analysis. Image processing techniques

**Unit 4: Online condition monitoring and instrumentation 6 Hours**

Recent methods (online), vibration, chemical and temperature monitoring, sensor and data acquisition system, Modern algorithms, GA, and signal processing techniques. Application to various equipments such as transformer, induction motor, synchronous generator and motor, DC motor, CT and PT, case studies.

**Unit 5: Current, Flux and Power Analysis 6 Hours**

Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response. Introduction to DFT in time domain and frequency domain, Derivation of DFT from DTFT, Inverse DFT, Convolution using DFT, Computational Complexity of the DFT, Decimation-in-time FFT Algorithm, Decimation In Frequency FFT Algorithm, Wavelet transform, Lab view platform.

**Unit 6: Reliability and failure rate Assessment 8 Hours**

Comparison of DIT AND DIF algorithms. Introduction to FIR and IIR Filter Design. Calculation of Power Equipment Reliability for Condition-based Maintenance Decision-making, Optimum

Reliability- Centered Maintenance, Cost Related Reliability Measures for Power System Equipment, Reliability based replacement refurbishment/planning

**Text Books:**


1. P. Vas, “Parameter estimation, condition monitoring and diagnosis of electrical machines”, Clarendon Press Oxford, 1993.
2. P. Tavner, Li Ran, J. Penman and H. Sedding, “Condition monitoring of rotating electrical machines”, IET press, 2008.


**Reference Books:**


1. Xose M Lo´pez, Ferna´ndez, H Bu¨lentErtan, J Turowski, “Transformers analysis, design, and measurement”, CRC Press, 2012
2. S.V. Kulkarni and S. A. Khaparde, “Transformer Engineering: Design, Technology and Diagnostics”, Second edition, CRC Press, 2013
3. R. Billinton and R. N. Allan, *“* Reliability Evaluation of Power Systems, 2nd ed. New York”, NY, USA: Plenum, 1996.
4. Videos on Transformer condition evaluation with ABBs Mature Transformer Management Program
5. Induction motor condition monitoring with ABBs, Siemens, General Electricals (source You Tube

**BTEEL507 POWER SYSTEM ANALYSIS LAB** **1 Credit**

Any Eight Experiments from the following list.(Any Experiment from the following list can be performed either SCILAB/MATLAB/Any Other Software.)

1. Write a program to draw the per unit reactance diagram of a given power system.
2. Solution of building the Bus Admittance matrix for given power system network.
3. Solution of power flow problem of a given power system using Gauss-Siedel method.
4. Solution of power flow problem of a given power system using Newton Raphson Method.
5. Solution of power flow problem of a given power system using Fast Decoupled method.
6. Single Line to Ground Fault (L-G) analysis of a Three Phase Transmission Line at no load and light load conditions.
7. Line to Line Fault (L-L) analysis of Three Phase Transmission Line at No load and Light load conditions.
8. Double Line to Ground Fault (LLG) analysis of Three Phase Transmission Line at No load and Light load conditions.
9. Symmetrical L-L-L Fault analysis of Three Phase Transmission Line at No load and Light load conditions.

**BTEEL508 MICROPROCESSOR AND MICROCONTROLLER LAB 01 Credit**

| | |
|---|---|
| 1 | Study of Architecture of 8085 |
| 2 | Assembly language program for addition and subtraction of 8 bit &16 bit numbers based on 8085 microprocessor |
| 3 | Assembly language program for multiplication of two numbers based on 8085 microprocessor |
| 4 | Assembly language program for Multiplication and division of two numbers based on 8085 microprocessor |
| 5 | Assembly language program for determination of smaller and larger no based on 8085 microprocessor |
| 6 | Assembly language program for ascending and descending order based on 8085 microprocessor |
| 7 | Assembly language program for rolling/flash LED based on 8085 microprocessor |
| 8 | Interfacing of 7 segment LED to 8085 microprocessor |
| 9 | Interfacing of Stepper motor with microprocessor |
| 10 | Programs based on arithmetic instructions for 8051 microcontroller |
| 11 | Interfacing of stepper motor to 8051 microcontroller |
| 12 | Interfacing of DC motor to 8051 microcontroller |
| 13 | Interfacing of converters ADC 0808/0809 and DAC 0808 |
| 14 | Generate Delay using Timer section of 8051 microcontroller. |

**Conduct any 4 practicals fro 1 to 7 and 4 practicals from 8 to 14.**

**BTEEL509 POWER ELECTRONICS LAB** **01 CREDIT**

1.V-I characteristics of various power electronics devices.(At least two devices SCR/MOSFET/IGBT/TRIAC/GTO)

Group A (minimum four)

2.Experimental analysis of single phase uncontrolled converter

3.Experimental analysis of single phase Half controlled converter

4.Experimental analysis of single phase fully controlled converter

5.Experimental analysis of three phase bridge inverter.

6.Experimental analysis of BUCK /BOOST/BUCK -BOOST converter

Group B

7.Simulation of Single phase Semi controlled converter

8.Simulation of Single phase Fully controlled converter

9.Simulation of Single phase inverter

**BTEEPE510 MINI PROJECT II** **01 Credits**

**Guidelines:**

| Stage | Work to be carried |
|---|---|
| **I** | • Selection of a project (Hardware or Software Based) on recent trends in Electrical Engineering.<br>• Planning the outcome of the project and listing out the expected outcome of the project.<br>• Literature Survey |
| **II** | • Development of Project Idea in the form of working model (Hardware based projects) or production of appropriate simulation results of the proposed idea (Software based projects). |
| **III** | • Verification of the results obtained of the working model or the simulation results.<br>• Comparing if the outcomes as defined in Phase I are met and taking corrective action. |
| **IV** | • Completion of project by developing the Project Report and submitting the report to the concerned to receive the final credits. |

## Semester VI

**BTEEC601 SWITCHGEAR AND PROTECTION 04 Credits**

**Unit 1: Introduction to Switchgear and Protection 7 Hours**

Introduction, Need for power system protection, effects of faults, Requirement of Relays, Relays Terminology, basic circuit, relay connection with trip circuit and circuit breaker, types of relay, Protective Devices: Philosophy of protection, zones of protection, primary and backup protection, Methods of earthing and their effect on fault conditions. Different types of relays: attracted armature type, balanced beam type, induction type.

**Unit 2: Static and Numerical Relays 7 Hours**

Amplitude and phase comparator techniques, Differential relays, directional relay, impedance relay, admittance relay, MHO relay, description of numerical relays, relaying algorithms, use of numerical relays as fault locator and disturbance recorder. Microprocessor Based Relays: Advantages, over current relays, directional relays, distance relays.

**Unit 3: Circuit Breakers and Fuses 7 Hours**

Introduction, arcing in circuit breakers, arc interruption, re-striking and recovery voltage, current chopping, resistance switch, Air blast circuit breakers, minimum and bulk oil circuit breakers, SF6 and Vacuum Circuit breakers, circuit breakers rating, testing of CB, point on wave switching, Definitions of terms in fuses, HRC fuses. Introduction, fuse characteristics, types of fuses, application of HRC fuses. Selection of circuit breakers, high voltage d.c. breakers.

**Unit 4: Protection of Transmission Lines 7 Hours**

Over current protection, construction and operation of instantaneous over current relay. Directional Over current relay , distance protection, unit protection schemes, carrier aided distance protection, protection of feeders, protection of ring main and parallel feeders, protection of radial feeders by over current relays, distance relays and carrier current protection scheme. Protection of induction motor‘s against overload, short-circuits, thermal release, miniature circuit breaker

**Unit 5: Protection of Alternators & Transformers 7 Hours**

Differential protection of alternator, protection of stator against phases to ground fault, phase to phase faults, inter turn fault, protection against unbalanced loading, protection of rotor against ground fault, field failure, reverse power, back up protection, field suppression, protection of bus bars, frame leakage protection. Differential protection of transformer for different winding configurations, difficulties encountered in differential protection and their remedies. Standards and specifications related to switch gear and protection

**Text/References Books:**

1. Power system protection and switchgear‖, Ravindranath and Chander, TMH

2. Fundamentals of power system protection‖, Paithankar and Bhide, PHI
3. J. L. Blackburn and T. J. Domin, Protective Relaying: Principles & Applications, CRC Press, 2006.
4. Electrical power system‖, Wadhwa, New Age. 2. ―Power system protection‖, Badri Ram, TMH.

**BTEEC602 ELECTRICAL MACHINE DESIGN 04 Credits**

**Unit I: Principles of Electrical Machine Design: 6 Hours**

Principles of design, design factors, limitations, Ratings, Specifications, Standards, Performance and other criteria to be considered, Brief study of magnetic, electric, dielectric and other materials, Introduction and advantages of various approaches of Computer Aided Designing.

**Unit II: Design of Simple Electrical Apparatus& AC and DC Windings: 6 Hours**

Detailed design of heating coils, starters, chokes and lifting magnets, Numerical examples.

**AC & DC Windings**: Constructional features, types of ac windings, Choice and design of simple/ duplex lap and wave winding, Concept of multiplex windings and reasons for choosing them, Single and double layer three phase AC winding (mush) with integral slots

**Unit III: Design of Induction Motor (Stator): 10 Hours**

Calculation of Ampere-Turns for flux distribution in rotating machines, Calculation of Ampere-Turns for flux distribution in rotating machines, output equation of three phase IM, specific electrical and magnetic loadings, ranges of specific loadings, turns per phase, number of stator slots, calculations for main dimensions, stator design parameters, Numerical examples.

**Unit IV: Design of Induction Motor (Rotor): 6 Hours**

Selection of length of air gap, factors affecting length of air gap, design of rotor, Unbalanced magnetic pull and its estimation, harmonic field effect on the performance of3-phase induction motor, Design of squirrel cage and wound rotor

**Unit V: Heating and Ventilation of Electrical Machines: 6 Hours**

Study of different modes of heat generation, Temperature rise and heat dissipation, Heating and Cooling cycles, heating and cooling time constants, their estimation, dependence and applications, Methods of cooling / ventilation of electrical apparatus, Thermal resistance, radiated heat quantity of cooling medium (Coolant) Numerical examples.

**Unit VI: Design of Transformer: 10 Hours**

Design of Transformer: Design of distribution and power transformers, Types, Classification and specifications, Design and main dimensions of core, yoke, winding, tank (with and without cooling tubes), Estimation of leakage reactance, resistance of winding, No load current, Losses, Mechanical force developed during short circuits, their estimation and measures to reduce them, Numerical examples.

**Textbooks:**

1. Sawhaney. A. K– A Course in Electrical Machine Design (DhanpatRai).

**Reference Books:**

1. .Deshpande. M. V- A Course in Electrical Machine Design (Prentice Hall Of India).

2. Siskind – Electrical Machine Design (Mcgraw Hill).

**BTEEC603 CONTROL SYSTEM ENGINEERING 04 Credits**

**Unit 1: Introduction 10 Hours**

Concept of open & closed loop control system, Transfer Function: Concept of system: Physical system, Physical model, Linear and Nonlinear systems, Time variant and Time invariant system. Equations of physical systems (Mass-Spring-Dashpot system, R-L-C series & parallel circuit) Transfer Function, Procedure of obtaining transfer function.

Block diagrams and Signal flow graphs: a) Block diagram, Block Diagram reduction, and Numerical examples. b) Signal flow graph; Masons gain formula for deriving overall transfer function of systems. Feedback characteristics of control system: Concept of Negative and Positive feedback, Sensitivity of the system to parameter variation and with negative and positive feedback.

**Unit 2: Time Domain Analysis 7 Hours**

Typical test signals, Time domain specifications, Steady state response, Types of system, Steady State Error constants and Steady State Error, Transient Response, Concept of stability, Determination of stability by Routh - Hurwitz criterion.

**Unit 3: Frequency Domain Analysis 10 Hours**

Introduction to Frequency Domain Analysis, Polar plots,Bode plots, Nyquist criterion, Relative stability from Nyquistcriterion. Root Locus, Construction of Root Locus, and Stability from Root Locus plots, Effect of addition of poles & zeros on Root Locus plots, Compensation network: Lag, Lead & Lag-Lead.

**Unit 4: PID Controllers 4 Hours**

Introduction to Proportional (P), Integral (I) & Derivative (D) controller, individual effect on overall system performance, P-PI & PID control and effect on overall system performance.

**Unit 5: State Variable Technique 8 Hours**

Concept of State, State Variable & State Vector, State Variable Analysis: Different forms of state variable representations (Phase, Physical & Canonical form), Concept of Diagonalization, Obtaining StateEquations from Transfer Function representation and vice versa, Solution of State Equations, StateTransition Matrix (STM), Methods of finding STM, Power Series Method, Laplace Transform Method, Calay Hamilton Method, Controllability & Observability of linear system, Kalman‘s test.

**Text Books/ReferenceBooks:**


1. Ogata K., “Modem Control Engineering”, Prentice Hall of India.
2. Kuo B. C., “Automatic Control System”, Prentice Hall of India.
3. Nagarath I. J. and Gopal M., “Control System Engineering”, Willey Eastern.
4. Norman S. Nice, “Control System Engineering”, Wiley.

5. Smarajit Ghosh, “Control Systems Theory & Applications”, Pearson.
6. Gopal M., “Control System”, Prentice Hall of India.

## BTEEPE604A FLEXIBLE AC TRANSMISSION SYSTEM 3 Credits

**Unit 1: Transmission Interconnection 7 Hours**

Flow of power in the AC system, factors affecting loading capability, power flow and dynamicstability consideration of a Transmission interconnection, Description and application of HVDCtransmission, DC System components and their functions, Converter configuration, Principles ofDC Link control and Converter control characteristics, Firing angle, Current and extinction anglecontrol, DC link power control

**Unit 2: Flexible AC Transmission 7 Hours**

Benefits of FACTS, Basic Realities & Roles, Types of FACTS Controller, Principles of Series and Shunt Compensation. Introduction to Voltage source and Current source converter. Shunt compensation (SVC): Objectives of shunt compensation, Midpoint voltage regulation for long transmission line, voltage instability prevention, improvement of transient stability

**Unit 3: Reactive power control and VAR sources 7 Hours**

Reactive power control and VAR sources Methods of controllable VAR generation, Description ofStatic VAR Compensators (SVC), Variable impedance type VAR generators. Thyristor controlledreactor (TCR), Thyristor Switched Capacitor (TSC), TSC-TCR, Fixed capacitor TCR (FC-TCR).Shunt compensation

**Unit 4: Variable impedance type series compensator 7 Hours**

Thyristor Switches Series Capacitor (TSSC), Thyristor Controlled Series Compensators (TCSC). Switching Converter type Series Compensator. Introduction to interline power flow controller, Special purpose FACTS controllers, Thyristor controlled voltage limiter and voltage regulator, Thyristor controlled braking resistor and current limiter.

**Unit 5: (STATCOM) 7 Hours**

Switching type VAR generator, Static Synchronous Compensator (STATCOM), Basic operatingprinciple, Configuration. Basic control approach, Comparison between SVC and STATCOM.Series Compensator: Objectives of series compensation, improvement of transient stabilitySynchronous Series Compensator: (SSSC) and Controller for SSSC, Basic configuration andworking of Unified Power Flow Controller (UPFC). Unified Power Flow Controller, CircuitArrangement, Basic Principle of P and Q Control, independent real and reactive power flow control, Applications GCSC, TSSC, TCSC & SSSC

**Text Books/Reference Books:**

1. N.G Hingorani, L. Gyugyi, ―Understanding FACTS: Concepts and Technology of FlexibleAC Transmission Systems‖, IEEEPress Book, Standard Publishers and Distributors, Delhi,2001.
2. Padiyar K.R., ―HVDC Power Transmission System‖, Wiely Eastern PVT Limited.

3. Thyristor Based FACTS Controllers for Electrical Transmission System, R.M. Mathur, and R. K.Verma
4. FACTS: Controller in Power Transmission & Distribution, K. R. Padiyar, New AgeInternational.
5. HVDC and F ACTS controllers, Application of Static converter in Power System, V.K. Sood
6. E.W. Kimbark ―Direct Current transmission‖, Vol.1, John Wielly, New York
7. T,J.E Miller, ―Reactive Power Control in Electric Systems‖, John Wiley & Sons.

**BTEEPE604B SMART GRID TECHNOLOGY 03 Credits**

**Unit 1: Introduction to Smart Grid 9 Hours**

Introduction, working definitions of Smart Grid, Need of Smart Grid, Present development & International policies in Smart Grid. Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Vehicle to Grid, Smart Sensors, Home & Building Automation Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage**,**Indian Smart Grid –Key Challenges for Smart Grid. Application and standards, Impacts of Smart Grid on reliability, Impacts of Smart Grid on air pollutant emissions reduction.

**Unit 2: Smart Grid Architecture 6 Hours**

Components and Architecture of Smart Grid Design –Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs –Transmission Automation – Distribution Automation –Renewable Integration Tools and Techniques for Smart Grid: Computational Techniques –Static and Dynamic Optimization Techniques –Computational Intelligence Techniques –Evolutionary Algorithms – Artificial Intelligence techniques

**Unit 3: Distribution Generation Technologies 6 Hours**

Introduction to Renewable Energy Technologies –Micro grids –Electric Vehicles and plug–in hybrids –Environmental impact and Climate Change –Economic Issues

**Unit 4: Communication Technologies and Smart Grid 7 Hours**

Introduction to Communication Technology – Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Synchro Phasor Measurement Units (PMUs) –Wide Area Measurement Systems (WAMS). Two-way Digital Communications Paradigm, Network Architectures, IP- based Systems Power Line Communications.

**Unit 5: Control of Smart Power Grid System 7 Hours**

Load Frequency Control (LFC) in Micro Grid System –Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids. Security and Privacy: Cyber Security Challenges in Smart Grid, Load Altering Attacks, False Data Injection Attacks, Defense Mechanisms, Privacy Challenges.

**Reference Books:**

1. James Momoh, ―Smart Grid Fundamentals of Design and Analysis, Wiley, 2012

2. Keyhani, ―Smart Power Grid Renewable Energy Systems, Wiley 2011
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, ―Smart Grid: Technology and Applications, Wiley 2012.
4. Jean Claude Sabonnadiere, NouredineHadjsaid, ―Smart Grids‖, Wiley ISTE 2012.

**BTEEPE604C MODELING, SIMULATION AND CONTROL OF ELCTRICAL DRIVES**

**3 Credits**

**Unit 1: Introduction** **7 Hours**

Introduction to Electric drives: Advantages of Electrical Drives, Parts of Electrical drive. Choice of Electric drives. Dynamics of Electrical drives: fundamental torque equations, multiquadrant operation Classes of motor duty & criteria for selection of motor.Load equalization, stability of electrical drives, sensors in drive systems.

**Unit 2: DC motor drives:** **6 Hours**

Review of basic characteristics of DC motors, Single phase andThree phase rectifier controlled drives.DC-DC converter drives:Principle of Rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives.

**Unit 3: AC Drives:** **8 Hours**

Speed control of three phase induction motors, Stator voltage control, Rotor voltage control, frequency control, Voltage and frequency control.Principle of Scalar andVector control of Induction motor, Static rotor resistance control method, static slip power recovery control.Direct torque control of Induction motor, direct torque control of PM synchronous motor drives

**Unit 4: Sensor less control of IM drives** **7 Hours**

Sensor less control of PMSM drives, Predictive torque control of induction motor drive, Multiphase machine drives, Fractional-slot concentrated winding machines and drives.

**Unit 5:Machine Modeling** **7 Hours**

DC, induction motor and synchronous machines; simulation of transients; simulation tools: SABER, PSPICE, and MATLAB-SIMULINK; Simulations of converters, inverters and cyclo-converters etc.

**Text/References Books:**

1. Dubey G. K., “Fundamentals of Electrical Drives”, Narosa Publishing house
2. De N. K., Sen P. K., “Electric Drives”, Prentice Hall of India
3. VedamSubramanyam, “Electrical Drives and Control”, TMH Publications
4. Mohammed Fazlur Rahman, ―Modeling, Simulation And Control Of Electrical Drives‖, Institution of Engineering And Technology Publication

**BTEEOE605A E-WASTE MANAGEMENT** **03 Credits**

**Unit 1: Sources** **7 Hours**

Composition and characteristic of hazardous waste, Hazardous Waste (Management and Handling) Rules, 1989 and amendments, Federal Hazardous Waste Regulations under RCRA, Superfund, CERCLA and SARA. Toxicology, public health impact, Protocols, issues and challenges in transportation of hazardous waste.

**Unit 2: E-waste** **7 Hours**

Introduction, toxicity due to hazardous substances in e-waste and their impacts, domestic e-waste disposal, e-waste management, technologies for recovery of resource from electronic waste.

**Unit 3: Guidelines for environmentally sound management of e-waste** **7 Hours**

Occupational perspectives of recycling e-waste in India, Environmental health perspectives of recycling e-waste.

**Unit 4: Hazardous substances waste Electrical and Electronic Equipment** **7 Hours**

Characteristics of pollutants, batteries, electrical and electronic components, plastic and flame retardants, circuit boards, pollutants in waste electrical and electronic equipment.

**Unit 5: E-Waste Recycling** **7 Hours**

Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials.

**Text/References Books:**

1. New Delhi. Johri R., ―E-waste: implications, regulations, and management in India and current global best practices‖, TERI Press, New Delhi.

2. E-Waste Managing the Digital Dump Yard, Edited by Vishakha Munshi, ICFAI University Press

3. E-Waste Managing the Digital Dump Yard, Edited by Vishakha Munshi, ICFAI University Press

4. Tchobanoglous G., Theisen H., Viquel S.A., ―Integrated Solid Waste Management: Engineering, Principles and Management issues‖, Tata McGraw Hill Publishing Company Ltd

**BTEEOE605B POWER PLANT ENGINEERING 3 Credits**

**Unit 1: Power Generation from conventional sources 7 Hours**

Introduction to conventional energy sources, Thermal, hydro, nuclear and gas power plants - their functions and control; types of prime movers, generators and excitation systems;

Alternate sources of power generation - solar, wind, geo-thermal, ocean-thermal, tidal, wave and MHD. Economic considerations in power systems-Load and Energy survey, load duration curve, plant factor and plant economics,

**Unit 2: Thermal and Hydro Power Plants 7 Hours**

Thermal Steam and Hydro Power Plants: Selection of site, elements and operational circuits of the power plant, turbo-alternators, plant layout, steam turbines, controls and auxiliaries.

Hydro-electric Power Plants – selection of site, elements of power plant, classification, water turbines, governor action, hydro-electric generator, plant layout, pumped storage plants.

**Unit 3: Nuclear Power Plants 7 Hours**

selection of site, nuclear reaction – fission process and chain reaction, constituents of power plant and layout, nuclear reactor – working, classification, control, shielding and waste disposal.

Diesel and Gas Power Plants: Advantage and limitations, types of diesel plants, general layout, and applications. Components of gas power plant, gas turbine, fuels, materials, working and applications.

**Unit 4: Renewable power plants 7 Hours**

Solar power generation – Photo-voltaic and solar thermal generation – solar concentrators,

Wind power generation – types of wind mills, wind generators, tidal, biomass, geothermal and magneto hydro dynamic power generation, micro-hydel power plants, fuel cells

**5: Combined operation of power plants 7 Hours**

Plant selection, choice of size and number of generator units, Concept of parallel operation of various generating sources and load sharing, interconnected systems, concept of

Grid, real and reactive power exchange among interconnected systems. Major electrical equipment in power plants, DC systems in power plants, station control - switch yard and control room. Economic considerations – types of costs, tariff and consumers.

**Text/Reference Books:**


1. Wadhwa, C.L.,"Generation Distribution and Utilisation of Electrical Energy", New Age International Publishers, 3rd Edition, 2010.
2. J.B.Gupta, "A Course in Power Systems", S.K.Kataria and Sons, Reprint 2010-2011.
3. M. M. El-Wakil, "Power Plant Technology", Mcgraw Hill, Digitized on Dec 2000
4. B. G. A. Skrotzki& W. A. Vopat, "Power Station Engineering & Economy", McGraw Hill, Digitized on Dec 2007.

5. Chakrabarti A., Soni M.L., Gupta P.V., and Bhatnagar U.S., "A Text Book on Power Systems Engg", DhanpatRai and Sons, New Delhi, 2nd Revised Edition, 2010.
6. Nag P. K., "Power Plant Engineering", Tata McGraw Hill Publications
7. R. K. Rajput, "Power Plant Engineering", Shree Laxmi Publications

## BTEEOE605C SENSOR TECHNOLOGY 03 Credits

**Unit 1: Measurement and Characteristics** **7 Hours**

Elements of a Measurement System; Classification of Instruments; Static Performance Parameters; Loading and Impedance Matching; Errors and Uncertainties in Measurement; Process and Standards of Calibration; Dynamic Characteristics Transfer Function Representation of a Measurement System, Impulse and Step Responses of First and Second Order Systems, Frequency Response of First and Second Order Systems.

**Unit 2: Mechanical Transducers** **7 Hours**

Temperature- Bimetallic Element and Fluid Expansion type Thermometers; Pressure- Manometers and Bourdon Gauges; Force- Balances, Helical Spiral Springs, Load Cells and Elastic Force Devices; Torque- Torsion Bars and Flat Spiral Springs; Liquid Level- Float Systems and Level to Pressure Converters; Flow- Pitot Static Tubes and Turbine type Flow Meters. Hot Wire Anemometer. Proximity Sensors- Reed Sensors, Inductive proximity sensor, capacitive proximity sensor, Optical sensor with through beam, Ultrasonic sensors.

**Unit 3: Electrical Transducers** **7 Hours**

Resistance Thermometers; Interfacing Resistive Transducers to Electronic Circuits; Thermistors-Measurement of Temperature and Thermal Conductivity, Temperature Control; Resistance Strain Gauges- Gauge Factor, Bonded and Unbonded Strain Gauges; Self Generating and Non Self Generating Inductive Transducers; Linear Variable Differential Transformers; Capacitive Transducers – Potentiometric Transducers; Thermoelectric Transducers and Sources of Errors in Thermocouples; Piezoelectric Transducers

**Unit 4: Basic Signal Conditioning Elements** **7 Hours**

Amplifiers- Non Electrical and Electrical types; Op Amps Inverting, Non Inverting, Summing, Differential, and Charge Amplifiers; Differentiating and Integrating Elements; Filters;

Data Transmission Elements- Electrical, Pneumatic, Position and Radio Frequency Transmission types; Compensation Elements for First and Second Order Systems – Basic Indicating, Recording, and Display Elements .

**Unit 5: Feedback in Instruments** **7 Hours**

Principles of Feedback and Advantages & Disadvantages of Feedback; Digital Voltmeters-Ramp and Dual Slope types; Servo type Potentiometric and Magnetic Tape Recorders; Digital Recorders of Memory type; Data Displays-Analog and Digital types.

**Text/References Books:**

1. Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson Education Publications
2. Electronic Instrumentation, H. S. Kalsi-TMH Publications

3. Albert D Helfrick and William D Cooper; Modern Electronic Instrumentation and Measurement Techniques; 2004, PHI
4. BC Nakra, and Chaudhry; Instrumentation, Measurement and Analysis; 2004, Tata McGrawHill.
5. DVS Murthy; Transducers and Instrumentation; 2003, PHI.
6. CS Rangan, GR Sarma, and VSV Mani; Instrumentation Devices and Systems; Tata McGraw-Hill
7. Doeblin and Ernest; Measurement Systems Application and Design; 2004, Tata McGraw-Hill.
8. Tilak Thakur ― Mechatronics ‖ Oxford University Press 2016

**BTEEOE605D Lightning Interaction with Power System 03 Credits**

**Unit 1: Lightning and Climate Change 7 Hours**

Lightning Phenomenon and Parameters for Engineering Applications, Lightning Return stroke models for electromagnetic field calculations, Lightning Interaction with Power Substations, Lightning Interaction with Power Transmission Lines

**Unit 2: Lightning Interaction with Medium 7 Hours**

Voltage Overhead Power Distribution Systems, Flash collection rate, Effects of various parameters on lightning overvoltage, Lightning protection of MV systems, Lightning performance of overhead distribution lines, Lightning Interaction with Low-Voltage Overhead Power Distribution Networks, Typical configurations of LV networks, Lightning surges on LV power systems, Lightning protection of LV networks,

**Unit 3: Lightning Protection of Structures and system inside of buildings 7 Hours**

Lightning currents, Lightning protection of buildings, Volume protected against direct lightning strike, Air-termination and down-conductor system, Earth-termination system, Lightning equipotential bonding, Separation distance, Currents and voltages on lines, Grid-like spatial shield, Smart Grid functions and technologies, Lightning and digital recording technology, Lightning protection of Smart Grid sensors..

**Unit 4: Impact on Renewable Energy Systems 7 Hours**

Wind turbine components and overview of the lightning protection system, Lightning phenomenology and wind turbines, Lightning damage to wind turbines due to direct impacts, Lightning protection of wind turbine components, Overvoltages in wind farms, Solar energy: solar radiation, parameters, hourly and daily parameters, PV systems: off-grid and grid-connected, considerations of the grid connection, Internal and overvoltage lightning protection, External lightning protection

**Unit 5: Measurement of Lightning Currents and Voltages 7 Hours**

Lightning current measurements, Measurement method of lightning voltage, Application of various lightning overvoltage sensors in power systems, Application of the FDTD Method to Lightning Studies, Fundamentals, Representations of lightning source, Applications, Software Tools for the Lightning Performance Assessment, FLASH program, Lightning-induced overvoltages–electromagnetic transients program.

**Text/References Books:**

1. Alexandre Piantini, ―Lightning Interaction with Power Systems- volume 1, Institution of Engineering and Technology

2. Alexandre Piantini, ―Lightning Interaction with Power Systems- volume 2, Institution of Engineering and Technology

3. Vernan Cooray. ” Lightning Protection”.Power and Energy services, IET.

## BTEEL606 SWITCHGEAR AND PROTECTION LAB 01 CREDITS

**Conduct any 8practicals from given list**

1. To verify characteristics of Static Overcurrent Relay.
2. To verify the characteristics Static over Voltage Relay.
3. To verify the characteristics of IDMT Relay.
4. To verify the characteristics of Reverse Power Overcurrent Relay/ Negative Sequence Relay.
5. To demonstrate working of Distance Protection Scheme for long transmission line.
6. To demonstrate working of Differential Protection of Transformer and sketch the schematic diagram for protection scheme.
7. To demonstrate working of Differential Protection of Alternator and sketch the schematic diagram for protection scheme.
8. Identify the components of different types of circuit breakers with their specifications (through visits/ videos/models)
9. To verify the characteristics of MCB, ELCB and HRC fuses.

**BTEEL 607 ELECTRICAL MACHINE DESIGN LAB 01 Credit**

**Conduct any eight practical from given list**

1 Symbols used in Electrical Engineering

2 Design and assembly of Choke with design report.

3 Design and assembly of Starter with design report.

4 Design and layout of simplex lap winding (Detailed Drawing Sheet)

5 Design and layout of wave winding (Detailed Drawing Sheet)

6 Design and layout of ac lap winding (Detailed Drawing Sheet)

7 Design and assembly of transformer with design report. (Detailed Sheet for General Assembly of transformer)

8 Design and assembly of three phase induction Motor with design report.(Detailed Sheet for General Assembly of Induction Motor)

9 Complete any two drawings sheets with the help of Computer Aided Design Software like AUTOCAD)

**BTEEL608 CONTROL SYSTEM ENGINEERING LAB 01 Credit**

Any Eight Experiments from the following list.

1. Write a program to obtain: i) pole, zero and gain values from a given transfer functionii)Transfer function model from pole, zero, gain values.
2. Write a program to determine of step & impulse response for a first order unity feedback system
3. Write a program to generate various standard test signals.
4. Write a program to plot the root locus for a given transfer function of the system using MATLAB.
5. Write a program to plot the Bode Plot for a given system using MATLAB.
6. Write a program to plot the Nyquist Plot for a given system using MATLAB.
7. Write a program to design Proportional, Proportional + Integral, Proportional+ Derivative and P-I-D Controller for second order system.
8. Write a program to determine of step & impulse response for a second order unity feedback system
9. Write a program to determine state space model from transfer function model & vice versa.
10. Write a program to determine state space model from transfer function model & vice versa

**BTEEM609 SEMINAR** **02 credit**

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# Dr. Babasaheb Ambedkar Technological University, Lonere.

**Dr. Babasaheb Ambedkar Technological University**

**(Established as a University of Technology in the State of Maharashtra)**

**(under Maharashtra Act No. XXIX of 2014)**

**P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra**

**Telephone and Fax. : 02140 -275142**

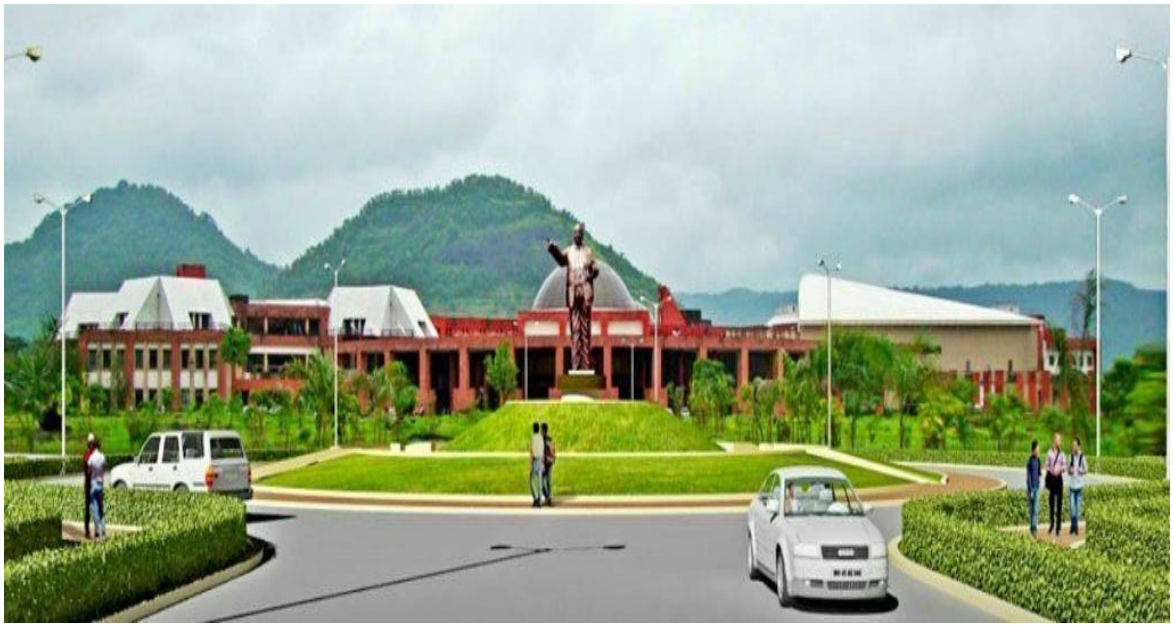
www.dbatu.ac.in

# COURSE STRUCTURE AND SYLLABUS

for

## Second Year B. Tech. Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering

## With effect from the Academic Year 2021-2022



# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

| **Basic Sciences Courses(BSC)** | | |
|---|---|---|
| BTBS101 | Engineering Mathematics - I | (3-1-0)4 |
| BTBS102 | Engineering Physics | (3-1-0)4 |
| BTBS107L | Engineering Physics Lab | (0-0-2)1 |
| BTBS201 | Engineering Mathematics - II | (3-1-0)4 |
| BTBS202 | Engineering Chemistry | (3-1-0)4 |
| BTBS207L | Engineering Chemistry Lab | (0-0-2)1 |
| BTBS301 | Engineering Mathematics-III | (3-1-0)4 |
| BTBS404 | Analog and Digital Electronics | (3-0-0)3 |
| BTBSL409 | Analog and Digital Electronics Lab | (0-0-2)1 |

| **Engineering Sciences Courses(BSC)** | | |
|---|---|---|
| BTES103 | Engineering Graphics | (2-0-0)2 |
| BTES105 | Energy and Environment Engineering | (2-0-0)2 |
| BTES106 | Basic Civil and Mechanical Engineering | (2-0-0) |
| BTES108L | Engineering Graphics Lab | (0-0-4)2 |
| BTES203 | Engineering Mechanics | (2-1-0)3 |
| BTES204 | Computer Programming | (3-0-0)3 |
| BTES205 | Workshop Practice | (0-0-4)2 |
| BTES206 | Basic Electrical and Electronics Engineering | (2-0-0) |
| BTES208L | Engineering Mechanics Lab | (0-0-2)1 |
| BTES305 | Engineering Material Science | (3-0-0) |

| **Humanities and Social Science Including Management Courses(HSSMC)** | | |
|---|---|---|
| BTHM104 | Communication Skills | (2-0-0)2 |
| BTHM109L | Communication Skills Lab | (0-0-2)1 |
| BTHM304 | Basic Human Rights | Audit |
| BTHM506 | Foreign Languages<br>(A) Japanese Language<br>(B) German Language | Audit |
| BTHM706 | Engineering Operations and Project Management | Audit |

| **Professional Core Course (PCC)** | | |
|---|---|---|
| BTEEC302 | Electrical Machines-I | (3-1-0)4 |
| BTEEC303 | Electrical and Electronics Measurement | (3-1-0)4 |
| BTEEL306 | Electrical Machines Lab | (0-0-2)1 |
| BTEEL307 | Electrical and Electronics Measurement Lab | (0-0-2)1 |
| BTEEC401 | Network Theory | (3-1-0)4 |
| BTEEC402 | Power System | (3-1-0)4 |
| BTEEC403 | Electrical Machines-II | (3-1-0)4 |
| BTEEL406 | Network Theory Lab | (0-0-2)1 |
| BTEEL407 | Power System Lab | (0-0-2)1 |
| BTEEL408 | Electrical Machines-II Lab | (0-0-2)1 |
| BTEEC501 | Power System Analysis | (3-1-0)4 |
| BTEEC502 | Microprocessor and Microcontroller | (3-0-0)3 |
| BTEEC503 | Power Electronics | (3-1-0)4 |
| BTEEL507 | Power System Analysis Lab | (0-0-2)1 |
| BTEEL508 | Microprocessor and Microcontroller Lab | (0-0-2)1 |
| BTEEL509 | Power Electronics Lab | (0-0-2)1 |
| BTEEC601 | Switchgear Protection | (3-0-0)3 |
| BTEEC602 | Electrical Machine Design | (3-1-0)4 |
| BTEEC603 | Control System Engineering | (3-1-0)4 |

| | | |
|---|---|---|
| BTEEL606 | Switchgear Protection Lab | (0-0-2)1 |
| BTEEL607 | Electrical Machine Design Lab | (0-0-2)1 |
| BTEEL608 | Control System Engineering Lab | (0-0-2)1 |
| BTEEC701 | High Voltage Engineering | (3-1-0)4 |
| BTEEC702 | Power System Operation and Control | (3-1-0)4 |
| BTEEL707 | High Voltage Engineering Lab | (0-0-2)1 |

| **Professional Elective Course (PEC)** | | |
|---|---|---|
| BTEEPE405 | (A)Electromagnetic Field Theory | (3-0-0)3 |
| | **(B)Signals and System** | |
| | ©Advance Renewable Energy Sources | |
| | (D)Electronic Devices and Circuits | |
| BTEEPE504 | (A)Industrial Automation | (3-0-0)3 |
| | (B)Power Quality Issues | |
| | ©HVDC | |
| BTEEPE604 | **(A)Application of Power Electronics in Power System** | (3-0-0)3 |
| | (B)Smart Grid Technology | |
| | ©Modeling, Simulation and Control of Electric Drives | |
| BTEEPE703 | (A)Energy Audit and Conservation | (3-0-0)3 |
| | (B)Electrical System Design for Building | |
| | ©Flexible AC Transmission System | |
| | (D)Electrical Utilization | |

| **Open Elective Course (OEC)** | | |
|---|---|---|
| BTEEOE505 | (A)Embedded System | (3-0-0)3 |
| | (B)Electrical Safety | |
| | ©Condition Monitoring of Electric Apparatus | |
| BTEEOE605 | **(A)E-waste Management** | (3-0-0)3 |
| | **(B)Power Plant Engineering** | |
| | ©Sensor Technology | |
| | (D)Lightning Interaction with Power System | |
| BTEEOE704 | (A)Process Control Instrumentation | (3-0-0)3 |
| | (B)Biomedical Instrumentation | |
| | ©Mechatronics | |
| BTEEOE705 | (A)Testing, Maintenance and Commissioning of Electrical Equipment | (3-0-0)3 |
| | (B)Electric and Hybrid Electric Vehicles | |
| | ©Internet of Things (IoT) | |

| **Seminar / Mini Project / Internship** | | |
|---|---|---|
| BTES209S | Seminar | (0-0-2)1 |
| BTES211P | (Internship – I) Field Training / Internship/Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in at one time). | 1 |
| BTEEM308 | Miniproject-I | (0-0-4)2 |
| BTEEP410 | (Internship – II) | 1 |
| BTEEM509 | Miniproject-II | (0-0-2)1 |
| BTEES609 | Seminar | (0-0-4)2 |
| BTEEP610 | (Internship – III) | |
| BTEEM708 | In house project-I / Mini project-III | (0-0-4)2 |

| **Project(MP)** | | |
|---|---|---|
| BTEEP802 | In house project-I / Internship & Project in Industry | (0-0-26) 13 |

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

**Plan of Study:**

| No.of Courses | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | I | II | III | IV | V | VI | VII | VIII |
| 2 | BTBS101 | BTBS201 | BTBS301 | BTEEC401 | BTEEC501 | BTEEC601 | BTEEC701 | BTEEPE801 |
| 3 | BTBS102 | BTBS202 | BTEEC302 | BTEEC402 | BTEEC502 | BTEEC602 | BTEEC702 | BTEEP802 |
| 4 | BTES103 | BTES203 | BTEEC303 | BTEEC403 | BTEEC503 | BTEEC603 | BTEEPE703 | |
| 5 | BTHM104 | BTES204 | BTHM304 | BTBS404 | BTEEPLE504 | BTEEPE604 | BTEEOE704 | |
| 6 | BTES105 | BTES205 | BTES305 | BTEEPE405 | BTEEOE505 | BTEEOE605 | BTEEOE705 | |
| 7 | BTES106 | BTES206 | BTEEL306 | BTEEL406 | BTHM506 | BTEEL606 | BTHM706 | |
| 8 | BTBS107L | BTBS207L | BTEEL307 | BTEEL407 | BTEEL507 | BTEEL607 | BTEEL707 | |
| 9 | BTES108L | BTES208L | BTEEP308 | BTEEL408 | BTEEL508 | BTEEM608 | BTEEM708 | |
| 10 | BTHM109L | BTES209S | BTES211P | BTEEL409 | BTEEPE509 | BTEEP609 | BTEEP609 | |
| 11 | | BTES211 | | BTEEP410 | BTEEP409 | | | |

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

## A. Program Educational Objectives (PEOs)

Graduates will able to–

1.To equip graduates with a strong foundation in engineering sciences and Electrical Engineering fundamentals to become effective collaborators, researchers and real-time problem solver with technical competencies.

2.Perceive the limitation and impact of engineering solutions in social, legal, environmental, economical and multidisciplinary contexts.

3.Excel in Industry/technical profession, higher studies, and entrepreneurship exhibiting global competitiveness.

## B. Program Outcomes (POs)

Engineering Graduate will be able to –

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

# Dr. Babasaheb Ambedkar Technological University, Lonere.

## B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

## Curriculum of Second Year

### Semester III

| Course Category | Course Code | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | Total | |
| BSC | BTBS301 | Engineering Mathematics-III | 3 | 1 | - | 20 | 20 | 60 | 100 | **4** |
| PCC1 | BTEEC302 | **Electrical Machines-I** | 3 | 1 | - | 20 | 20 | 60 | 100 | **4** |
| PCC2 | BTEEC303 | Electrical and Electronics Measurement | 3 | 1 | - | 20 | 20 | 60 | 100 | **4** |
| HSSMC | BTHM304 | Basic Human Rights | 2 | - | - | | | | | **Audit** |
| ESC | BTES305 | **Engineering Material Science** | 3 | - | - | 20 | 20 | 60 | 100 | **3** |
| LC | BTEEL306 | Electrical Machines-I Lab | | | 2 | 60 | | 40 | 100 | **1** |
| LC | BTEEL307 | Electrical and Electronics Measurement Lab | | | 2 | 60 | | 40 | 100 | **1** |
| Project | BTEEP308 | Mini Project-I | | | 4 | 60 | | 40 | 100 | **2** |
| Internship | BTES211P | Internship-I Evaluation | | | | | | 50 | 50 | **1** |
| | | | 14 | 3 | 8 | 260 | 80 | 410 | 750 | **20** |

### Semester IV

| Course Category | Course Code | Course Title | Teaching Scheme | | | Evaluation Scheme | | | | Credit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CA | MSE | ESE | Total | |
| PCC3 | BTEEC401 | **Network Theory** | 3 | 1 | - | 20 | 20 | 60 | 100 | **4** |
| PCC4 | BTEEC402 | **Power System** | 3 | 1 | - | 20 | 20 | 60 | 100 | **4** |
| PCC5 | BTEEC403 | Electrical Machine-II | 3 | 1 | - | 20 | 20 | 60 | 100 | **4** |
| BSC | BTBS404 | Analog and Digital Electronics | 3 | - | - | 20 | 20 | 60 | 100 | **3** |
| PEC1 | BTEEPE405 | Group A | 3 | - | -- | 20 | 20 | 60 | 100 | **3** |
| LC | BTEEL406 | Network Theory Lab | - | - | 2 | 30 | | 20 | 50 | **1** |
| LC | BTEEL407 | Power System Lab | - | - | 2 | 30 | | 20 | 50 | **1** |
| LC | BTEEL408 | Electrical Machine-II Lab | - | - | 2 | 30 | | 20 | 50 | **1** |
| LC | BTEEL409 | Analog and Digital Electronics lab | - | - | 2 | 30 | | 20 | 50 | **1** |
| Internship | BTEEP410 | Internship-II (minimum of 4 weeks which can be completed partially in third or fourth semester or in at one time) | - | - | - | - | - | - | - | - |
| | | | | | | 220 | 100 | 380 | 700 | **22** |

**Group-A**

(A)Electromagnetic Field Theory

(B) **Signals and System**

(C) Advance Renewable Energy Sources

(D) **Electronic Devices and Circuits**

## Semester III

**(BTBS301) ENGINEERING MATHEMATICS 04 Credits**

**Unit 1: Vector Calculus 9 Hours**

Vector Algebra, Cartesian, Cylindrical and Spherical Co-ordinate System. Transformation of Variables from Cartesian to Cylindrical and Spherical Coordinate System and Vice-Versa Coulomb‘s Law, Electric Field Intensity, Field of _N‘ Point Charges, Field of Line and Sheet of Charge, Electric Flux Density, Gauss‘s Law and Its Applications, Divergence and Divergence Theorem

**Unit 2: Complex Numbers 9 Hours**

Complex Numbers, geometric representation, powers and roots of complex numbers, Functions of a complex variable, Analytic functions, Cauchy-Riemann equations; elementary functions, Conformal mapping (for linear transformation); Contours and contour integration, Cauchy‘s theorem, Cauchy integral formula; Power Series and properties

**Unit 3: Fourier Series 9 Hours**

Introduction, Dirichlet Conditions, Fourier Series and its Coefficients for a given range, Even, odd functions and Fourier Series, Half-range Series, problems, Parseval Identity, Complex form of Fourier Series.

**Unit 4: Differential Eqns., First Order ODE, 9 Hours**

Differential Eqns., First Order ODE, y‘=f(x,y)- geometrical interpretation of solution, Eqns. reducible to separable form, Exact Eqns., integrating factor, Linear Eqns., Orthogonal trajectories,

**Unit 5: Bessel functions 9 Hours**

Fourier Method for IBV problem for wave and heat equation, rectangular region, Fourier method for Laplace equation in 3 dimensions, Numerical Methods for Laplace and Poisson‘s equation. Biot-Savart, Amperes Circuital Laws and their Applications, Curl, Stoke‘s Theorem, Magnetic Flux Density, Scalar and Vector Magnetic Potential, Maxwell‘s Equations in Steady Electric and Magnetic Fields 30 ,FOURIER TRANSFORMS: Fourier Integral representation, Fourier integrals, Fourier transforms, Sine, Cosine transforms, inverse transforms, Illustrations, Properties, Parseval Identity, evaluation of certain real integrals.

**Text Books :**

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
3. A Course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
4. A Text Book of Applied Mathematics (Vol I & II) by P. N. Wartikar and J. N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.
5. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.

**Reference Books :**

1. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.
2. A Text Book of Engineering Mathematics by Peter O‘ Neil, Thomson Asia Pte Ltd., Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.

**(BTEEC302)ELECTRICAL MACHINE-I** **04 Credits**

**Unit 1: Single Phase Transformer** **7 Hours**

Transformer construction, Ideal and practical transformer, exact and approximate equivalent circuits, no load and on load operation, phasor diagrams, power and energy efficiency, voltage regulation, parallel operation, effect of load on power factor, Per Unit system, excitation phenomenon in transformers, switching transients, Auto transformers, Variable frequency transformer, voltage and current transformers, welding transformers, Pulse transformer and applications

**Unit 2: Three Phase Transformers** **8 Hours**

Constructional features of three phase transformers, Cooling methodology, Standard and special transformer connections, Phase conversion, Parallel operation of three phase transformers, three winding transformers and its equivalent circuit, On load tap changing of transformers, Modern trends in transformers, Type and routine tests, Standards.

**Unit 3: Electromechanical Energy Conversion Principles** **6 Hours**

Energy in a magnetic systems, field energy and mechanical force, energy in singly and multiply excited magnetic systems, determination of magnetic force and torque from energy and coenergy, Forces and torques in magnetic field systems, dynamic equations of electromechanical systems and analytical techniques.

**Unit 4: DC Generators** **9 Hours**

Construction of armature and field systems, Working, types, emf equation, Armature windings, Characteristics and applications, Building of emf, Armature reaction - Demagnetizing and Cross magnetizing mmfs and their estimation; Remedies to overcome the armature reaction; Commutation process, Causes of bad commutation and remedies: Construction of armature and field systems, Working, types, emf equation, Armature windings, Characteristics and applications, Building of emf, Armature reaction - Demagnetizing and Cross magnetizing mmfs and their estimation; Remedies to overcome the armature reaction; Commutation process, Causes of bad commutation and remedies,

**Unit 5: D.C. Motors** **9 Hours**

Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency, Condition for Maximum Efficiency, Braking of DC Motors, Effect of saturation and armature reaction on losses; Applications, Permanent Magnet DC Motors, Type and Routine test

**Unit 6: Special Machines** **6 Hours**

Constructional details of reluctance machine, variable-reluctance machines, basic VRM analysis, practical VRM analysis, stepper motors and their analysis, Brushless DC motors.

**Text Books :**


1. J. B. Gupta," Theory and Performance of Electrical Machines," S. K. Kataria& Sons, New Delhi
2. P. S .Bimbra," Electrical Machinery", Khanna Publishers
3. B. L. Theraja, A. K. Theraja," A text book of Electrical Technology," S. Chand Publishers
4. Asfaq Hussein," Electric Machines," Danpat Rai Publisher

**Reference Books :**


1. Bhattacharya S. K, “Electrical Machines”,(Tata McGraw Hill Publications)
2. Kothari Nagrath, “Electrical Machines”, (Tata McGraw Hill Publications)
3. M. N. Bandopadhyay, “Electrical Machines”, (Tata McGraw Hill Publications)
4. Fitzaralda, “Electrical Machines”, (Tata McGraw Hill Publications)

**BTEEC303 ELECTRICAL & ELECTRONICS MEASUREMENT 04 Credits**

**Unit 1: Philosophy of Measurement 4 Hours**

Introduction to Measurement, Methods of Measurements, Measurement System, Instruments, Classification of Instruments, Characteristics of Instruments & Measurement System, Errors in Measurement, Types of Errors, Calibration, Standards and their classifications.

**Unit 2: Analog Measurement of Electrical Quantities 8 Hours**

Classification of Analog Instruments, Principle of Operation, Operating Torques, Different types of Damping and Control Systems, Types of Instrument: PMMC, Extension of Range of PMMC Instruments, Moving Iron, Electro-dynamometer, Hot wire, Thermocouple, Induction, Electrostatic, Rectifier.

Power Measurement: Power measurement in AC and DC circuits, Power and Power Factor, Electrodynamometer-type Wattmeter, Induction-type Wattmeter, Power measurement in Poly-phase systems, Power measurement in Three-Phase systems, Reactive Power measurements, Power measurement with Instrument Transformers - Potentiometer and Current Transformer.

Measurement of Energy: Induction-type Energy Meter, Errors in Induction-type Energy Meters and their compensation, Testing of Energy Meters.

**Unit 3: A.C. and D.C. Bridges 8 Hours**

Measurement Resistance: Wheatstone Bridge, Kelvin Bridge Method, Kelvin Double Bridge Method, Ammeter-Voltmeter Method, Direct deflection method**,** Loss of charge method**,** Megohm Bridge**,** Megger.

Measurement of Inductance and Capacitance: Maxwell Bridge, Hays Bridge, Anderson Bridge, De-Sauty Bridge, Schering Bridge, Wien Bridge.

Localisation of Cable Faults: Murray Loop Test, Varley Loop Test.

Magnetic Measurements: Ballistic Galvanometer, Flux Meter, Maxwell's Bridge Method, AC Potentiometer Method.

**Unit 4: Digital Measurement of Electrical Quantities 7 Hours**

Concept of Digital Measurement, Block diagram of Digital Instrumentation System, Digital versus Analog Instrument, Digital Voltmeter, Types of Digital Voltmeter, Digital Multi-meter Digital Counter, Digital Frequency Meter, **Power Analyzer &** Harmonic Analyzer, Spectrum & Wave analyzer, Oscilloscopes, Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscopes (DSO), Signal Generator, Q-Meter.

**Unit 5: Transducers 8 Hours**

**Definition,** Classification & selection of transducers, **Characteristics, Transducers for measurement of Displacement (RVDT & LVDT), Speed, Angular Rotation, Altitude, Force, Torque, Humidity and Moisture, Pressure, Strain and Temperature (Thermocouple and RTD method), Position, Hall Effect transducer and applications. Instrumentation amplifiers,** Signal Conditioning, **Data Transmission and Telemetry,** Data Acquisition Systems.

**Displays and Recorders: Different types of Display – Different types of Recorder:** Graphic Recorder, Strip Chart Recorder, G**alvanometric and** Potentiometer type R**ecorders,** X-Y Recorder, Circular Chart Recorder, Magnetic Tape Recorder, D**igital Recorders,** Printer and Plotter **(Block Diagram, theory and applications only)**

**Reference Books/ Text Books:**


1. E.W. Golding & F.C. Widdis, "Electrical Measurement &Measuring Instrument", A.H. Wheeler & Co. India.
2. A.K. Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai & Sons.
3. Forest K. Harries, "Electrical Measurement", Willey Eastern Pvt. Ltd. India.
4. M.B. Stout, "Basic Electrical Measurement" Prentice hall of India.
5. W.D. Cooper, "Electronic Instrument & Measurement Technique", Prentice Hall International.
6. J.B. Gupta, "Electrical Measurements and Measuring Instruments", S.K. Kataria & Sons.
7. Prithwiraj Purkait, Budhaditya Biswas , Santanu Das and Chiranjib Koley, "Electrical and Electronics Measurements and Instrumentation", McGraw Hill.

**BTHM304 BASIC HUMAN RIGHTS** **Audit Course**

**Unit 1: The Basic Concepts** **6Hrs**

Individual, Group, Civil Society, State, Equality, Justice, Human Values: - Humanity, Virtues, Compassion.

**Unit 2: Human Rights and Human Duties:** **6 Hrs**

Origin, Civil and Political Rights, Contribution of American Bill of Rights, French Revolution, Declaration of Independence, Rights of Citizen, Rights of working and Exploited people, Fundamental Rights and Economic program, India's Charter of freedom

**Unit 3: Society, Religion, Culture, and their Inter-Relationship** **6 Hrs**

Impact of Social Structure on Human behaviour, Roll of Socialization in Human Values, Science and Technology, Modernization, Globalization, and Dehumanization.

**Unit 4: Social Structure and Social Problems** **6 Hrs**

Social and Communal Conflicts and Social Harmony, Rural Poverty, Unemployment, Bonded Labour, Migrant workers and Human Rights Violations, Human Rights of mentally and physically challenged.

**Unit 5: State, Individual Liberty, Freedom and Democracy** **6 Hrs**

The changing of state with special reference to developing countries, Concept of development under development and Social action, need for Collective action in developing societies and methods of Social action, NGOs and Human Rights in India: - Land, Water, Forest issues.

**Unit 6: Human Rights in Indian Constitution and Law** **6 Hrs**

The constitution of India:

(i) Preamble

(ii) Fundamental Rights

(iii) Directive principles of state policy

(iv) Fundamental Duties

(v) Some other provisions

Universal declaration of Human Rights and Provisions of India, Constitution and Law, National Human Rights Commission and State Human Rights Commission

**Reference Books:**

1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd.), 2005.

2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India.

**(BTES 305) ENGINEERING MATERIAL SCIENCE 04 Credits**

**Unit: 1 Electrical Conducting Materials 7 Hours**

Introduction,Crsytal structure, atomic bonding,Electronic and Ionic Conduction , Conductivity in Metals , Ohm‘s Law , Relaxation Time , Collision Time , Mean Free Path of an Electron , Electron Scattering , Resistivity of Metals , Effect of Temperature and Impurity on Conductivity , Joule‘s Law , High Conductivity And Resistivity Materials , Superconductivity and Applications Conducting materials: quantum free electron theory- Fermi-Dirac distribution - Materials for electric resistances.

**Unit 2: Dielectric Materials 7 Hours**

Crystalline structure-perfection/imperfection, Dielectric as Electric Field Medium, Dielectric constant and polarizability, types of polarization,leakage currents, dielectric loss, dielectric strength,breakdown voltage,temperature and frequency dependences of Dielectric parameter, internal fields in solids, Clausius-Mosotti equation, ferroelectric, pyroelectric and piezoelectric materials, applications of dielectric materials

**Unit 3: Semiconductor Materials 7 Hours**

Semiconductors: Mechanism of conduction in semiconductors. Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI). Properties of Semiconductors: Electron-hole concentration, Fermi level, Generation and recombination, carrier life-time, diffusion length. Scattering and mobility of carriers. Einstein relation.LASER Plain carbon steels and their applications. Alloy steels: High speed steels, stainless steels,HSLA; Non Ferrous alloys: Al alloys, Cu alloys, applications of these alloys

**Unit 4: Magnetic Materials 7 Hours**

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. factors effecting permeability and hysteresis, Ferromagnetic materials, properties of ferromagnetic materials in static fields,curie point, anti-ferromagnetic materials, piezoelectric materials ,pyro electric materials Magnetic Properties of Materials: Atomic Interpretation of Diamagnetic, Paramagnetic, Anti-Ferromagnetic and Ferromagnetic Materials. Ferromagnetic Domain, Magnetic Materials for Ferromagnetic Tape And Memory Devices, Magnetic materials: magnetic materials used in electrical machines instruments.

**Unit 5: Special Purpose Materials 05 Hours**

Refractory Materials, Structural Material‘s, Radioactive Materials, Galvanization and Impregnation of materials, Non Destructive Testing: Ultrasonic Radiography, X-ray diffraction- Bragg‘s law.

**Text Books:**

1. Material Science and Engineering – V. Raghavan

**Reference Books**

1. Electrical Engineering Materials – A.J. Dekker
2. Science of Engineering Materials and Carbon Nanotubes - C.M. Srivastava and C. Srinivasan
3. Solid State Physics – A.J. Dekker.

**(BTEEL306)ELECTRICAL MACHINE-I LABORATORY 01 Credits**

**Perform Any eight experiment from given list as a part of practical submission**

**List of Experiments**

1. To perform the polarity test on single phase transformer
2. To perform the transformation ratio test on single phase transformer
3. To perform the following three phase transformer connections:
   1) Star-star 2) Star-Delta
   3) Delta – Delta 4) Delta –Star
   5)Open Delta 6) Scott Connection
4. To perform the direct loading test on three phase transformer to calculate efficiency and regulation
5. To perform the indirect loading test on three phase transformer to calculate efficiency
6. To perform the parallel operation of two single phase transformers.
7. To study D. C. Machine
8. To draw the speed characteristics of DC shunt motor by- (1) Armature Control method (2) Field Control method
9. To perform the load test on DC Shunt motor.
10. To study the load characteristics of DC generator
    I) Cumulative compound generator.
    II) Differential compound Generator
11. To study the magnetization ,internal and External characteristics of a D. C. generator
12. To Study Starters for DC Shunt Motor.

## BTEEL307 ELECTRICAL & ELECTRONICS MEASUREMENTS LABORATORY 1 Credit

**List of Experiments:** (Perform minimum 8-10 experiments from following list)

1) Measurement of Low resistance by Kelvin Double bridge.
2) Measurement of High resistance and Insulation resistance using Megger.
3) Measurement of Inductance by Maxwell bridge, Hays bridge, Anderson bridge.
4) Measurement of Capacitance by De Sauty bridge, Schering bridge.
5) Measurement of Earth resistance using Earth Tester.
6) Study the extension of Voltmeter, Ammeter and Wattmeter.
7) Measurement of three phase power by Two Wattmeter and One Wattmeter method.
8) Study of types of instrument: PMMC, Moving Iron, Electro-dynamometer, Hot wire, Thermocouple, Induction, Electrostatic, Rectifier.
9) Study of Energy Meter.
10) Study of Instrument T/F and its types.
11) Characterize the temperature sensor (RTD):
    a) Static Characteristics of RTD: Study the change in resistance of RTD probe depending on the process temperature.
    b) Dynamic characteristics: Study the dynamic response of RTD probe
12) Characterize the Thermocouple:
    a) Static Characteristics of Thermocouple: Study the change in EMF of a thermocouple in response to the process temperature.
    b) Dynamic characteristics of Thermocouple: Study the dynamic response of Thermocouple.
13) Characterize of LVDT: To find the effect of various parameters like change in supply voltage, change in supply frequency on output of given LVDT
14) Characterize the strain gauge sensor:
    a) Study of Strain Gauge: To study the working principle of strain gauge.
    b) Study of effect of change in position of weight applied on Strain Gauge performance.
    c) Study of effect of change in temperature on the performance of Strain Gauge.
15) Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
16) Study of storage oscilloscope and determination of transient response of RLC circuit.

**BTEEP308 Miniproject-I** **2 Credits**

**Guidelines:**

| Stages | Work to be carried | Time |
|---|---|---|
| **I** | • Selection of a mini viable project idea (Hardware or Software Based) on recent trends in Electrical Engineering. | **4 hours** |
| **II** | • Study various resources and components in electrical engineering projects<br>• Application of those components in Selected Project | **6 hours** |
| **III** | • Study of Circuit Diagram<br>• Study datasheet of basic circuit components of a project<br>• Study various software in building of project like SCILAB, MATLAB or other circuit Simulator | **6 hours** |
| **IV** | • Designing of PCB for selected Project once tested on breadboard | **4 hours** |
| **V** | • Verification of the results obtained of the working model or the simulation results.<br>• Compare with desired results and take corrective action | **4 hours** |
| **VI** | • Completion of project by developing the Project Report and submitting the report to the concerned to receive the final credits. | **6 hours** |

## Semester IV

**BTEEC401 NETWORK THEORY** **04 Credits**

**Unit 1:Active & Passive Circuit Element** **7 Hours**

Independent & dependent voltage & current sources, R, L, C, self and mutual inductance circuit parameters, Their mathematical models, Voltage- current- power relations, Independent voltage and current sources, dependent sources, Source transformation, star-delta conversion. Classification of element: Lumped and distributed, Linear and non-linear, Unilateral and Bilateral, Time invariant and variant.

**Unit 2: Network theorems** **12Hours**

Kirchhoff‘s laws (KCL and KVL), Mesh analysis, nodal analysis, Solution of D.C. resistive network, writing loop equations, Node equations directly in matrices form, super node and super mesh analysis, Superposition theorem, Thevenin’s theorem, Norton‘s theorem, Reciprocity theorem, Maximum power transfer theorem, Substitution theorem, Millman‘s Theorem, Tellegen's theorem for D.C and A.C. circuits.

**Graph Theory:** Network topology, graph, Tree, Branches, Chords, incidence, cut set and tie set matrix using network topology, Concept of duality & dual networks.

**Unit 3: Transient Response Analysis in circuit** **7 Hours**

Initial and final condition of circuit, procedure for evaluating initial conditions, solution of first and Second order differential equations of series & parallel R-L, R-C, R-L-C circuits, Time constant, General & particular solutions, Particular integral & complimentary functions, Numerical

**Unit 4: Application of Laplace’s Transform** **7 Hours**

Standard test input signal- Unit step, Impulse & ramp functions and their Laplace transform, Solution of differential equation using Laplace transform, solve of R-L, R-C, R-L-C circuits using Laplace transform, Transient and steady state response of RL and RC circuit to various functions using Laplace transform.

**Two port network:** Terminals& terminal pairs, Driving points & transfer admittance, Transfer functions, Concept of poles & zeroes, Two port networks, Z, Y & the transmission parameters relationship between parameter sets.

**Unit 5: Sinusoidal Steady State A. C. Circuit** **7 Hours**

R-L-C series circuits, Series resonance Variation of Z with frequency, maximum value of VC & VL, Magnification, Bandwidth, Q factor. Parallel Resonance: Resonance frequency for tank circuit frequency, Locus diagram of series R-L, R-C with variable R & X.

**Filter:** Introduction classification, Low pass, High pass, Band pass & band reject filter, active & passive filters. Application of Fourier series, Expansion for periodic & non-sinusoidal waveforms.

**Text/Reference Books:**


1. N Balabanian and T.A. Bickart, “Linear Network Theory: Analysis, Properties, Design andSynthesis”, Matrix Publishers, Inc. 1981.
2. L.O. Chua, C.A. Desoer, E.S. Kuh, “Linear and Nonlinear Circuits”, McGraw – HillInternational Edition 1987.

3. Van Valkenburg, “Network Analysis”, Third Edition, 2009, Prentice Hall of India.
4. Sudhakar, A.Shyammohan, “Circuits and Network”, Third Edition, 2006, Tata McGrawHill
5. D. Roy Choudhury, “Networks and systems”.New Age International Publishers
6. Kelkar and Pandit, “Linear Network Theory”, Pratibha Publication.
7. Mahmood Nahvi, Joseph AEdminister, “Schaum's Outline of Electric Circuits”, 6th edition,Tata McGraw-Hill.

## (BTEEC402) POWER SYSTEM 04 Credits

### Unit 1: Electrical Power Generation 9 Hours

Evolution of Power Systems, Typical Layout of an Electrical Power System–Introduction to different sources of energy. Construction and working of thermal power plants, Hydro power station, Nuclear Power Plant with neat block diagram of main parts. Descriptive treatment of alternator exciter & excitation systems, major electrical equipments in generating stations.

### Unit 2: Electrical Design of Overhead Transmission Lines 9 Hours

Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, concept of GMD and GMR, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance. skin effect, proximity effect, Ferranti Effect.

**Corona:** Introduction, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona.

### Unit 3: Mechanical Design of Transmission Lines 8 Hours

Types of conductors, Choice of conductor materials, Stranded copper & ACSR conductor, Insulation consideration, Different types of insulator, supports, distribution of voltage across the insulator string, String efficiency, Effect of wind & ice coating on transmission line, sag due to equal & unequal supports, with their derivation, Numericals.

### Unit 4: Performance of Transmission Lines 8 Hours

Classification of overhead transmission lines, important terms, performance of single phase short transmission lines, three phase short transmission lines, effect of load power factor on regulation and efficiency, different types of medium transmission line, Analysis of long transmission lines, generalized constant of transmission line, determination of generalized constant of transmission lines, percentage regulation, Transmission efficiency, numerical based on above.

### Unit 5: AC & DC Distribution 8 Hours

Classification of Distribution system, Requirement of distribution system, design consideration in distribution system. AC Distribution: Calculations, method of Solving AC Distribution problem, three phase unbalanced load, four wire unbalanced star connected load, ground detector, DC Distribution: types, DC distribution calculation, three wire DC system.

**Text/References :**

REFERENCES:

1. V.K Mehta & Rohit Mehta. “ Principles of Power System” S Chand Publications
2. Gupta B. R. ” Power Plant Engineering”.(Eurasia publications)
3. Nag P. K. “ Power Plant Engineering”,(Tata McGraw Hill Publications)
4. Kothari Nagrath, “Electric Power System”, (Tata McGraw Hill Publications)
5. Wadhva S. L.,“Electric Power System”,(Tata McGraw Hill Publications)
6. Stevension W. B., “Power System”, (English Language Book Society publications)

**(BTEEC403)ELECTRICAL MACHINE-II 04 Credits**

**Unit 1: Basic Concepts in A.C. Machines 5 Hours**

Classification of A.C. Machines, principle of operation and constructional features of synchronous and induction machines, rotating mmf waves in A.C. Machines

**Unit 2: Constructional Armature windings 5 Hours**

Introduction, ac machine windings, winding factors, the emf equation, harmonics in generated emf, causes of harmonics and their suppressions

**Unit 3: Synchronous Machines 9 Hours**

Synchronous Machines : Construction, types, armature reaction, circuit model of synchronous machine, determination of synchronous reactance, phasor diagram, power angle characteristics, parallel operation of synchronous generators, synchronizing to infinite bus bars, two axis theory, synchronous motor operation, characteristic curves, synchronous condenser, dynamics.

**Unit 4: Three phase Induction (Asynchronous) Motor 9 Hours**

Types of induction motor, flux and mmf waves, development of circuit model, power across air gap, torque and power output, oc and sc tests, circle diagram, starting methods, cogging and crawling, speed control, deep bar/ double cage rotor, induction generator, induction machine dynamics, high efficiency induction motors

**Unit 5: Fractional Kilowatt Motors 6 Hours**

Introduction, single phase induction motors, double revolving field theory, circuit model of single phase induction motor, determination of circuit parameters

**Unit 6: Special Machines 6 Hours**

Single phase synchronous motors, permanent magnet ac motors, ac servomotors, linear induction motor

**Text Books :**


1. J. B. Gupta," Theory and Performance of Electrical Machines," S. K. Kataria& Sons, New Delhi
2. P. S .Bimbra," Electrical Machinery", Khanna Publishers
3. B. L. Theraja, A. K. Theraja," A text book of Electrical Technology," S. Chand Publishers
4. Asfaq Hussein," Electric Machines," Danpat Rai Publisher


**Reference Books :**


1. 1.Say M. G., "Design & performance of A.C. Machines", (Book Publications,3rd edition)
2. 2..Bhimra P. S., "Electric Machines", (South Ex Publications, New Delhi)
3. D. P. Kothari, I. J. Nagrath,"Electric Machines ", Tata McGraw Hill Publication, Fourth edition, reprint 2012.
4. A. F. Puchstein, T.C. Lloyd, A.G. Conrad, "Alternating current machines", John Wiley and Sons, New York 1954.
5. 5.A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans ,"Electric Machinery ", Tata McGraw Hill Publication, sixth edition 2002 4. Fitzaralda, "Electrical Machines", (Tata McGraw Hill Publications))

**BTBS404 ANALOG AND DIGITAL ELECTRONICS 04 Hours**

**Unit 1: Transistor as an Amplifier 5 Hours**

Load line, Small signal low frequency analysis of single stage amplifier in different configuration, High frequency equivalent circuit of transistor (hybrid pi), Cascade amplifier, High input resistance circuits- C coupled amplifier Frequency response, Definition of 3 dB bandwidth, Effect of cascading on gain & BW, Classification of amplifiers

**Unit 2: operational amplifier 6 Hours**

Block diagram of operational amplifier, Properties of ideal operational amplifier, Explanation of different terms appearing in OP-Amp application (offset, bias, quantities, PSRR, CMRR, Ad, AC, Slew rate etc.), Operation of circuit diagram of OP-Amp using discrete components & I.C. diagram, Different types of current of current sources in I.C. technology, frequency response of OP-Amp, OP-Amp parameters & minimization technique of temperature effect, Inverting & Non-inverting operation of Op-Amp & analysis for AG, RI, RO, Linear & non-linear circuit application of OP-Amp

**Unit 3: Number Systems 6 Hours**

Basic Logic Gates & Boolean Algebra: Binary Arithmetic & Radix representation of different numbers. Sign & magnitude representation, fixed point representation, complement notation, various codes & arithmetic in different codes & their inter conversion. Features of logic algebra, postulates of Boolean algebra. Theorems of Boolean algebra. Boolean function. Derived logic gates: Exclusive-OR, NAND, NOR gates, their block diagrams and truth tables. Logic diagrams from Boolean expressions and Vica-versa. Converting logic diagrams to universal logic. Positive, negative and mixed logic. Logic gate conversion.

**Unit 4: Digital Logic Gate Characteristics 6 Hours**

TTL logic gate characteristics: Theory & operation of TTL NAND gate circuitry. Open collector TTL. Three state output logic. TTL subfamilies. MOS & CMOS logic families. Realization of logic gates in RTL, DTL, ECL, and C-MOS & MOSFET. Interfacing logic families to one another. Sequential Systems: Latches, flip-flops, R-S, D, J-K, Master Slave flip flops. Conversions of flip-flops Counters: Synchronous & asynchronous ripple and decade counters, Modulus counter, skipping state counter, counter design, state diagrams and state reduction techniques. Ring counter. Counter applications. Registers: buffer register, shift register

**Unit 5: Minimization Techniques 7 Hours**

Minterm, Maxterm, Karnaugh Map, K map upto 4 variables. Simplification of logic Conversion of truth tables in POS and SOP form Incomplete specified functions. Variable mapping Quinn-McKlusky minimization techniques c functions with K-map

**Unit 6: Combinational Systems 6Hours**

Combinational logic circuit design, half and full adder, subtractor. Binary serial and parallel adders BCD adder Binary multiplier Decoder: Binary to Gray decoder, BCD to decimal, BCD to 7- segment decoder‘ Multiplexer, DE multiplexer, encoder. Octal to binary, BCD to excess-3 encoder. Diode Switching matrix. Design of logic circuits by multiplexers, encoders, decoders and DE multiplexers.

**Text/Reference Books:**

1. Mandal, Digital Electronics: Principles and Applications, TMH 2009

2. Leach, Digital Principles and Applications, ed. 7, TMH 2008

3. M. Morris Mano, Digital Logic and Computer Design, Pearson Edu. 2014

**(BTEEPE405A)ELECTROMAGNETIC FIELD THEORY 03credits Credits**

**Unit 1: vector calculus 7 Hours**

Scalars and vectors, Vector algebra, Vector components and unit vectors, Vector field Vector field Dot, cross products circular, cylindrical and spherical coordinate systems Coulomb's Law and electric field intensity Electric field due to a continuous Volume Charge Distribution field of a line charge field of a Sheet of a charge streamlines and sketches of fields

**Unit 2: Electromagnetic field 1 8 Hours**

Constructional Gauss's Law and its Applications: to some symmetrical charge distribution and differential volume element divergence Maxwell's first equation (electrostatics), the vector operator and the Divergence theorem Energy and Potential Energy expended in moving a point charge in an electric field line integral, potential difference potential, potential gradient, potential field of a point charge and system of charges dipole, energy density in electrostatic field

**Unit 3: Electromagnetic field 2 6 Hours**

Current and current density, continuity of current, metallic conductors conductor properties and boundary conditions method of images, semiconductors, nature of dielectric, boundary conditions for perfect dielectric capacitance, and capacitance of two-wire line. Poisson's and Laplace Equations Uniqueness theorem examples in rectangular, spherical and cylindrical coordinates, product solutions of Laplace equations, and solutions of Poisson's equations

**Unit 4: Magneto statics 1 8 Hours**

Biot-Savart's law Amperes circuital law curls strokes theorem magnetic flux and magnetic flux density scalar and vector magnetic potentials

**Unit 5: Magneto statics 2 7 Hours**

Force on moving charge, differential current element force between differential current element and torque on a closed circuit nature of magnetic materials, magnetization permeability, magnetic boundary conditions, magnetic circuit, potential energy and forces on magnetic materials, self and mutual inductance

**Unit 6: Maxwell's equations 4 Hours**

Faradays law, Maxwell's equations in point form, Maxwell's equations in integral form, Retarded potentials.

**Text Books :**


1) "William H. Hayt & John. A. Buck, "Engineering Electromagnetics" Mc. Graw-Hill Companies, 7th Editon.2006.
2) "Sadiku- "Electromagnetic Fields" , Oxford Publications**.**


**Reference:**


3) D. J. Griffiths, _Introduction to Electrodynamics', Addison Wesley, 1999.
4) D. K. Cheng, _Field and Wave Electromagnetics', Addison Wesley, 1999.
5) N. N. Rao, _Elements of Engineering Electromagnetics', Pearson Education, Inc, 2004.
6) Mathew N.O. Sadiku,Elements of Electromagnetics,Oxford Univ Press
7) N.N. Rao, Basic electromagnetic and applications, McGraw Hill

**BTEEPE405BSignals and System** **03 Credits**

**Unit 1: Elements of Signal Space Theory** **7 Hours**

Objective and overview, signal and system types and classifications, Different types of signals; Linearity, time invariance and causality; Impulse sequence, impulse functions and other singularity functions

**Unit 2: Classification of System** **9 Hours**

CT and DT system, basic properties of system – linear time invariant system and properties, LTI system: Causality, stability, step response, impulse response.

**Unit 3: Convolution** **7 Hours**

Convolution sum, convolution integral and their evaluation; Time-domain representation and analysis of LTI systems based on convolution and differential equations. Convolution for CT & DT signals and systems; Necessity of representations of Signals & Systems in Time- and Transformed-domains

**Unit 4: Transform domain considerations** **7 Hours**

Laplace transforms, inverse Laplace transforms and Z-transforms; Applications of transforms to discrete and continuous systems-analysis; Transfer function, block diagram representation.

**Unit 5: Fourier series and Fourier Transform** **7 Hours**

Sampling theorem, Discrete Fourier transform (DFT), estimating Fourier transform using DFT Analysis of discrete time signal: sampling of CT signals and aliasing, DTFT and properties.

**Reference Books:**


1. Signals and Linear Systems, Gabel R.A. and Robert R.A, John Wiley and Sons, New York
2. Signals and Systems , Oppenheim, Wilsky and Nawab, Prentice Hall, New Delhi
3. Systems and Signal Analysis, C.T.Chen, Oxford University Press, New Delhi
4. Probabilistic Methods of Signals and System Analysis, Cooper G.R and McGillem C.D, Oxford University Press, Cambridge.
5. Signals and Systems, Ziemer R.E., Tranter W.H., and Fannin D.R., Pearson Education Asia, Singapore

## (BTEEPE405C) ADVANCED RENEWABLE ENERGY SOURCES 04 Credits

### Unit 1: Introduction 7 Hours

**Renewable Sources of Energy-** Introduction to renewable energy, various aspects of energy conversion, principle of renewable energy systems, Grid-Supplied Electricity-Distributed Generation-Renewable Energy Economics-Calculation of Electricity Generation Costs –Demand side Management Options –Supply side Management Options-Modern Electronic Controls of Power Systems.

**Fuel Cells:** The Fuel Cell-Low and High Temperature Fuel Cells-Commercial and Manufacturing Issues-Constructional Features of Proton Exchange-Membrane Fuel Cells –Reformers-Electrolyzer Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent Circuit-Practical Determination of the Equivalent Model Parameters -Aspects of Hydrogen as Fuel.

### Unit 2: Wind Power Plants 7 Hours

Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, windspeed monitoring, Appropriate Location -Evaluation of Wind Intensity -Topography -Purpose ofthe Energy Generated -General Classification of Wind Turbines-Rotor Turbines-Multiple-BladeTurbines -Drag Turbines -Lifting Turbines-Generators and Speed Control used in Wind PowerEnergy -Analysis of Small Generating Systems. Aerodynamics of wind turbine rotor, site selection,wind resource assessment, wind energy conversion devices: classification, characteristics, andapplications. Hybrid systems, safety and environmental aspects.

### Unit 3: Photovoltaic Power Plants 7 Hours

**Solar Energy**-Generation of Electricity by Photovoltaic Effect -Dependence of a PV CellCharacteristic on Temperature-Solar cell Output Characteristics-Equivalent Models and Parametersfor Photovoltaic Panels-Photovoltaic Systems-Applications of Photovoltaic Solar EnergyEconomical.

**Analysis of Solar Energy. environment and social implications Solar Energy**: Solarradiation its measurements and prediction, solar thermal flat plate collectors, concentratingcollectors, applications, heating, cooling, desalination, power generation, drying, cooking etc,principle of photovoltaic conversion of solar energy, types of solar cells and fabrication.

Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping,power generation schemes.

### Unit 4: Bio-Energy 8 Hours

**Biomass** resources and their classification, chemical constituents and physicochemical characteristics of biomass, biomass conversion processes, thermo chemical conversion: direct combustion, gasification, pyrolysis and liquefaction. Biochemical conversion: anaerobic digestion, alcohol production from biomass. Chemical conversion process: hydrolysis and hydrogenation.

**Biogas:** generation, types of Biogas Plants, applications

**Induction Generators:** Principles of Operation-Representation of Steady-State Operation-Power andLosses Generated-Self-Excited Induction Generator-Magnetizing Curves and Self-Excitation Mathematical Description of the Self-Excitation Process-Interconnected and Stand-alone operation Speed and Voltage Control-Economical Aspects.

**Unit 5: Storage Systems** **8 Hours**

Energy Storage Parameters-Lead–Acid Batteries-Ultra Capacitors-Flywheels - SuperconductingMagnetic Storage System-Pumped Hydroelectric Energy Storage - Compressed Air Energy Storage-Storage Heat -Energy Storage as an Economic Resource.Integration of Alternative Sources of Energy: Principles of Power Injection-Instantaneous Activeand Reactive Power Control Approach-Integration of Multiple Renewable Energy SourcesIslandingandInterconnectionControl-DGControlandPowerInjection.

**Interconnectionof Alternative Energy Sources with the Grid:** Interconnection Technologies Standardsand Codes for Interconnection-Interconnection Considerations -InterconnectionExamples for Alternative Energy Sources.

**Text/Reference Books :**


1. Rao and Parulekar, Energy Technology, Khanna Publishers, New Delhi, Second reprint 2002
2. G.D Rai, Non-conventional Energy Sources,Khanna Publishers, New Delhi, tenth reprint 2002
3. C. S. Solanki, ―Solar Photovoltaics Fundamentals, Technologies and Applications‖, PHI, 2011
4. B. H. Khan,―Non-conventional Energy Resources‖,TataMcGrawhill Publishing Co.Ltd.,2006
5. S.P. Sukhatme, J.K. Nayak, ―Solar Energy-Principals of Thermal Collection and Storage,Tata Mc Graw hill Publishing Co. Ltd., New Delhi 2008
6. J. Twidell and T. Weir, ―Renewable Energy Resources‖, E & F N Spon Ltd, London, 1999
7. Thomas Ackermann, ―Wind Power in Power System‖, John Willey &Sons.

**BTEEL406 NETWORK THEORY LAB 1 Credits**

**Any Eight Experiments from the following list**

| Expt. No. | Title of Experiment |
|---|---|
| 1 | Verification of Kirchhoff's Laws |
| 2 | Verification of Superposition Theorem |
| 3 | Verification of Thevenin's Theorem |
| 4 | Verification of Norton's Theorem |
| 5 | Verification of Maximum Power Transfer Theorem |
| 6 | Verification of Reciprocity Theorem |
| 7 | Determination of transient response of RL & RC series circuits |
| 8 | To study Resonance in RLC series Circuit. |
| 9 | To study Resonance in parallel RLC Circuit. |
| 10 | Determination of driving point and transfer functions of a two port ladder network and verifywith theoretical values |
| 11 | To calculate and verify 'Z'Parameters of a Two-Port Network. |
| 12 | To calculate and verify 'Y' parameters of Two-Port Network. |

**BTEEL407 : Power System Lab** **1 Credit**

| Sr. No | Experiment Title |
|---|---|
| 1 | To study the layout of a Thermal Power Plant with its components. |
| 2 | To study the layout, classification and components of a Hydro Power Plant. |
| 3 | To study the alternator excitation system |
| 4 | To study the types and properties of various Overhead insulators |
| 5 | To study the types and properties of various Overhead Conductors. |
| 6 | To study the Power cable and its various components and types. |
| 7 | To study the layout of a substation along with its components |
| 8 | To determine the ABCD parameters of a medium and long transmission line. |
| 9 | To Visit a Thermal Power plant and write a technical report on the observations |

## (BTEEL408)ELECTRICAL MACHINE-II LABORATORY 01 Credits

**Perform Any Eight experiment from given list as a part of practical submission**

**List of Experiment**

1. Determination of sequence impedances of salient pole synchronous machine To perform
2. Determination of Xd and Xq of a salient pole synchronous machine from slip test.
3. V and inverted V curves of a3-phasesynchronous motor 1
4. Regulation of alternator by Direct loading method (R,L,C load)
5. Regulation of alternator by synchronous impedance method
6. Regulation of alternator by MMF method
7. Parallel operation of Synchronous generator
8. To study different types of starters for three phase Squirrel cage induction motor
9. Rotor resistance starter for slip ring induction motor.
10. To conduct no load and blocked rotor test and to determine performance characteristics of three phase induction motor from circle diagram
11. Load and block rotor tests on squirrel cage induction motor
12. Brake test on slip ring induction motor
13. To control speed of wound rotor induction motor by rotor resistance control method
14. To control speed of induction motor by V/F
15. To control speed of induction motor by i) star-delta ii) autotransformer

## (BTEEL409) ANALOG AND DIGITAL ELECTRONICS LAB 01 Credits

**Perform Any Eight experiment from given list as a part of practical submission**

**List of Experiment**

1. To plot input characteristics and Output characteristics of common emitter configuration.
2. To plot frequency response of RC coupled and Transformed coupled amplifier
3. To measurement of OP-AMP parameter
4. To verify the operation of op amp in Inverting & Non-inverting mode on AC input
5. Verify truth table of following basic and derived gates
    a. AND, OR, AND
    b. Ex-OR, NAND, NOR
6. Verification of truth table of flipflop
7. Design and implementation of 3-bit synchronous up/down counter
8. Design and implementation of half and full adder using logic gates
9. Design and implementation of Multiplexer and De-multiplexer and study of IC74150 and IC 74154
10. Design and implementation of code converters
    a. Binary to gray code converter
    b. BCD to Excess 3