INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

1. **Subject Code:** EEC-101 **Course Title:** Programming with C++
2. **Contact Hours:** **L:** 3 **T:** 0 **P:** 2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 10-25 **PRS:** 25 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Autumn **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To familiarize the students with the fundamentals of programming in C++ and the concepts of object oriented programming (OOPS).

10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Basic Programming in C++**: Concepts of algorithm & flow charts; Input/output, constants, variables, expressions and operators; Naming conventions and styles; Conditions and selection statements; Looping and control structures (while, for, do-while, break and continue); File I/O, header files, string processing; Pre-processor directives such as #include, #define, #ifdef, #ifndef; Compiling and linking.	9
2.	**Programming through Functional Decomposition**: Functions (void and value returning), parameters, scope and lifetime of variables, passing by value, passing by reference, passing arguments by constant reference; Design of functions and their interfaces (concept of functional decomposition), recursive functions; Function overloading and default arguments; Library functions; Matters of style, naming conventions, comments.	10
3.	**Aggregate Data-types**: Arrays and pointers; Structures; Dynamic data and pointers, dynamic arrays.	4
4.	**Object Oriented Programming Concepts**: Data hiding, abstract data types, classes and access control; Class implementation-default constructor, constructors, copy constructor, destructor, operator overloading, friend functions; Introduction to Templates	12
5.	**Object Oriented Design:** Inheritance and composition; Dynamic binding and virtual functions; Polymorphism; Dynamic data in classes.	7
Total		**42**

11. **Suggested Books:**

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Dietel H.M. & Dietel P.J., "C ++ How to Program", Prentice Hall Publications, 8th Edition.	2011
2.	Nell Date, Chip Weems, Mark Headington, "Programming and Problem Solving with C++", CBS Publishers and Distribution.	2000

3.	Cohoon J.P. & Davidson, J.W., "C++ Program Design", McGraw Hill, 3rd Edition.	2002
4.	David Gries, "The Science of Programming", Springer.	1987
5.	Dromey, "How to Solve it by Computer", Prentice Hall of India, 8th Edition.	1996

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

1. **Subject Code:** EEC-102 **Course Title:** Basic Electrical Science
2. **Contact Hours:** **L:** 2 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 3 **6. Semester:** Spring **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce the fundamentals of Electrical Engineering.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Introduction:** DC and AC sources, voltage and current sources; independent and dependent source, Source Transformation. Network elements: lumped and distributed; linear and non-linear; active and passive; unilateral and bilateral.	2
2.	**AC and DC circuits**: Introduction to phasors, concept of Impedance/Admittance in AC circuit, Star-Delta transformation, Circuit analysis using mesh and node methods, Series, Parallel and Series-Parallel resonance, and basic filters. Concept of complex power in AC circuits.	4
3.	**Electrical Power Generation:** Generation of electrical power, Conventional power generation - Hydro, Thermal, Nuclear and Gas Power. Types of Turbines, Working principle of Steam, Hydro and Gas turbines, Renewable energy generation. **Electrical Power Transmission:** Purpose of transmitting power, AC transmission voltage levels, Power transformer, Transmission lines, Single line diagram of the power transmission network, Transmission substation, Protective equipment used in the network, HVDC Transmission. **Electrical Power Distribution:** Distribution network and substation, Overhead lines and underground cables, Protective equipment.	6
4.	Energy stored in electric and magnetic fields, energy conversion in single and multi-excited systems and torque production	4
5.	Generating and motoring operations, Introduction to convertors, Introduction to EV and traction systems.	4
6.	Basics of electrical measurements and measuring instruments, Introduction and principle of sensors and transducers	4
7.	Basics of open and closed loop control system, Introduction to time domain analysis.	4
Total		**28**

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Beaty H.W., Fink D.G., "Standard Handbook for Electrical Engineers", McGraw Hill 15th Edition.	2007
2.	Singh, S.N., "Electric Power Generation, Transmission and Distribution", Prentice Hall of India, 2nd Edition.	2010
3.	Das Kamalesh, "Electrical Power Systems for Industrial Plants", JAICO Publishing House.	2011
4.	Jelley N., Andrews J., "Energy Sciences – Principles, Technologies, and Impacts", Oxford University Press.	2011
5.	Mullin Ray C., "Electrical Wiring Residential", Delmar Publishers Inc., 11th Edition.	1993
6.	Nagrath I. J. and Gopal M., "Control System Engineering", 5th Ed., 2011 New Age International.	2011
7.	Fitzgerald A. E., Kingsley C. and Kusko A., "Electric Machinery", 6th 2008 Ed., McGraw-Hill International Book Company.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electrical Engineering

1. **Subject Code:** EEC-104 **Course Title:** Signals and Systems
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Spring **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce signals and systems characteristics and analysis.

10. Details of the Course

S.No.	Contents	Contact hours
1.	**Introduction:** Size of a signal, classification of signals, elementary signals, signal operations, signal models, even and odd functions, systems, classification of systems, properties of systems, system model.	3
2.	**Linear Time-Invariant Systems:** Properties of linear, time – invariant systems, convolution, interconnection of LTI systems, zero- input response, zero state response, impulse response, and stability, systems represented by differential and difference equations.	5
3.	**Fourier Representations of Continuous – Time Signals:** Signals and vectors, correlation, orthogonal set, continuous – time Fourier series, trigonometric and exponential Fourier series, continuous – time Fourier transform, properties, Parseval relationships, Fourier transform properties.	9
4.	**Fourier Representations of Discrete – Time Signals:** Sampling, discrete – time signals, models, operations, discrete – time systems, zero input response, zero state response, stability, discrete – time Fourier series, discrete – time Fourier transform, reconstruction of continuous – time signals from samples, interpolation.	9
5.	**Laplace Transform:** Properties, solution of differential and integro-differential equations, bilateral Laplace transform, transfer function, causality and stability, continuous – time second order systems, poles and zeros.	8
6.	**Z-Transform:** Properties, region of convergence, solution of linear difference equations, system realization, bilateral transfer function, causality and stability, poles and zeros, Z- transform connection between the Laplace and Z- transform, sampled-data systems.	8
Total		**42**

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Oppenheim A.V., Willsky A.S., Nawab S.H., "Signals and Systems", 2nd edition, Prentice Hall.	2015
2.	Haykin S., Veen B.V., "Signals and Systems", 2nd edition, John Wiley.	2007
3.	Lathi B.P., "Principles of Signal processing and Linear Systems", Oxford International Version.	2009
4.	Lee E.A., Varaiya P., "Structure and Interpretation of Signals and Systems", 2nd edition, Addison-Wesley.	2011
5.	Hsu H.P., "Schaum's Outline of Signals and Systems, 3rd edition, McGraw Hill Education.	2013

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

1. **Subject Code:** EEC-201 **Course Title:** Network Theory
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Autumn **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce the fundamentals of network analysis using matrices, two-port networks, analysis of three-phase ac circuits and Basic Magnetic Circuits.
10. **Details of the Course**

S.No.	Contents	Contact Hours
1.	**Network Topology:** Concept of network graphs, Tree, Link, and Cut set. Network Matrices: Node Incidence matrix, Loop Incidence matrix, Cut-Set incidence matrix. Network analysis using network incidence matrices.	6
2.	**Network Theorems:** Thevenin's, Norton's, Superposition, Maximum power transfer theorem, Compensation, Reciprocity and Tellegen's theorems for DC and AC circuits.	8
3.	**Transient Network Analysis:** Response of RL, RC and RLC networks using Laplace Transforms for unit step, impulse, ramp inputs and AC signals.	6
4.	**Single and Two-Port Networks and their Characterization:** Driving point impedances, Open-circuit (Z), Short-circuit (Y), Hybrid (h) and Transmission (t) parameters. Series, Parallel, Series-Parallel and Tandem connections of two-port networks. Terminated two-port networks.	6
5.	**Three-Phase A.C. Circuit Analysis:** Analysis of balanced and unbalanced three-phase networks; Introduction to Symmetrical components;	8
6.	**Analysis of AC circuits with non-sinusoidal inputs.**	2
7.	**Introduction to Magnetic Circuits:** Magnetic fields and flux, Magnetomotive force (MMF), Reluctance, Air gaps, Ohm's law for magnetic circuits, Series, Parallel and series-parallel magnetic circuit calculations. Magnetically coupled coils, dot convention, equivalent circuits of coupled coils for AC (phasor) and transient analysis (s-domain).	6
Total		**42**

11. **Suggested Books:**

S.No.	Name of Authors/ Books/Publishers	Year of Publication/ Reprint
1.	DeCarlo R. A. and Lin Pen-Min, "Linear Circuit Analysis", 2nd Ed., Oxford University Press.	2001
2.	Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 9th Ed., Tata McGraw-Hill Publishing Company Ltd.	2019
3.	Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition.	2007

4.	Alexander C.K., Sadiku M.N.O., "Fundamentals of Electric Circuits", 7th Ed., McGraw Hill Indian Edition.	2022
5.	J. David Irwin J.D., Nelms R.M.," Basic Engineering Circuit Analysis", 12th Ed., John Wiley and Sons,	2021

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electrical Engineering

1. **Subject Code:** EEE-101 **Course Title:** Control System Engineering
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** ESC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce the fundamentals of control systems engineering in continuous time domain.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	Introduction to Controls: Historical development of control theory, notion of feedback and its necessity, difference between open-loop and closed-loop systems.	3
2.	Mathematical modeling of systems, linear and nonlinear models, concept of linearization, notion of block diagram, notion of signal flow, concept of transfer functions	6
3.	Introduction to first and second order systems, transient response of first and second-order systems, steady-state error analysis, concept of peak overshoot, settling time, effect of addition of poles and zeros to the transfer function of the system.	5
4.	Concept of stability, BIBO stability, asymptotic stability, characteristic equation of the system, criterion to detect stability: Routh-Hurwitz criterion, root locus technique.	6
5.	Frequency response of systems, Bode plots, gain margin and phase margin, polar plot, Nyquist plot and Nyquist stability criterion.	8
6.	Basics of P, PI, PID controllers and Lead-lad compensators, design of lead-lag compensators	5
7.	Various forms of state space realization, solution of state equations, minimal realization, controllability and observability, pole placement using state feedback control.	9
Total		42

11. **Suggested Books:**

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	M. Gopal, Control Systems: Principles and Design, McGraw Hill, 4 th Edition	2012
2.	K. Ogata, Modern Control Engineering, Pearson, 5th Edition	2015
3.	N. Nise, Control Systems Engineering, Wiley India, 6th Edition	2018
4.	G.F.Franklin, J.D. Powell, A.E. Naeini, Feedback Control of Dynamical Systems, Pearson, 8th Edition	2021

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

1. **Subject Code:** EEE-102 **Course Title:** Basic Electrical Engineering
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 2/2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 15-30 **PRS:** 20 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** ESC
8. **Pre-requisite:** Nil
9. **Objective:** To familiarize the students with the fundamentals of electrical engineering.
10. **Details of the Course**

S.No.	Contents	Contact Hours
1.	**Power Generation, Transmission, and Distribution:** Conventional energy resources (thermal and hydro power generation), Renewable resources (Solar PV and wind power generation systems), Power transmission and distribution systems, substation components, concepts of voltage, current, power, power factor and Types of energy tariffs	12
2.	**Electrical Machines:** Introduction to magnetic circuit and DC Machine**,** Transformer: voltage and current transformation, efficiency, and regulation. Induction Motors: Working principle and speed control. Alternator (synchronous generator): EMF generation, Operation and control.	10
3.	**Feedback Control System:** Open and closed loop control, Transfer function and response of second order systems, Introduction to P, PI, and PID controllers.	10
4.	**Sensors and Transducers:** Electric measurements meters, transducers and sensors (temperature, humidity, displacement, torque, stress, strain, etc.).	10
		42

11. List of experiments:

1. Perform load test on single –phase transformer to determine its efficiency and voltage regulation
2. Starting and load test on three-phase induction motor
3. Determine no-load and load characteristics of Alternator
4. Measurement of power, power factor, and energy in AC systems
5. Closed loop temperature control of furnace/oven
6. Determine Characteristics of LVDT transducer

12. Suggested Books:

S.No.	Name of Authors /Books/Publishers	Year of Publication/ Reprint
1.	B. M. Weedy, B. J. Cory, N. Jenkins, Janaka B. Ekanayake, and Goran Strbac, Electric Power Systems, 4th Ed., John Wiley and Sons, West Sussex, United Kingdom.	2012
2.	C. L. Wadhwa, Electrical Power System, New Age Techno Press, New Delhi.	2010
3.	Chapman, Stephen, J., "Electric Machinery Fundamentals", McGraw Hill Book Company.	1985
4.	Katsuhiko Ogata , "Modern Control Engineering" Fifth Edition, Prentice Hall	2010
5.	Docbelin E.O., "Measurement Systems: Application and Design", McGraw Hill,	1990

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

1. **Subject Code:** EEE-103 **Course Title:** Measurements and Transducers
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** ESC
8. **Pre-requisite:** Nil
9. **Objective:** To impart knowledge of measuring instruments and transducers.
10. **Details of the Course**

S.No.	Contents	Contact Hours
1.	**Introduction:** SI units, introduction of Electrical measuring Instrument, static electrical instruments.	3
2.	**Analog and Electronic Instruments:** Ammeters, Voltmeters, Watt meters and Energy Meters: Review of PMMC and moving iron instruments; Electro-dynamic and electrostatic meters; Induction wattmeters, errors and their compensation, multi-element wattmeter. Induction energy meter, calibration devices, errors and their compensation, digital voltmeter and multimeter, accuracy and resolution considerations, comparison with analog electronic instruments.	9
3.	**Resistance Measurement:** Measurement of low, medium and high resistances, measurement of volume and surface resistivity.	4
4.	**Transducers:** Basics of transducer, sensor and actuator; Active and passive transducers, generating and parametric transducers; Analog, digital and pulse outputs of sensors; Static characteristics of transducer and transducer system	7
5.	**Measurement of Displacement and Strain:** Resistive, inductive and capacitive transducers for displacement; Wire, metal film and semiconductor strain gauges.	6
6.	**Measurement of Force and Pressure:** Column, ring and cantilever-beam type load cells; Elastic elements for pressure sensing.	6
7.	**Measurement of Temperature:** Resistance temperature detector, NTC and PTC thermistors, Seebeck effect, thermocouple and thermopile.	7
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Golding E. W. and Widdis F. C., "Electrical Measurements and Measuring Instruments", 5th Ed., A.H. Wheeler and Company.	1994
2.	Doebelin E. O. and Manik D. N., "Measurement Systems", 5th Ed., Tata McGraw-Hill Publishing Company Limited.	2008
3.	Tumanski S., "Principles of Electrical Measurement ", CRC Press, Taylor and Francis.	2006
4.	Morris A. S., "Measurements and Instrumentation Principle", 3rd Edition, Butterworth-Heinemann.	2001
5.	Rangan C. S., Sarma G. R. and Mani V. S. V., "Instrumentation Devices and Systems", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
6.	Cooper W. D. and Helfrick A. D, "Modern Electronic Instrumentation and Measurement Techniques", Pearson Education.	2008
7.	Oliver B. M. and Cage J. M., "Electronic Measurement and Instrumentation", McGraw-Hill International Book Company.	1983
8.	Anand M. M. S., "Electronic Instruments and Instrumentation Technology", Pearson Education.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Electrical Engineering

Subject code: EEC-202 **Course Title:** Electrical and Electronic Measurements

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Error analysis, Measurement of low and medium range of voltage, current, power and energy using analog meters, Measurement of resistance, inductance, capacitance and frequency. Time and Phase measurement, Measurement of voltage, current, power and energy using digital meters, ac and dc current and voltage probes, Application of CRO, determination of harmonics and spectrum analysis, Grounding and Shielding.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Electrical Engineering

Subject code: EEC-204 **Course Title:** Control Systems

L-T-P: 3-1-2 **Credits:** 5 **Subject Area:** PCC

Course Outlines: Open-loop and closed-loop systems; feedback control and its need; Mathematical modelling of physical systems, transfer function, block diagram, signal flow graph; Introduction to state-space representation; Time Domain Analysis: Transient response steady-state error analysis; Concept of stability, characteristic equation, Routh-Hurwitz criterion, Root Locus Technique. Frequency Domain Analysis: Bode plots, gain margin and phase margin, Polar plot, Nyquist stability criterion. Basics of controllers: Proportional, Derivative, and Integral actions, Compensator Design: Design of lead lag compensators; State-Space Analysis: Solution of state equations, concept of controllability and observability, state feedback controller.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Electrical Engineering

Subject code: EEC-303 **Course Title:** Power Electronics

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Principle of operation and working of power devices power diodes, Single-phase half wave converter, 2-pulse midpoint converter, half controlled and fully controlled bridge converters, converter fed dc drives, Principle of operation of single-phase ac regulators. electric drive, types of load; Speed-torque characteristic of driven unit/loads, motors, steady state and transient stability of drives. Principle of operation of DC-DC converters and dc drive operation. Voltage source and current source inverters, Variable frequency control of induction motor, constant V/f operation and constant flux operation, slip power recovery control and its different schemes, Introduction to CSI fed drive.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Electrical Engineering

Subject code: EEC-351 **Course Title:** Fundamentals of AI/ML

L-T-P: 2-0-0 **Credits:** 2 **Subject Area:** PCC

Course Outlines: Introduction to Artificial Intelligence; Intelligent Agents; Solving problems by searching; Constraint satisfaction problems; Adversarial search and games. Introduction to Machine Learning: Forms of Learning; Supervised learning; Learning decision trees; Linear regression and classification; Simple feedforward networks; Nonparametric models.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-208 **Course Title:** Power Systems-I

L-T-P: 3-1-2/2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Transmission and distribution Systems, Overhead line insulators, Concept of sag and tension, Corona, Underground cables, Parameters and performance of overhead transmission lines, Series and s hunt compensation, Transients and travelling waves in power system, Single-line representation, Per unit calculations, Load flow analysis, Short circuit analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE/SCHOOL: Department of Electrical Engineering

Subject Code: EEC-301 **Course Title:** Power Systems-II

L-T-P: 3-0-2 **Credits:** 4 **Subject Area:** PCC

Course Outlines: Fundamentals of power system stability, Concept of economic dispatch and unit commitment, Load-frequency control, Principle of operation and characteristics of relays, Concept of numerical relays, Protection of transmission line, bus bar, transformers and generators, Arc interruption theory, Different types of circuit breakers, Different types of fuses.