Department of Electrical Engineering.

1.	MAN-001	Mathematics-1	BSC	4
2.	PHN-003	Electromagnetic Field Theory	BSC	4
3.	CEN-105	Introduction to Environmental Studies	GSC	3
4.	HS-001A	Communication Skills (Basic)	HSSC	2
5.	HS-001B	Communication Skills (Advance)	HSSC	2
6.	HSN-002	Ethics and General Awareness	HSSC	2
7.	EEN-101	Introduction to Electrical Engineering	DCC	2
8.	EEN-103	Programming in C++	ESC	4
9.	MAN-002	Mathematical Methods	BSC	4
10.	PHN-004	Modern Physics	BSC	4
11.	MIN-106	Engineering Thermodynamics	DCC/ESC	4
12.	EEN-102	Network Theory	DCC	4
13.	EEN-104	Electrical Measurements and Measuring Instruments	DCC	4
14.	EEN-106	Analog Electronics	DCC	4
15.	EEN-201	Electrical Machines-I	DCC	5
16.	EEN-203	Digital Electronics and Circuits	DCC	4
17.	EEN-205	Design of Electronic Circuits	DCC	4
18.	EEN-211	Control Systems	DCC	4
19.	EEN-291	Engineering Analysis and Design	DCC	3
20.	MTN-105 *	Electrical and Electronic Materials	ESC	4
21.	EEN-202	Electrical Machines-II	DCC	5
22.	EEN-204	Microprocessors and Peripheral Devices	DCC	5
23.	EEN-206	Power Transmission & Distribution	DCC	4
24.	EEN-208	Applied Instrumentation	DCC	4
25.	EEN-301	Power System Analysis and Control	DCC	4
26.	EEN-303	Power Electronics	DCC	4

27	EEN-305	Advanced Control Systems	DCC	5
28	EEN-300*	Industry Oriented Problem	DCC	3
29	EEN-302	Electric Drives	DCC	4
30	EEN-304	Protection and Switchgear	DCC	4
31	EEN-351	Artificial Neural Networks	PEC	4
32	EEN-352	Digital Image Processing	PEC	4
33	EEN-353	Digital Design with VHDL	PEC	4
34	EEN-354	Digital Control Systems	PEC	4
35	EEN-355	Digital Signal Processing	PEC	4
36	EEN-356	Signals and System	PEC	4
37	EEN-357	Advanced Microprocessors and Interfacing	PEC	4
38	EEN-358	Data Structures	PEC	4
39	EEN-359	Single Chip Microcontroller and Its Applications	PEC	4
40	EEN-360	Embedded Systems	PEC	4
41	EEN-365	Digital Signal Processors	PEC	4
42	EEN-361	Optimization Techniques	PEC	4
43	EEN-363	Fuzzy Logic System	PEC	4
44	EEN-364	Utilization and Traction	PEC	4
45	EEN-540	Advanced Power Electronics	PEC	4
46	EEN-541	Analysis of Electrical Machines	PEC	4
47	EEN-580	Advanced Linear Control Systems	PEC	4
48	EEN-542	Advanced Electric Drives	PEC	4
49	EEN-543	FACTS Devices	PEC	4
50	EEN-522	Biomedical Instrumentation	PEC	4
51	EEN-523	Intelligent Sensors and Instrumentation	PEC	4
52	EEN-541	Analysis of Electrical Machines	PEC	4
53	EEN-561	Power System Operation and Control	PEC	4
54	EEN-563	EHV AC and DC Transmission	PEC	4
55	EEN-564	HVDC Transmission Systems	PEC	4
56	EEN-582	Advanced Systems Engineering	PEC	4

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-202** Course Title: **Electrical Machines-II**

2. Contact Hours: **L: 3** **T: 1** **P: 2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:3**

4. Relative Weight**:** **CWS: 15** **PRS:25** **MTE: 20** **ETE:40** **PRE:00**

5. Credits**:5** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: NIL**

9. Objective:

The objective of the course is to impart knowledge of the constructional features and principle of operation of induction and synchronous machines. The course also deals with the methods of starting and speed control of induction motors.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Classification and constructional features of wound rotor and squirrel cage induction machines.	**2**
2.	Qualitative description of working of poly-phase induction machine from rotating field view point; Coupled circuit model of an idealized three-phase machine, concept of leakage reactance and its importance on machine performance and design; Equivalent circuit, phasor diagram, circle diagram; Generator action, methods of excitation, characteristics.	**7**
3.	Methods of starting induction motors; Principles of speed control (i) stator voltage control (ii) slip speed control (iii) rotor resistance control (iv) V/f control; Effect of voltage injection in secondary of slip-ring induction motor, action of commutator as a frequency converter.	**6**
4.	Double-cage and deep-bar squirrel cage rotor induction motor; Space and time harmonics and their effect on motor performance.	**4**
5.	Single-phase induction motor working, double revolving field theory, equivalent circuit, torque-speed characteristic, performance.	**3**

S. No.	Contents	Contact Hours
6.	Classification and constructional features of salient pole and cylindrical rotor three-phase synchronous machine.	**2**
7.	Generated emf, winding coefficients, harmonics in generated emf, tooth ripples and armature reaction; Coupled circuit model of an idealized salient pole synchronous machine, two-reaction theory, operation under balanced steady state conditions; Power-angle equations of salient pole and cylindrical rotor synchronous machines.	**7**
8.	Voltage regulation of salient pole and cylindrical rotor machine, effect of saturation on voltage regulation.	**4**
9.	Steady state operating characteristic of synchronous motor; O and V-curves and phasor diagram, hunting.	**3**
10.	Parallel operation of synchronous machines, synchronization and	**4**

	load division, synchronous machine on infinite bus, stability and hunting in synchronous machine.	
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Fitzgerald A. E., Kingsley C. and Kusko A., "Electric Machinery", 6th Ed., McGraw-Hill International Book Company.	2008
2.	Say M. G., "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors.	2005
3.	Nagrath I. J. and Kothari D. P., "Electrical Machines", 3rd Ed., Tata McGraw-Hill Publishing Company Limited.	2004
4.	Langsdorf A. S., "Theory of AC machines", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
5.	Kimbark E.W., "Power System Stability, Vol. III: Synchronous Machines", Wiley India.	2008
6.	Chapman S. J., "Electric Machinery Fundamentals", 4th Ed., McGraw-Hill International Book Company.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-203** Course Title: **Digital Electronics and Circuits**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:2**

4. Relative Weight**:** **CWS:20** **PRS:20** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-106 or EC-102**

9. Objective:

To familiarize the students with the fundamentals of combinational and sequential logic circuits, and their design with HDL.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of Number System**: Representation of binary, hexadecimal, octal and BCD numbers, conversion from one system to another system, signed number representation, addition and subtraction of signed numbers.	**2**
2.	**Boolean Algebra**: Theorems and postulates; Logic gates, positive and negative logic gates and their truth tables.	**3**
3.	**Digital Integrated Circuits:** DTL, TTL, ECL, CMOS; Universal gates using TTL logic, open collector devices, TTL parameters; NAND and NOR gates using CMOS.	**3**
4.	**Boolean Function:** Canonical forms of representing Boolean function, Karnaugh map, simplification of 3, 4 and 5 variables function using Karnaugh map and McCluskey method.	**3**
5.	**Combinational Logic Circuits:** Design procedure & analysis of combinational logic circuits, binary adder, binary subtractor, binary comparator, BCD adder, multiplexers, realisation of Boolean function using multiplexers and decoders.	**5**
6.	**Combinational Logic Design using HDL:** Introduction, program structure, logic system, variables and constants, vectors and operators, structural data flow, behavioural design elements, functions, simulation, test benches; Design of logic circuits.	**7**
7.	**Sequential Logic Circuits**: Analysis of basic memory element, Mealy and Moore state transition diagram; Development of R-S flip flop, level triggered and edge triggered flip flops, α-β-0-1 behaviour of flip-flop, J-K, D and T flip-flops; Principle of operation of Schmitt trigger, monostable and astable multivibrator.	**6**
8.	**Counters**: Synchronous and asynchronous counters, design of counters, state transition diagram, shift register, ring counter and twisted ring counter and their design.	**5**
9.	**A/D and D/A Converters**: Binary weighted and R-2R ladder type DAC, DAC parameters; Flash type, counter ramp type, tracking, single slop and dual slope type ADC, Successive Approximation ADC.	**3**

10.	**Sequential Logic Design with HDL:** Design of flip-flops and counters, state machines design, state machine test benches	**5**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Malvino A. P. and Leach D. P., "Digital Principles and Applications", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.	2008
2.	Mano M. Morris and Ciletti M. D., "Digital Design", 4th Ed., Pearson Education.	2008
3.	Tocci R. J., "Digital Systems – Principles and Applications", 9th Ed., Pearson Education.	2008
4.	Cook N. P., "A First Course in Digital Electronics", Prentice Hall International Edition.	1999
5.	Wakerly J. F., "Digital Design – Principles and Practices", 4th Ed., Pearson Education.	2008
6.	Michael Ciletti, " Advanced Digital Design with the Verilog HDL", 2nd Eition, Prentice Hall	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-204** Course Title: **Microprocessors and Peripheral Devices**

2. Contact Hours: **L: 3** **T: 1** **P: 2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:2**

4. Relative Weight**:** **CWS:15** **PRS :25** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:5** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective:

To provide in-depth knowledge of the architecture, instruction set and programming of typical 8-bi microprocessor and programmable support chips used in microprocessor-based systems.

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10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction of Microcomputer System**: CPU, I/O devices, clock, memory, bussed architecture, tri-state logic, address bus, data bus and control bus.	**3**
2.	**Semiconductor Memories**: MROM, ROM, EPROM, EEPROM, DRAM, internal structure and decoding, memory read and write timing diagrams.	**3**
3.	**Intel 8085A microprocessor:** Pin description and internal architecture; Timing and control unit, op-code fetch machine cycle, memory read/write machine cycles, I/O read/write machine cycles, interrupt acknowledge machine cycle, state-transition diagram.	**8**
4.	**Instruction Set:** Addressing modes; Data transfer, arithmetic, logical, branch, stack and machine control groups of instruction set, macro RTL and micro RTL flow chart of few typical instructions; Unspecified flags and instructions.	**7**
5.	**Assembly Language Programming:** Assembler directives, simple examples; Subroutines, parameter passing to subroutines.	**5**
6.	**Interfacing:** Interfacing of memory chips, address allocation technique and decoding; Interfacing of I/O devices, LEDs and toggle-switches as examples, memory mapped and isolated I/O structure; Input/Output techniques: CPU initiated unconditional and conditional I/O transfer, device initiated interrupt I/O transfer.	**5**
7.	**Interrupts:** Interrupt structure of 8085A microprocessor, processing of vectored and non-vectored interrupts, latency time and response time.	**3**
8.	**Programmable Peripheral Interface:** Intel 8255, pin configuration, internal structure of a port bit, modes of operation, bit SET/RESET feature, programming; ADC and DAC chips and their interfacing.	**4**
9.	**Programmable Interval Timer:** Intel 8253, pin configuration, internal block diagram of counter, modes of operation, counter read methods, programming, READ-BACK command of Intel 8254.	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Hall D. V., "Microprocessor and Interfacing –Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
2.	Gaonkar R. S., "Microprocessor Architecture, Programming and Applications", 5th Ed., Penram International.	2007
3.	Stewart J, "Microprocessor Systems- Hardware, Software and Programming", Prentice Hall International Edition.	1990
4.	Short K. L., "Microprocessors and Programmed Logic", 2nd Ed., Pearson Education.	2008
5.	Intel Manual on 8-bit Processors	--
6.	Intel Manual on Peripheral Devices	--

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-205** Course Title: **Design of Electronic Circuits**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weight**:** **CWS:20** **PRS:20** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-102**

9. Objective:

To introduce the fundamentals of modeling, analysis and response of control systems in continuous and discrete data systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Concepts of system**,** open loop and closed loop systems, model classification; Mathematical modeling and representation of physical systems, analogous systems.	**4**
2.	**Transfer Function Analysis:** Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.	**4**
3.	**Control System Components:** Potentiometers, synchros, principles and applications of dc and ac servomotors, analysis and transfer function, servo amplifiers, modulators and demodulators, magnetic amplifiers; Position and speed control systems.	**6**
4.	**Time Domain Analysis:** Time domain performance criterion, transient response of first order, second order and higher order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non unity feedback systems, performance analysis for P, PI and PID controllers.	**8**
5.	**Stability Analysis:** Concept of stability by Routh stability criterion, root-loci and root contours, sensitivity analysis,	**5**
6.	**Frequency Response Analysis:** Polar and inverse polar plots, logarithmic plots, Bode plots, Nyquist stability criterion, gain and phase margins, relative stability, frequency response specifications, correlation with time domain M and N circles, Nichol's chart, closed loop frequency response from open loop response.	**8**
7.	**Compensation Techniques:** Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system; Feedback compensation using P, PI, PID controllers, ON-OFF control.	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Nagrath I. J. and Gopal M., "Control System Engineering", 5th Ed., New Age International Private Limited Publishers.	2008
2.	Kuo B. C., "Automatic Control Systems", 8th Ed., Wiley India.	2008
3.	Ogata K., "Modern Control Engineering", 4th Ed., Pearson Education.	2008
4.	Dorf R. C. and Bishop R. H., "Modern Control Systems", 8th Ed., Pearson Education.	2008
5.	Norman S. N., "Control Systems Engineering", 4th Ed., Wiley India.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-206** Course Title: **Power Transmission & Distribution**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weight**:** **CWS:25** **PRS:00** **MTE:25** **ETE:50** **PRE:00**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-102**

9. Objective:

To introduce the design aspects of power system distribution and transmission systems, and to familiarize students with the practical operation of power systems.

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10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Transmission and Distribution Systems:** Introduction, electrical supply system, comparison of AC and DC systems, overhead versus underground systems, choice of working voltages for transmission and distribution, transmission and distribution system architecture.	**5**
2.	**Overhead Transmission Lines:** Mechanical design, line support, types of conductors; Overhead line insulators, types of insulators- pin, suspension and strain insulators, insulator materials, insulator string; Calculation of voltage distribution and string efficiency, methods of equalizing voltages, use of guard rings.	**6**
3.	**Corona:** Theory of corona formation, factors affecting corona, calculation of potential gradient, disruptive critical voltage and visual critical voltage, corona power loss, minimizing corona, merits and demerits of corona.	**3**
4.	**Line Parameters**: Line resistance, inductance and capacitance calculations, effect of earth on capacitance of overhead transmission lines, short and medium transmission lines, line performance and compensation.	**6**
5.	**Underground Cables:** Elements of a power cable, properties of the insulation and sheath materials, classification of power cables: belted, screened and pressure cables, dielectric stress in cable insulation, grading of cables: capacitance grading and inter-sheath grading, measuring capacitances and charging current in a cable.	**4**
6.	**Tariff:** Cost analysis of power plants, types of tariffs- flat rate, block rate, two-part and three-part, time of day and real time pricing, fixed and running charges, comparison of tariffs and computation of monthly/annual bill; Economics of power factor improvement.	**4**
7.	**HVDC**: Advantages and limitations of HVDC transmission over HVAC transmission, elementary ideas about converter and inverter operation, classification of HVDC links: mono-polar, bipolar and homopolar, economic comparison of HVDC and ac systems.	**4**
8.	**Surge Performance and Protection:** Switching surges, origin and	**6**

	mechanism of lightening strokes, direct and induced strokes, protection from surges- lightning arrestors (rod gap, horn gap, multi-gap and expulsion type) and surge diverters, evaluation of surge impedance, energy and power of a surge.	
9.	**Introduction to Traveling Waves:** Introduction and mechanism of traveling waves, wave equation, characteristic impedance of a line, incident and reflected waves, transmission and refraction of waves, velocity of traveling waves, behavior of traveling waves for different terminations: inductor, capacitor, open-end, short-end and over the junction of dissimilar lines, attenuation of traveling waves.	**4**
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., Wiley India.	2008
2.	Grainger J. J. and Stevenson W.D., "Elements of Power System Analysis", Tata McGraw-Hill Publishing Company Limited.	2008
3.	Gonen T., "Electric Power Transmission System Engineering: Analysis and Design", John Wiley and Sons.	1990
4.	Nagrath I. J. and Kothari D. P., "Modern Power System Analysis", 3rd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
5.	Roy S., "Electrical Power System- Concepts, Theory and Practices", Prentice Hall of India Private Limited.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-208** Course Title: **Applied Instrumentation**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weight**:** **CWS:20** **PRS:20** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-104**

9. Objective:

To impart knowledge of the principles, working and characteristics of transducers and the associated signal conditioning circuits for industrial applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** 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; Dynamic characteristics of n^{th}, 0^{th}, first and second order transducers.	**5**
2.	**Measurement of Displacement and Strain:** Resistive, inductive and capacitive transducers for displacement; Wire, metal film and semiconductor strain gauges; Wheatstone-bridge circuit with one, two and four active elements, temperature compensation.	**6**
3.	**Measurement of Speed and Torque:** Electro-magnetic and photo-electric tachometers; Torque shaft, strain-gauge, electromagnetic and radio type torque meters.	**3**
4.	**Measurement of Force and Pressure:** Column, ring and cantilever-beam type load cells; Elastic elements for pressure sensing; Using displacement sensors and strain gauges with elastic elements.	**3**
5.	**Measurement of Temperature:** Resistance temperature detector, NTC and PTC thermistors, Seebeck effect, thermocouple and thermopile.	**2**

S. No.	Contents	Contact Hours
6.	**Analog Electronic Instrumentation:** Tuned and sampling voltmeters; AC and DC current probes; Wattmeter and energy meter; Wave analyzer, harmonic distortion meter, harmonic analyzer, spectrum analyzer.	**8**
7.	**Digital Electronic Instrumentation:** Digital counter-timer and frequency meter, time standards, digital voltmeter and multimeter, accuracy and resolution considerations, comparison with analog electronic instruments.	**8**
8.	**Noise and Interference in Instrumentation:** Sources and effects of noise and interference; SNR and its improvement; Introduction to	**2**

	noise suppression methods; Grounding and shielding.	
9.	**Display Devices and Recorders:** CRO, frequency and phase measurement with CRO, direct reading frequency and phase meters.LCD and LED displays, X-Y plotter, strip-chart recorder.	**5**
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Rangan C. S., Sarma G. R. and Mani V. S. V., "Instrumentation Devices and Systems", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
2.	Doebelin E. O. and Manik D. N., "Measurement Systems", 5th Ed., Tata McGraw-Hill Publishing Company Limited.	2008
3.	Johnson C. D., "Process Control Instrumentation Technology", 8th Ed., Prentice Hall of India Private Limited.	2008
4.	Cooper W. D. and Helfrick A. D, "Modern Electronic Instrumentation and Measurement Techniques", Pearson Education.	2008
5.	Oliver B. M. and Cage J. M., "Electronic Measurement and Instrumentation", McGraw-Hill International Book Company.	1983
6.	Anand M. M. S., "Electronic Instruments and Instrumentation Technology", Pearson Education.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-211** Course Title: **Control Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weight**:** **CWS:25** **PRS:00** **MTE:25** **ETE:50** **PRE:00**

5. Credits**: 4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-102**

9. Objective:

To introduce the fundamentals of modeling, analysis and response of control systems in continuous and discrete data systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Concepts of system**,** open loop and closed loop systems, model classification; Mathematical modeling and representation of physical systems, analogous systems.	**4**
2.	**Transfer Function Analysis:** Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.	**4**
3.	**Control System Components:** Potentiometers, synchros, principles and applications of dc and ac servomotors, analysis and transfer function, servo amplifiers, modulators and demodulators, magnetic amplifiers; Position and speed control systems.	**6**
4.	**Time Domain Analysis:** Time domain performance criterion, transient response of first order, second order and higher order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non unity feedback systems, performance analysis for P, PI and PID controllers.	**8**
5.	**Stability Analysis:** Concept of stability by Routh stability criterion, root-loci and root contours, sensitivity analysis,	**5**
6.	**Frequency Response Analysis:** Polar and inverse polar plots, logarithmic plots, Bode plots, Nyquist stability criterion, gain and phase margins, relative stability, frequency response specifications, correlation with time domain M and N circles, Nichol's chart, closed loop frequency response from open loop response.	**8**
S. No.	**Contents**	**Contact Hours**
7.	**Compensation Techniques:** Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system; Feedback compensation using P, PI, PID controllers, ON-OFF control.	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of

		Publication/ Reprint
1.	Nagrath I. J. and Gopal M., "Control System Engineering", 5th Ed., New Age International.	**2011**
2.	Kuo B. C., "Automatic Control Systems", 8th Ed., Wiley India.	**2009**
3.	Ogata K., "Modern Control Engineering", 5th Ed., Pearson Education.	**2009**
4.	Dorf R. C. and Bishop R. H., "Modern Control Systems", 8th Ed., Pearson Education.	**2008**
5.	Norman S. N., "Control Systems Engineering", 4th Ed., Wiley India.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-291** Course Title: **Engineering Analysis and Design**

2. Contact Hours: **L: 2** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory :2** **Practical: 0**

4. Relative Weight**:** **CWS: 15** **PRS:25** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:3** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-102 and EE-106**

9. Objective:

To introduce fundamentals of design and simulation using software packages.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Model of Physical Systems:** Introduction to physical systems: Mass-spring-damper system, accelerometer, rotational mechanical system, gear trains, liquid level system; Circuit models: RL, RC, LC, RLC series and parallel circuits with sinusoidal and non-sinusoidal excitations, diode rectifier.	**3**
2.	**Solution of Differential Equations:** Systems of linear equations, homogeneous and non-homogeneous linear equations, Polynomial equations, least squares fit; ordinary differential equations: Euler's method, Runge-Kutta method, Newton-Raphson method, Predictor-Corrector methods; Numerical integration: Forward and backward integration rules, Trapezoidal rule, Simpson's rule, Errors of integration.	**9**
3.	**Simulation Techniques:** Continuous state simulation: circuit level simulators, Discrete-event simulation: Fixed time step, variable time step; Response analysis of circuits: DC analysis, AC Analysis, Transient analysis.	**6**
4.	**Programming in MATLAB**: Programming a function, repetitive and conditional control structures, Iterative solution of equations, polynomial interpolation; Plotting and analysis: two-dimensional and three-dimensional plots, Histograms, Polar plots, Function evaluation; Handling external files: saving and loading data.	**4**

S. No.	Contents	Contact Hours
5.	**PSPICE Circuit Simulator**: Introduction, circuit descriptions, Input files, nodes, circuit elements, element values, sources, output variables; Analysis: DC sweep, Transient and AC analysis. PSPICE models.	**3**
6.	**Design Case Studies**: DC Motor speed control, State space model, heater systems with temperature control.	**3**
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Adrian Biran, Moshe Breiner, “MATLAB 5 for Engineers”, second edition, Addison Wesley.	1999
2.	Muhammad H. Rashid, Hasan M. Rashid, “SPICE for Power Electronics and Electric Power”, Second edition, Taylor & Francis.	2009
3.	William J. Palm III, “Introduction to MATLAB for Engineers”, Third edition, McGraw Hill.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-301** Course Title: **Power System Analysis and Control**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weight**:** **CWS:20** **PRS:20** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-206**

9. Objective:

To provide in-depth knowledge of power system analysis under normal conditions and on fault, and the concepts of power system control and stability.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**System Representation:** Single line representation, review of per unit calculations.	**2**
2.	**Formation of Network Matrices:** Formation of admittance matrix with and without mutual impedances, Z_{bus} building algorithm with and without mutual impedances.	**6**
3.	**Load Flow Analysis:** Formation of static load flow equations, solution of load flow problem by Gauss-Seidel, Newton-Raphson (polar and rectangular) and fast decoupled techniques.	**10**
4.	**Short Circuit Analysis:** Review of symmetrical components, sequence networks, fault calculations for balanced and unbalanced short circuit faults using Z_{BUS}, analysis of open conductor fault.	**10**
5.	**Power System Stability:** Swing equation, power angle equation, synchronizing power coefficient, basic concepts of steady state, dynamic and transient stability, equal area criterion, solution of the swing equation, multi-machine transient stability studies with classical machine representation.	**8**
6.	**Power System Control:** Elementary idea of load-frequency control, automatic generation control, reactive power and voltage control.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Saadat H., "Power System Analysis" Tata McGraw-Hill Publishing Company Limited.	2008
2.	Pai M. A., "Computer Techniques in Power System Analysis", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
3.	Miller T. J. E., "Reactive Power Control in Electric Systems", John Wiley and Sons.	1982
4.	Grainger J. J. and Stevenson W. D., "Power System Analysis", McGraw-Hill International Book Company.	2008
5.	Glover J. D. and Sarma M. S., "Power System Analysis and Design", 4th Ed., Cengage Learning.	2008
6.	Kothari D. P. and Nagrath I. J., "Modern Power System Analysis", 3rd Ed., Tata McGraw-Hill Publishing Company Limited.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-302** Course Title: **Electric Drives**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:0**

4. Relative Weight**:** **CWS: 20** **PRS:20** **MTE: 20** **ETE:40** **PRE:00**

5. Credits**:4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-201, EE-202 and EE-303**

9. Objective:

To introduce the fundamentals of electric drives, operation and analysis of solid state control of ac/dc drives and estimation of drive rating for different duty cycle operations.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction**: Definition of electric drive, type of drives; Speed-torque characteristic of driven unit/loads, motors, joint speed-torque characteristic; Classification and components of load torque; Review of power converters used in drives, multi-quadrant operation of electric drive, example of hoist operation in four quadrant.	**5**
2.	**Estimation of Drive Motor Rating**: Selection of motor power capacity for continuous duty at constant load and variable loads; Selection of motor capacity for short time and intermittent periodic duty, permissible frequency of starting of squirrel cage motor for different duty cycles; Load equalization.	**6**
3.	**DC Drives:** Single-phase half controlled and fully controlled converter fed dc motor drives, operation of dc drives with continuous armature current, voltage and current waveforms; Concept of energy utilization and effect of free-wheeling diode; Operation of drive under discontinuous current, expression for speed-torque characteristic.	**8**

S. No.	Contents	Contact Hours
4.	**Chopper fed DC Drives**: Principle of operation and control techniques, chopper circuit configurations used in dc drives: Type A, B, C, D and E; Motoring operation of chopper fed separately excited dc motor, steady state analysis of drive with time-ratio control.	**4**
5.	**Closed Loop Control of DC Drives:** Drives with current limit control, single-quadrant closed loop drive with inner current control loop, advantage of inner current control loop in drives.	**5**
6.	**AC Drives:** Variable voltage, rotor resistance and slip power recovery control of induction motors, torque-speed characteristics under different control schemes; Variable frequency control of induction motor, analysis of induction machine under constant V/f operation, constant flux operation and controlled current operation.	**6**
7.	**Inverter fed AC Drives**: Voltage source inverter fed induction	**8**

	motor drive in open loop, frequency and voltage control in PWM VSI; Operation of closed loop slip-speed controlled VSI fed induction motor drive; Current source inverter, advantage of CSI fed drives, closed loop slip speed controlled CSI fed drive.	
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Dubey G. K., "Fundamentals of Electric Drives", 2nd Ed., Narosa Publishing House.	2007
2.	Pillai S. K., "A First Course in Electric Drives", 2nd Ed., New Age International Private Limited.	2008
3.	Sen P. C., "Thyristor DC Drives", John Wiley and Sons.	1991
4.	Dubey G. K., "Power Semiconductor Controlled Drives", Prentice Hall International Edition.	1989
5.	Murphy J. M. D. and Turnbull F. G., "Power Electronics Control of AC Motors", Peragmon Press.	1990
6.	Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-303** Course Title: **Power Electronics**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:2**

4. Relative Weight**:** **CWS:20** **PRS:20** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:4** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-106 and EE-203**

9. Objective:

The course aims at familiarizing the students with the operating characteristics of semiconductor devices, triggering circuits and their applications for power control. The course also deals with the detailed analysis and operation of power controllers.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Solid State Power Devices:** Principle of operation of SCR, dynamic characteristic of SCR during turn ON and turn OFF, parameters of SCR, dv/dt and di/dt protection, snubber circuit, commutation circuits; Heat sink design.	**7**
2.	**Modern Power Devices:** Principle of operation of MOSFET, IGBT, GTO, MCT, SIT, SITH, IGCT, their operating characteristics.	**2**
3.	**Single-phase Converter**: Half wave converter, 2-pulse midpoint converter, half controlled and fully controlled bridge converters, input current and output voltage waveforms, effect of load and source impedance, expressions for input power factor, displacement factor, harmonic factor and output voltage, effect of free-wheeling diode, triggering circuits.	**6**
4.	**Dual Converter**: Control principle, circulating current and circulating current free modes of operation of single-phase dual converter.	**2**

S. No.	Contents	Contact Hours
5.	**Three-phase Converter:** Half wave, full wave, half controlled and fully controlled bridge converters, effect of load and source impedance, expressions for input power factor, displacement factor, harmonic factor and output voltage,	**6**
6.	**A.C. Regulator:** Principle of operation of single-phase ac regulator, effect of load inductance, firing pulse requirement.	**2**
7.	**AC-AC Converters:** Principle of operation of cycloconverter, waveforms, control technique; Introduction of matrix converter.	**3**
8.	**DC-DC Converters:** Principle of operation of single quadrant chopper, continuous and discontinuous modes of operation; Voltage and current commutation, design of commutating components; Introduction to SMPS.	**5**
9.	**Inverters:** Voltage source and current source inverters, Principle of operation of single-phase half bridge and full bridge voltage source	**9**

	inverters, voltage and current waveforms; Three-phase bridge inverter, 120^0 and 180^0 modes of operation, voltage and current waveforms with star and delta connected RL load; Voltage and frequency control of inverters; PWM techniques-single pulse, multiple pulse, selective harmonic elimination, sinusoidal PWM.	
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors /Books / Publishers**	**Year of Publication/ Reprint**
1.	Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., "Thyristorised Power Controllers", New Age International Private Limited.	2008
2.	Mohan N., Undeland T. M. and Robbins W. P., "Power Electronics-Converters, Applications and Design", 3rd Ed., Wiley India.	2008
3.	Rashid M. H., "Power Electronics Circuits Devices and Applications", 3rd Ed., Pearson Education.	2008
4.	Lander C. W., "Power Electronics", 3rd Ed., McGraw-Hill International Book Company.	2007
5.	Ramshaw R.S., "Power Electronics Semiconductor Switches", Chapman & Hall.	1993

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-304** Course Title: **Protection and Switchgear**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:2**

4. Relative Weight**:** **CWS:15** **PRS:25** **MTE:20** **ETE:40** **PRE:00**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-206**

9. Objective:

To introduce the concept and necessity of protection in generation and transmission, and applications of switchgears including internal operation of different types of circuit breakers.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Various types of electromechanical relays, construction and principle of operation and characteristic, applications and limitations; Over and under current, directional, differential, distance and other types of relay; Concept of static relays; Protection system and properties; Introduction to numerical relays.	**8**
2.	Protection of transmission lines using overcurrent, differential, directional-overcurrent and distance relays, back-up protection, carrier relaying; Busbar protection.	**6**
3.	Protection of transformers against internal faults such as short circuit and turn-to-turn fault using differential and overcurrent relays, protection for other abnormal conditions.	**6**
4.	Protection of generators against short circuit and turn-to-turn fault, stator ground fault, field ground fault, loss of excitation, loss of synchronism using different types of relays.	**6**
5.	Switchgear, arc and interruption theory, application in different conditions, ratings and selection, principle of operation of air break, oil filled, air blast, vacuum and SF_6 circuit breakers, elementary idea of testing methods.	**12**

S. No.	Contents	Contact Hours
6.	Necessity of grounding of system neutral and substation equipments, methods of grounding.	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Van A. R. and Warrington C., "Protective Relays - Theory and Practice", Vol. I and II, 3rd Ed., Chapman and Hall.	1982
2.	Mason C. R., "The Art and Science of Protective Relaying", Wiley Eastern Limited.	1987
3.	Ray S., "Electrical Power Systems: Concepts, Theory and Practice", Prentice Hall of India Private Limited.	2008
4.	Ravindranath B. and Chander M., "Power System Protection and Switchgear", New Age International Private Limited.	2008
5.	Paithankar Y. G. and Bhide S. R., "Fundamentals of Power System Protection", Prentice Hall of India Private Limited.	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-305** Course Title: **Advanced Control Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 2**

3. Examination Duration (Hrs.): **Theory :3** **Practical :3**

4. Relative Weight**:** **CWS:15** **PRS:25** **MTE:20** **ETE:40** **PRE:00**

5. Credits**:5** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-205**

9. Objective:

To familiarize students with classical and modern control systems including non-linear systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**State Variable Approach:** Derivation of state model of linear time invariant (LTI) continuous systems, transfer function from ordinary differential equations, canonical variable diagonalization, system analysis by transfer function and state space methods for continuous systems convolution integral; State transition matrices and solution of state equations for continuous and discrete time systems.	**8**
2.	**Discrete Data Systems:** Introduction to discrete time systems, sample and hold circuits, pulse transfer function, representation by difference equations and its solution using z-transform and inverse-z transforms, analysis of LTI systems, unit circle concepts; Stability criterion.	**10**
3.	**Controllability and Observability:** Concept of controllability and observability, definitions, state and output controllability and observability tests for continuous and discrete systems, controllability and observability of time varying systems.	**8**
4.	**Model Control:** Introduction, effect of state feedback on controllability and observability, design via state feedback full order observer, reduced order observers design of state observers and controllers.	**8**

S. No.	Contents	Contact Hours
5.	**Non Linear Systems:** Types of non linearity, limit cycles, jump resonance, linearization techniques; Perturbation methods: phase plane and describing function analysis; Stability concepts, Lyapunov functions for linear and non linear systems.	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Nagrath I. J. and Gopal M., "Control System Engineering", 5th Ed., New Age International Private Ltd. Publishers.	2008
2.	Kuo B. C., "Automatic Control Systems", 8th Ed., Wiley India.	2008
3.	Ogata K., "Modern Control Engineering", 4th Ed., Pearson Education.	2008
4.	Dorf R. C. and Bishop R. H., "Modern Control Systems" Pearson Education.	2008
5.	Norman S. N., "Control Systems Engineering", 4th Ed., Wiley India.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-101** Course Title: **Introduction to Electrical Engineering**

2. Contact Hours: **L: 2** **T: 0** **P: 0**

3. Examination Duration (Hrs.): **Theory** 0 **Practical** 0

4. Relative Weight**:** **CWS** 0 **PRS** 0 0 100 0

5. Credits**:** 2 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: NIL**

9. Objective:

To introduce the fundamentals of Electrical Engineering including energy resources, generation, transmission, distribution and utilization of electrical energy.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Energy Resources:** Conventional and non-conventional energy resources; Availability of resources; Principle of energy conversion and its utilization; National and International energy trends; Global warming and greenhouse effects.	**3**
2.	**Generation:** Generation of electrical power, synchronous generator; Conventional power generation - Hydro, Thermal, Nuclear and Gas Power; Renewable energy generation; Generated voltage waveform, voltage and frequency level; Governor and Excitation System.	**4**
3.	**Transmission:** Purpose of transmitting power, AC transmission voltage levels; Power transformer; Transmission lines, single line diagram of power transmission network; Protective Equipments used in the network; Types of faults; Transmission substation; HVDC Transmission.	**4**
4.	**Distribution:** Distribution network and substation; single line diagram of distribution network; Distribution transformer; Overhead lines and underground cables; Protective equipment, grounding and earthing.	**4**

5.	**Utilization:** Types of load- Heating, motor, traction, lighting and fans; Load characteristics; Consumer loads; Power electronic equipment.	**5**
6.	**Metering:** Active and reactive power, apparent power, voltage, current and power measurement; Energy meters.	**3**
7.	**Electrical Wiring Concepts:** Residential wiring diagram, symbols of switches, fuse, rheostat, SPDT, DPDT, contacts, contactors, MCB.	**3**
8.	**Power Quality and Control**: Nature of non linear loads; Problems due to non-sinusoidal current; Use of electronics, microprocessor and digital signal processing in control.	**2**
	Total	**28**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	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**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-102** Course Title: **Network Theory**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical : 0**

4. Relative Weight**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: NIL**

9. Objective: To introduce the fundamentals of network analysis using matrices, two-port and multi-port networks, and network synthesis.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Network Theorems:** AC & DC circuits; Thevenin's, Norton's, superposition and maximum power transfer theorems; Compensation, reciprocity and Tellegen's theorems.	**6**
2.	**Network Topology:** Concept of network graphs, tree, link, cut set, network matrices, node incidence matrix, loop incidence matrix, cut set incidence matrix, network analysis using network incidence matrices.	**6**
3.	**Transient Network Analysis:** Response of RL, RC and RLC networks using Laplace Transforms for unit step, impulse and ramp inputs**.**	**6**
4.	**Network Functions:** Driving point impedances; Transfer functions of networks.	**2**
5.	**Two Port Networks and their Characterization:** Open circuit, short circuit, hybrid and transmission parameters; Series, parallel and tandem connections of two-port networks, multi-port networks, multi-terminal networks; Indefinite admittance matrix and its properties.	**6**
5.	**Three-Phase A.C. Circuit Analysis:** Analysis of balanced and unbalanced three-phase networks; Symmetrical components and their application in analysis of unbalanced networks; Analysis of A.C. circuits with non-sinusoidal inputs	**8**
6.	**Network Synthesis:** Poles and zeros of network functions, positive real functions and their properties, tests for positive real functions, Hurwitz polynomials; Driving-point synthesis of LC, RC and RL networks, Foster forms and Cauer forms.	**6**
7.	**Introduction to Computer Aided Network Analysis:** Analysis of linear and non-linear networks, concept of companion network model; Computer aided transient network analysis.	**2**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Desoer C. A. and Kuh E. S., "Basic Circuit Theory", McGraw Hill International Book Company.	1984
2.	DeCarlo R. A. and Lin Pen-Min, "Linear Circuit Analysis", 2nd Ed., Oxford University Press.	2001
3.	Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw-Hill Publishing Company Ltd.	2008
4.	Director S. W., "Circuit Theory: A Computational Approach", 2nd Ed., John Wiley and Sons Inc.	1993
5.	Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition.	2007
6.	Kuo F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-103** Course Title: **Programming in C++**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 15 30 40 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: ESC**

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 Course:

S. No.	Contents	Contact Hours
1.	**Basic Computer Fundamentals**: Introduction to computer systems - CPU organization, ALU, registers, memory and input-output devices; Number system: Binary and Hexadecimal, addition and subtraction.	3
2.	**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.	8
3.	**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	10

	style, naming conventions, comments.	
S. No.	**Contents**	**Contact Hours**
4.	**Aggregate Data-types**: Arrays and pointers; Structures; Dynamic data and pointers, dynamic arrays.	**4**
5.	**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; Use of pointers in linked arrays.	**10**
6.	**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 / Books / Publishers	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 DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-104** Course Title: **Electrical Measurements and Measuring Instruments**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory : 3** **Practical : 2**

4. Relative Weight**:** **CWS : 15** **PRS: 15** **MTE: 15** **ETE: 40** **PRE: 15**

5. Credits**: 4** 6. Semester **: Spring** 7. Subject Area **: DCC**

8. Pre-requisite**: NIL**

9. Objective: To impart knowledge of principles of measurement of electrical quantities, construction and operating principles of electrical instruments, their static and dynamic characteristics, and errors in measurement.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** SI units, static and dynamic characteristics of electrical instruments.	**3**
2.	**Galvanometers:** Galvanometer equation in dc and ac measurements; D'Arsonval, vibration and ballistic type galvanometers.	**4**
3.	**Ammeters, Voltmeters and Wattmeters:** Review of PMMC and moving iron instruments; Electro-dynamic and electrostatic meters; Induction wattmeters, errors and their compensation, multi-element wattmeter.	**6**
4.	**Energy Meters:** Induction energy meter, calibration devices, errors and their compensation, polyphase energy meter, testing; IS codes.	**3**
5.	**Special Meters:** Maximum demand indicator, power factor and frequency meters.	**4**
6.	**Potentiometer:** Review of dc potentiometer; Polar and coordinate ac potentiometers.	**4**
7.	**Resistance Measurement:** Measurement of low, medium and high resistances, measurement of volume and surface resistivity.	**4**
8.	**A.C. Bridges :** General principles, sensitivity analysis; Hay, Owen and Heavyside Campbell bridges for inductance; De Sauty and Wein bridges for capacitance; T and P type high-frequency bridges; High-voltage Schering bridge and grounding.	**7**
9.	**Instrument Transformers:** Construction, phasor diagrams, error analysis and compensation, testing and application of measuring CT and VT; IS codes.	**4**

10.	**Magnetic Measurements:** Determination of hysteresis loop and permeability, measurement of iron-loss.	**3**
	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.	Harris F. K., "Electrical Measurement", Wiley Eastern Private Limited.	1974
3.	Stout M. B., "Basic Electrical Measurements", Prentice Hall of India Private Limited.	1984
4.	Doebelin E. O., " Measurement Systems: Application and Design ", 5th Edition, Tata McGraw Hill.	2004
5.	Tumanski S., " Principles of Electrical Measurement ", CRC Press, Taylor and Francis.	2006
6.	Morris A. S., " Measurements and Instrumentation Principle", 3rd Edition, Butterworth-Heinemann.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-106** Course Title: **Analog Electronics**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 2**

4. Relative Weight**:** **CWS: 15** **PRS: 15** **MTE: 15** **ETE: 40** **PRE: 15**

5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: DCC**

8. Pre-requisite**: Nil**

9. Objective: The course aims at familiarizing the students with the concepts of electronic devices, their operating characteristics and circuits for their engineering applications.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Diode:** Review of semiconductors, p-n junction, forward and reverse biased junction, equivalent circuits; Applications - rectifier, clipper, clamper, voltage doubler, transfer characteristics; Zener diode; Power supply, filter, zener regulator; Special purpose diodes.	**5**
2.	**Bipolar Junction transistors:** npn and pnp transistors, input and output characteristics - cut-off, saturation and active regions; CE, CE and CC configurations, small signal model, BJT as amplifier; Biasing circuits; Stability analysis, DC and AC equivalent circuits.	**7**
3.	**Small-signal Analysis:** h-parameter model of BJT, analysis of BJT amplifier circuits, cascaded amplifiers, frequency response of RC-coupled amplifier.	**4**
4.	**Power Amplifiers**: DC and AC load lines; Class A operation; Class B operation, push-pull circuit; Biasing circuits, Class C amplifier; Current source	**3**
5.	**Field Effect Transistor**: Operating characteristic, transductance, JFET as amplifier, biasing circuits; Applications.	**5**
6.	**Operational Amplifier:** Differential amplifier, level shifter, output stage and parameters of OPAMP; Applications of OPAMP: inverting and non inverting amplifier, active filters- low pass, high pass, band pass, active diode, active full wave rectifier, clipper, clamper, waveform generator circuits – square, triangular and sine wave generator.	**11**
7.	**Oscillators:** Barkhausen criterion, damped oscillation in LC circuits; Harmonic oscillators- RC-phase shift oscillator, transistor	**4**

	phase shift oscillator, Wein's bridge oscillator; Tuned oscillator- Colpitts oscillator, Hartley oscillator; Crystal oscillator ; ;	
8.	**Voltage Regulators:** Zener voltage regulator, emitter follower regulator, series voltage regulator, IC regulator	**3**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Boylestad R. and Nashelsky L., "Electronic Devices and Circuit Theory", 10th Ed., Prentice Hall of India Private Limited.	2009
2.	Gayakward R. A., "OP-AMPs and Linear Integrated Circuit Technology", 4th Ed., Penguin Books Ltd.	2009
3.	Millman J., and Grabel A., "Microelectronics", McGraw Hill Higher Publication, 2nd Edition.	1988
4.	Schilling D. and Belove C., "Electronic Circuits- Discrete and Integrated", McGraw Hill, 3rd Edition.	2002
5.	Malvino A. and Bates D., "Electronic Principles", Tata McGraw Hill Publishing Company, 7th Edition.	2006
6.	Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw Hill, 3rd Edition.	2001

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-201** Course Title: **Electrical Machines-I**

2. Contact Hours: **L: 3** **T: 1** **P: 2**

3. Examination Duration (Hrs.): **Theory:3** **Practical:3**

4. Relative Weight**:** **CWS:15** **PRS:25** **MTE:20** **ETE:40** **PRE:0**

5. Credits**:5** 6. Semester**: Autumn** 7. Subject Area**: DCC**

8. Pre-requisite**: EE-102 or EE-112**

9. Objective:

The course aims at giving the fundamentals of energy conversion in electromechanical systems, construction and operation of dc machines in motoring and generating modes. The course also deals with the magnetizing characteristics and operation of three-phase transformers.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Principle of Electromechanical Energy Conversion:** Energy stored in electric and magnetic fields, energy conversion in single and multi-excited systems and torque production, reluctance torque; Reluctance and hysteresis motors.	**4**
2.	**General Description of Electrical Machines:** Constructional details of dc and ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machines, mmf distribution of current carrying single and multiple coils; Armature winding as a current sheet, associated mmf and flux density waves; Harmonic analysis of induced voltage; Torque as a function of flux and mmf.	**6**
3.	**DC Machines:** Simplex lap and wave windings, emf and torque equations, interaction of the fields produced by field and armature circuits.	**5**
4.	**Commutation**: Causes of bad commutation, methods of improving commutation, effect of brush shifts; Compensating winding; Interpole winding.	**4**
S. No.	**Contents**	**Contact Hours**
5.	**DC Generators**: Methods of excitation, shunt, series and compound generators, characteristics, testing.	**4**
6.	**DC Motors**: Methods of excitation, characteristics, starting and speed control methods; Losses and their estimation, efficiency.	**6**

7.	**Single-phase Transformers**: Principle of operation, equivalent circuit, voltage regulation and efficiency; Parallel operation.	**4**
8.	**Three-phase Transformers**: Various connections and their comparative features, harmonics in emf and magnetizing current, effect of connections and construction on harmonics; Parallel operation of three-phase transformers, sharing of load, 3-phase to 2-phase conversion, 3-phase to 6-phase conversion.	**6**
9.	**Autotransformers:** Principle of operation and comparison with two winding transformer	**3**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Fitzgerald A. E., Kingsley C. and Kusko A., "Electric Machinery", 6th Ed., McGraw-Hill International Book Company.	2008
2.	Say M. G., "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors.	2005
3.	Say M. G. and Taylor E. O., "Direct Current Machines", 3rd Ed., ELBS and Pitman.	1986
4.	Nagrath I. J. and Kothari D. P., "Electrical Machines", 3rd Ed., Tata McGraw-Hill Publishing Company Limited.	2008
5.	Clayton A. E. and Hancock N., "The Performance and Design of DC Machines", CBS Publishers and Distributors.	2003
6.	Langsdorf A. S., "Theory of AC Machines", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Mechanical & Industrial Engineering**

1. Subject Code: **MIN-106** Course Title: **Engineering Thermodynamics**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weightage: **CWS: 15** **PRS: 15** **MTE: 30** **ETE: 40** **PRE: 0**

5. Credits: **4** 6. Semester: **Both** 7. Subject Area: **DCC/ESC**

8. Pre-requisite: **Nil**

9. Objective: To familiarize the students with basic concepts of macroscopic thermodynamics.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Introduction to thermodynamic system, surrounding, state, process, properties, equilibrium, heat and work, Zeroth Law of Thermodynamics	**3**
2.	**Properties of Pure Simple Compressible Substance:** PvT surface, Pv, Tv, TP diagrams. Equation of state for ideal and real gases. Virial equation of state, van der Waal equation, use of steam tables and Mollier diagram	**6**
3.	**First Law of Thermodynamics:** First law application to non-flow processes such as isochoric, isobaric, isothermal, adiabatic and polytropic processes. Steady flow energy equation, flow work. Application to various practical systems viz. nozzles, diffuser, turbines, heat exchangers etc. Application of energy equation to transient flow problems.	**7**
4.	**Second Law of Thermodynamics:** Second law, reversible and irreversible processes, Clausius and Kelvin Planck statements, Carnot cycle, corollaries of second law: thermodynamic temperature scale, Clausius inequality, entropy as a property, principle of increase of entropy. Calculation of entropy change.	**6**
5.	**Entropy and Exergy:** Entropy and its generation, entropy balance for closed system and for control volume, basic concepts of exergy and irreversibility, exergy for closed system and control volume, exegetic efficiency.	**5**

6.	**Gas-Vapour Mixtures and Air-conditioning:** Properties of gas-vapour mixtures, adiabatic-saturation and wet-bulb temperatures, psychrometric chart, human comfort and air conditioning, various air conditioning processes.	**4**
7.	**Gas and Vapour Power Cycles:** Otto, Diesel, Dual, Stirling, Joule-Brayton cycle. Thermal efficiency and mean effective pressure, Rankine cycle.	**5**
8.	**Refrigeration Cycles:** reverse Carnot cycle, vapour compression refrigeration cycle.	**4**
	TOTAL	**42**

List of Experiments:

1. Study of P-V-T surface of H_2O and CO_2.
2. Determine P-T relationship for steam and verify Clausius Clapeyron equation.
3. Determine the calorific value of coal using Bomb calorimeter.
4. Analysing exhaust gases using Orsat apparatus.
5. Determine Relative Humidity and Specific Humidity of air using Sling Psychrometer and Psychrometric Chart.
6. Determine COP of a vapour compression refrigeration unit.
7. Analysing different processes on an air conditioning unit.

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Borgnakke, C. and Sonntag, R.E., " Fundamentals of Thermodynamics," Wiley India	2011
2.	Cengel, Y.A. and Boles, M.A., "Thermodynamics an Engineering Approach", Tata McGraw-Hill	2008
3.	Moran, M.J. and Shapiro, H.M., "Fundamentals of Engineering Thermodynamics", 4th Ed., John Wiley	2010
4.	Russel, L.D., Adebiyi, G. A.," Engineering Thermodynamics", Oxford University Press	2007
5.	Arora, C.P., "Thermodynamics", Tata-McGraw Hill	2001
6.	Nag, P.K., "Engineering Thermodynamics", Tata-McGraw Hill	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN- 522** Course Title**:** **Biomedical Instrumentation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-308 and EE-309 or equivalent**

9. Objective:

To familiarize students with various types of biomedical instrumentation systems being used in clinical laboratory, in medical imaging, in biotelemetry, in prosthetic, orthotic, assisting and therapeutic devices.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Human Body Subsystems:** Brief description of neuronal, muscular, cardiovascular and respiratory systems, their electrical, mechanical and chemical activities.	4
2.	**Transducers and Electrodes:** Principles and classification of transducers for Biomedical applications; Electrode theory, different types of electrodes.	4
3.	**Cardiovascular System Measurements:** Measurement of blood flow, blood flow, cardiac output, cardiac rate, heart sounds; Electrocardiograph; Phonocardiograph; Plethysmograph; Echo-cardiograph.	4
4.	**Respiratory System Measurements:** Measurement of gas volume, flow rate, carbon-dioxide and oxygen concentration in exhaled air.	4
5.	**Instrumentation for Clinical Laboratory:** Measurement of pH value of blood, ESR measurement, haemoglobin measurement, O_2 and CO_2 concentration in blood, GSR measurement, polarographic measurements.	4

S. No.	Contents	Contact Hours
6.	**Measurement of Electrical Activity in Neuromuscular System and Brain:** Neuron potential, muscle potential, electromyograph, brain potentials, electroencephalograph.	**4**
7.	**Medical Imaging:** Diagnostic X-rays, CAT, MRI, thermography, ultrasonography, medical use of Isotopes, endoscopy.	**4**
8.	**Patient Care, Monitoring and Safety Measures**	**2**
9.	**Computer Applications and Bio-Telemetry:** Real time computer applications, data acquisition and processing.	**3**
10.	**Prosthetics and Orthotics:** Introduction to artificial kidney, artificial heart, heart lung machine, limb prosthetics and orthotics Elements of audio and visual aids.	**4**
11.	**Assisting and Therapeutic Devices:** Introduction to cardiac pacemakers, defibrillators, ventilators, muscle stimulators, diathermy.	**3**
12.	**Lasers:** Application of lasers to biomedical sciences.	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Geddes L. A. and Baker L. E., "Principles of Applied Biomedical Instrumentation", John Wiley and Sons.	**1989**
2.	Khandpur R. S., "Handbook on Biomedical Instrumentation", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
3.	Cromwell L., Weibell F. J. and Pfeifer E. A., "Biomedical Instrumentation and Measurements", Prentice Hall of India Private Limited.	**2003**
4.	Aston R., "Principles of Biomedical Instrumentation and Measurements", Macmillian.	**1991**
5.	Antoui H., Chilbert M. A., and Sweeny J. D., "Applied Bioelectricity", Springer-Verlag.	**1998**
6.	Hill D. W. and Dolan A. M., "Intensive Care Instrumentation", Academic Press.	**1982**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-523** Course Title**:** **Intelligent Sensors and Instrumentation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weight**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-308 and EE-309 or equivalent**

9. Objective of course:

To familiarize students with the state of art of smart, intelligent and network sensors, and instrumentation systems and their design.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review:** Sensor, actuator and transducer; Classification of sensors on the basis of energy source and type of output signals; Signal conditioning; Meaning and types of smart sensors.	**4**
2.	**Smart Sensor Technologies:** Thick-film, thin-film and monolithic IC technologies and their use in making smart sensors; Bulk and surface micromachining technologies, wafer bonding, LIGA process, plasma etching, and their use in making smart sensors; Examples.	**5**
3.	**MEMS Sensors:** Concept and methods of making MEMS devices, sensors and actuators; Examples.	**2**
4.	**Intelligent and Network Sensors:** Concept and architecture of intelligent sensors; Concept and architecture of network sensors; Examples.	**2**
5.	**Sensor Networking:** 7-Layer OSI model of communication system, device-level networks, introduction to protocols and technologies for wired and wireless LANs; Ethernet, RS-485 and Foundation Fieldbus protocols; Wi-Fi; Zigbee and Bluetooth protocols; Concept of adhoc networks; Smart Transducer Interface Standard IEEE 1451.	**12**

S. No.	Contents	Contact Hours
6.	**Intelligent Instrumentation:** Introduction meaning and advantages; Microprocessor application techniques; I/O techniques; Interfacing of I/O devices; Examples.	**12**
7.	**Future Trends:** Neurosensors; Biosensors; Nano-technology; Soft-computing techniques in instrumentation.	**5**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Fraden J., "Handbook of Modern Sensors: Physics, Design and Applications", AIP press.	**2003**
2.	Frank R., "Understanding Smart Sensors", Artech House publishers.	**2000**
3.	Yamasaki H., "Intelligent Sensors", Elsevier Eastern Limited.	**1996**
4.	Ramon P. A. and Webster J. G., "Sensors and Signal Conditioning" 2nd Ed., John Wiley and Sons.	**2001**
5.	Feng Z. and Leonidas G., "Wireless Sensor Networks", Elsevier Eastern Limited.	**2007**
6.	Barney G., "Intelligent Instrumentation", Prentice-Hall International Editions.	**1988**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-540** Course Title: **Advanced Power Electronics**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 20 **PRS** 20 20 40 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: MSC**

8. Pre-requisite**: EE-206 or equivalent**

9. Objective:

To impart knowledge of modern semiconductor devices and their applications in power electronic controllers for rectification, inversion and frequency conversion with improved performance.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Review of SCR, driving circuits and protection; Modern semiconductor devices: MOSFET, GTO, IGBT, GTO, SIT, SITH, MCT, their operating characteristics; Heat sink design.	**3**
2.	Three-phase converters, effect of load and source impedances; Dual converter, twelve-step converter, multi-pulse converters.	**5**
3.	PWM converter, power factor improvement techniques.	**5**
4.	Voltage and current commutated choppers, dc-dc converters: buck converter, boost converter, Cuk converter.	**4**
5.	Three-phase ac regulators, operation with resistive load.	**3**
6.	Single-phase and three-phase Cyclo-converters; Matrix converters.	**2**
7.	Review of line commutated and forced commutated inverters, three-phase voltage source inverters, voltage and frequency control.	**2**
8.	Harmonic reduction techniques, PWM inverters, Space Vector Modulation.	**6**
9.	Multi-level inverters, advantages, configurations: Diode clamped, flying capacitor and cascade multi-level inverters, applications.	**3**

S.No.	Contents	Contact Hours
10.	Current source inverters, commutation circuits, transient voltage suppressing techniques	**3**
11.	DC link resonant converters, operation and control.	**3**
12.	MATLAB simulation of power electronic converters.	**3**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Dubey G. K., Doradla S. R., Joshi A. and Sinha R. M. K., "Thyristorised Power Controllers", New Age International Private Limited.	**2008**
2.	Mohan N., Underland T.M. and Robbins W.P., "Power Electronics – Converters, Applications and Design", 3rd Ed., Wiley India.	**2008**
3.	Bose B.K., "Power Electronics and Variable Frequency Drives – Technology and Applications", IEEE Press, Standard Publisher Distributors	**2001**
4.	Lander C. W., "Power Electronics", 3rd Ed., McGraw-Hill International Book Company.	**2007**
5.	Rashid M., "Power Electronics- Circuits, Devices and Applications", 3rd Ed., Pearson Education.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-541** Course Title: **Analysis of Electrical Machines**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: PCC**

8. Pre-requisite**: Electrical Machines**

9. Objective:

The objective of the course is to present a general theory of rotating electrical machines applicable to all normal types of machines and to all condition of operation. Students will be taught development of mathematical model of the 3-phase balanced induction machine and synchronous machine in arbitrary reference frame and in field oriented reference frame for transient and steady-state performance of ac machines.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	Generalized transformations, Physical model, Different reference frame, Primitive machine, dynamic variable, Formulation of dynamic equations of a generalized machine in arbitrary reference frame	**10**
2.	Analysis of induction machines, Space vector, induction motor modeling in arbitrary reference frame and in field oriented frame, Performance analysis	**12**
3.	Analysis of synchronous machine, Modeling, Operational impedances, Time constants, torque expression, Asynchronous damping,	**8**
4.	Steady state and transient performance, Phasor diagram and power angle characteristics,	**6**
5.	Symmetrical and asymmetrical short circuit analysis, Measurement of reactances and time constants	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Concordia, Charles, "Synchronous Machines- Theory and Performance", Wiley, New York.	**1989**
2.	Kimbark E.W., Power System Stability: Synchronous Machines", Vol.3, Cover Publication, New York.	**1976**
3.	Adkins B., Harley R.G., "The Generalized Theory of Alternating Current Machines", Chapman & Hall, London.	**1979**
4.	Leonard W., "Control of Electrical Drives", 3rd Edition. Springer Press, New York.	**2002**
5.	Murphy J.M.D., Turnbull F.G., "Power Electronics Control of AC Motors", Pergamon Press, New York.	**1988**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-542** Course Title: **Advanced Electric Drives**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 20 **PRS** 20 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: MSC**

8. Pre-requisite**: EE-541 or equivalent**

9. Objective:

To provide state-of-the-art speed control techniques used in modern ac drives, fed from LCI/VSI/CSI, for superior high-performance requirements.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**Review**: Power electronic converters for ac drive control, voltage source and current source inverters.	**3**
2.	**LCI-IM Drive:** Drive configuration, commutation at different speeds, mathematical modeling, control structure, resonance problem and performance.	**5**
3.	**FOC-IM Drive:** Drive configuration, mathematical modeling, direct and indirect FOC, influence of parameters, VSI and CSI fed schemes, adaptive drive control.	**7**
4.	**Brushless DC Drive:** Self control, CSI with load commutation, low speed commutation, inverter control strategies and performance.	**5**
5.	**Permanent Magnet SM Drive:** Principle of operation, converter configuration, synchronization, trapezoidal and sinusoidal drive control structures and performance.	**6**
6.	**Switched Reluctance Motor Drive:** Principle of operation, converter circuits, sensors, speed control and performance.	**5**
7.	**Resonant-Link Converter fed Drive:** Principle of soft switching in inverters and converters utilizing resonant circuits, modulation strategies and application in IM drives.	**5**

S.No.	Contents	Contact Hours
8.	**Advanced Control Techniques:** Application of modern and evolutionary techniques in drives such as fuzzy and ANN control.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Dubey G. K., "Power Semiconductor Controlled Drives", Prentice-Hall International Editions.	**1989**
2.	Murphy J. M. D. and Turnbull F. G., “Power Electronics Control of AC Motors”, Peragmon Press.	**1990**
3.	Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.	**2001**
4.	Krishnan R., “Electric Motor Drives – Modeling, Analysis and Control”, Prentice Hall of India Private Limited.	**2007**
5.	Bose B. K., “Modern Power Electronics and AC Drives”, Pearson Education.	**2008**
6.	Leonard W., “Control of Electric Drives”, Springer Press.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-543** Course Title: **FACTS Devices**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: MSC**

8. Pre-requisite**: EE-206 and EE-301 or equivalent**

9. Objective:

To familiarize students with FACTS devices, their control techniques and applications in enhancement of system dynamic and transient stability.

10. Details of Course:

S.No.	Contents	Contact Hours
1.	**FACTS**: Concept, power flow and stability, basic theory of line compensation	**4**
2.	**Power Electronic Controllers:** Review of PWM voltage source inverters used in FACTS, classifications of FACTS controllers.	**4**
3.	**Static Shunt Compensators:** SVC and STATCOM - TCR, TSC, system stability.	**6**
4.	**Static Series Compensators:** GCSC, TSSC, TCSC and SSSC, control techniques.	**6**
5.	**Static Voltage and Phase Angle Regulators**: Power flow control, TCVR and TCPAR.	**4**
6.	**Unified Power Flow Controller (UPFC)**: Concept of power flow control, operation and control of UPFC, Interline Power Flow Controller.	**4**
7.	**Stability Analysis:** Modeling of FACTS devices, optimization of FACTS, transient and dynamic stability enhancement	**8**
8.	**Applications:** Principle of control of FACTS in HVDC links, co-ordination of FACTS devices with HVDC links.	**3**

S.No.	Contents	Contact Hours
9.	**Other Topics:** Advanced FACTS devices, case studies and other applications of FACTS controllers.	**3**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Miller T. J. E., "Reactive Power Control in Electric Systems," Wiley-Interscience.	**1982**
2.	Song Y. H. and Johns A. T., "Flexible AC Transmission Systems (FACTS)", IEE Press.	**2000**
3.	Hingorani N. G. and Gyugyi L., "Understanding FACTS", IEEE Press, Standard Publishers Distributors.	**2001**
4.	Ghosh A. and Ledwich G., "Power Quality Enhancement Using Custom Power Devices," Kluwer Academic Publishers.	**2002**
5.	Mathur R. M. and Varma R. K., "Thyristor – Based FACTS Controllers for Electrical Transmission Systems," John Wiley and Sons.	**2002**
6.	Padiyar K. R., "FACTS Controller in Power Transmission and Distribution", New Age International Private Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EE-617** Course Title**:** **Instrumentation in Electric Drives**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-304 or equivalent**

9. Objective:

To impart knowledge of instrumentation related to electric drive parameters and their signal conditioning circuits using linear/analog and digital integrated circuits.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Transducers and sensors, definitions, classification of errors,.	**3**
2.	Review of characteristics and parameters of transducers: tachometers, shaft-encoders, torque sensors, Hall-effect sensors, and magnetic pick-ups.	**5**
3.	Devices for instrumentation, design characteristics and typical applications of instrumentation, operational trans-conductance, isolation amplifiers, analog multipliers and dividers, function generators, timers, analog multiplexers.	**8**
4.	Sample and hold, optical and magnetic isolators; Frequency to voltage converters, temperature to current converters.	**4**
5.	Review of A/D and D/A converters, specifications, multiplexed ADC, multiplying ADC; Data acquisition system.	**4**
6.	Instrumentation and signal processing.	**3**
7.	Basic concept of PLL system, definitions of lock-in-range, capture-range, loop gain, design aspects of phase detector, loop filter, PLL based motor speed control.	**6**

S. No.	Contents	Contact Hours
8.	Drive related signals and their instrumentation and conditioning.	**3**
9.	Data acquisition system, basic structure, data acquisition of voltage, currents, speed, temperature, torque and flux.	**6**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Cerni, R. H. and Foster L. E., "Instrumentation for Engineering Measurement", John Wiley and Sons.	**1966**
2.	Coughlin R. F. and Driscoll F. F., "Operational Amplifier and Linear Integrated Circuits", Prentice Hall of India Private Limited.	**2008**
3.	Norton N., "Handbook of Transducers", Prentice Hall International Edition.	**2004**
4.	Hamilton T. D. S., "Handbook of Linear Integrated Electronics", McGraw-Hill International Book Company.	**1977**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-561** Course Title**:** **Power System Operation and Control**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-301 or equivalent**

9. Objective:

To introduce the engineering and economic aspects of planning, operation, controlling power generation and transmission systems in electric utilities.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	General characteristics of modern power systems, evolution, structure, power system control, operating states of a power system and control strategies, economic load dispatch, function and applications, price based unit commitment problem.	**8**
2.	Concept of reactive power, control of active power and reactive power - active power and frequency control, reactive power flow analysis, real power balance and its effect on system frequency; Static VAR systems, types of SVC, fundamental frequency performance of SVC, application of SVC.	**8**
3.	Automatic generation control (AGC), generation control loops, load frequency control, AGC, tie-line bias control, AGC in isolated and interconnected power systems, AGC with economic dispatch.	**10**
4.	Elements of an excitation system, types of excitation systems, dc, ac, static and recent developments and future trends, dynamic performance measures, large signal, small signal, control and protective functions, ac and dc regulators, design of robust controllers in power systems.	**8**

S. No.	Contents	Contact Hours
5.	Division of power system into control areas, load-frequency control of single area and two area system - optimum control criterion, two area and multi-areas power system with and without integral control, SCADA systems, supervisory control, supervisory master stations, remote terminal units, communication links, SCADA systems applications in power networks.	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Elgerd O. I., "Electric Energy Systems Theory – An Introduction", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
2.	Nagrath I. J. and Kothari D. P., "Power System Engineering", 2nd Ed., Tata Mc-Graw Hill Publishing Company.	**2008**
3.	Grainger J. J. and Stevenson W. D., "Power System Analysis", Tata McGraw-Hill Publishing Company Limited.	**2008**
4.	Wood A. J. and Wollenberg B. F., "Power Generation, Operation and Control", Second Edition, Willey – Inter Science Publications.	**2008**
5.	Kundur P. and Balu N. J., "Power System Stability and Control", EPRI Series, McGraw-Hill International Book Company.	**1998**
6.	Saadat H., "Power System Analysis", 1st International Edition, Tata McGraw-Hill Publishing Company Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-563** Course Title**:** **EHV AC and DC Transmission**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**:** **EE-301 or equivalent**

9. Objective:

To expose students to the advanced concepts in EHVAC and HVDC transmission systems, their analysis and control.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**EHVAC Transmission System:** Sequence impedance calculation, calculation of transmission line parameters and sequence impedances for lines with ground returns, lines with bundle conductors and ground returns, sequence networks for various three phase transformer connections.	12
2.	**Corona:** Basic phenomenon and calculation of voltage gradient of conductors, power loss, audible noise and radio interference due to corona, electrostatic field of EHV lines.	6
3.	**EHV Transmission Line:** Introduction, concepts of design**.**	3
4.	**Reactive Power Compensation:** Basic concepts of reactive power compensation, principles of series and shunt compensation; Improvement of system performance due to reactive power compensation.	5
5.	**HVDC Transmission System:** Brief history of HVDC transmission system, comparison with EHVAC transmission, analysis of converter circuits for HVDC transmission, HVDC control system: CIA, CC and CEA control, analysis of faults in HVDC converters, basic concepts of multi-terminal HVDC system.	16
	Total	42

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Begamudre R. D., "Extra High Voltage AC Transmission Engineering", 3rd Ed., New Age International Private Limited.	**2008**
2.	Hingorani N. G. and Gyugyi L., "Understanding FACTS", IEEE Press, Standard Publishers Distributors.	**2001**
3.	Miller T. J. E., "Reactive Power Control in Electric Systems", John Wiley and Sons.	**1982**
4.	Sood V. K. "HVDC and FACTS Controller", Springer.	**2004**
5.	Arrilaga J., "High Voltage Direct Current Transmission", 2nd Ed., IET Publications.	**1998**
6.	Padiyar K. R., "HVDC Power Transmission System", New Age International Private Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-564** Course Title: **HVDC Transmission Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: MSC**

8. Pre-requisite**: EE-206 and EE-301 or equivalent**

9. Objective:

To provide an in-depth understanding of different aspects of high voltage direct current power transmission system.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Converter Operation (Normal And Abnormal):** 6-pulse and 12-pulse rectifiers and inverters; Equivalent circuits of rectifier and inverter, relations between ac and dc quantities.	12
2.	**Converter Charts:** Charts with dc voltage and current as rectangular coordinates, charts with active and reactive powers as rectangular coordinates and their relation.	2
3.	**Harmonics and Filters:** Characteristic and non-characteristic harmonics, input harmonics, output harmonics, problems due to harmonics, ac and dc filters.	4
4.	**HVDC Control Systems:** Constant current control, constant excitation angle control, VDCOL, constant ignition angle control, Individual phase control and equidistant pulse control; Valve blocking and by-passing; Starting, stopping and power flow reversal.	8
5.	**Mis-operation of Converters:** Arcback, short circuit on a rectifier, commutation failure, by-pass valves.	6
6.	**Faults in HVDC System and their Protection:** DC line faults, clearing line faults, converter faults, ac system faults, rectifier side and inverter side faults; DC circuit breakers, overvoltage protection.	3

S. No.	Contents	Contact Hours
7.	**Measurements:** Measurement of voltage and current for fault detection.	**2**
8.	**Parallel Operation of AC-DC Systems:** Influence of ac system strength on ac-dc interaction, effective short-circuit ratio (ESCR), problems with low ESCR systems.	**3**
9.	**DC Transmission Systems:** Monopolar, bipolar and homopolar lines, back-to-back HVDC systems, advantages of dc transmission.	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Kimbark E. W., "Power System Stability: Vol. I: Direct Current Transmission", Wiley India.	**1971**
2.	Ulmann E., "Power Transmission by Direct Current", Springer-Verlag.	**1975**
3.	Padiyar K. R., "HVDC Power Transmission System", New Age International Private Limited.	**2008**
4.	Kundur P., "Power System Stability and Control", Tata McGraw-Hill Publishing Company Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-580** Course Title: **Advanced Linear Control Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 20 **PRS** 20 20 40 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: PCC**

8. Pre-requisite**: Knowledge of Linear Control System**

9. Objective:
To introduce advanced control methods, including linear and nonlinear systems. Also to introduce advanced state space methods.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction**: Modeling of dynamical system in continuous time state space and discrete time state space model, Solution of continuous time state equation using: Similarity Transformation, Cayley Hamilton approach and Inverse Laplace approach, Solution of discrete time state equation.	**6**
2.	**Controllability and Observability:** General concept of Controllability and Observability, Controllability test for continuous time and discrete time system, Observability test for continuous time and discrete time system, Stabilizabilty and Detectability definition and tests, loss of Controllability and Observability due to sampling, Controllable and Observable canonical forms	**8**
3.	**Nonlinear Control System:** Nonlinear Models, Equilibrium points, Linearization of Nonlinear models, Separable Nonlinearities, Describing function analysis, Describing function of common nonlinearities, stability analysis by describing function method, Phase plane analysis of nonlinear systems, Bang-Bang control system, feedback linearization	**10**
4.	**Stability Analysis:** Stability concept, stability definition in the sense of Lyapunov, stability of continuous time Linear systems, stability of discrete time Linear systems, stability of nonlinear systems, Lyapunov stability	**8**

	theorem, Lyapunov instability theorem, direct method of Lyapunov for continuous time and discrete time systems, Lyapunov function for nonlinear systems	
5.	**Controller/Observer Design:** Pole placement technique, Ackerman's approach and Linear quadratic regulator for continuous time and discrete time systems, sliding mode control, H-infinity control, full order and reduced order observer design.	**10**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Hostetter G. H., Savant, and Stefani, *Design of Feedback Control Systems*, Oxford University Press	**2001**
2.	Kailath Thomas, *Linear Systems*, Prentice Hall	**1996**
3.	Khalil, H., *Nonlinear Systems*, 3nd Ed., Macmillan,	**2002**
4.	Slotine, J.J., and Li. W.P., *Applied Nonlinear Control*, Prentice-Hall,	**1991**
5.	Vidyasagar M., Nonlinear Systems Analysis, Prentice Hall, 2nd Edition	**1992**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./ CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-582** Course Title: **Advanced Systems Engineering**

2. Contact Hours: **L:** 3 **T:** 1 **P:** 0

3. Examination Duration(Hrs.): **Theory** 3 **Practical** 0

4. Related Weight: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: **04** **6.** Semester: **Autumn** **7.** Subject Area: **PCC**

8. Pre-requisite: NIL

9. Objective: The course aims at providing a background for system engineering concepts, modeling methodologies and various analysis techniques. It is a foundation course and would enable the student to have the required tools to pursue advanced courses in this area.

10. Details of Course :

S. No.	Contents	Contact Hours
1.	Systems models and their classifications, principles used in modeling of systems of objectives of constructing models.	**4**
2.	Reduced Order Models, Reduced Order Modeling Problem in time domain and frequency domain, necessity for model reduction, application of reduced order models algebraic reduction methods, different reduction methods in time domain and frequency domain, stable reduction methods, models of discrete systems.	**14**
3.	System simulation, advantages and disadvantage steps in simulation study.	**4**
4.	Probability concepts, sample space, probability distributions, random signals, characterization of random variables, statistical averages of random variables, discrete and continuous random variables, density and distribution functions, properties of cumulative distribution and probability density function, joint distribution functions.	**10**
5.	Stochastic process, classification of random process, response of linear systems to random inputs, auto correlation and cross correlation function, power spectral density.	**6**
6.	Basic principles of system reliability and failures, component reliability and hazard model. Bath tub curve, Series and parallel systems, reliability of complex system.	**4**

11. Suggested Books:

Sr. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Geoffrey Gordon, "System Simulation", PHI	**1978**

2.	Jamshidi M., "Large Scale Systems Modeling and Control ", Series Volume- 9, North Holland NY	**1983**
3.	Mahmud M. S., Singh M. G., " Large Scale Systems Modelling", Volume -3, Pergamum Press	**1981**
4.	Peebles Z. P. Jr., "Probability, Random Variables and Random Signal Principles", 4th Edition, Tata McGraw Hill	**2002**
5.	Papoulis A., " Probability and Statistics", PHI	**1990**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-620** Course Title**:** **Process Instrumentation and Control**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 25 50 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-306 and EE-309 or equivalent**

9. Objective:

To introduce the basic concepts of system response, characteristics of transducers and design of analog and digital controllers, programmable logic controllers and computer control of processes.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of Concepts of System Response:** Response of first order systems including transfer function and transient response to different forcing functions; Response of first order systems in series including non-interacting and interacting systems.	**2**
2.	**Sensors and Transducers:** Basic concepts and working principles of sensors and transducers for measuring process variables like pressure, temperature, level and flow; electromechanical, capacitive, inductive, resistive and photoelectric type proximity sensors.	**10**
3.	**Controller Principles:** Process characteristics; Control system parameters; Discontinuous controller modes; Continuous controller modes; Composite control modes.	**4**
4.	**Analog Controllers:** General features; Electronic controllers; Pneumatic controllers; Design considerations.	**4**
5.	**Digital Controllers:** Digital simulation of control systems; Simulation software; Computer software for process control; Microprocessor based controller.	**6**

S. No.	Contents	Contact Hours
6.	**Control Loop Characteristics:** Control system configuration; Multivariable control system; Control system quality and stability; Process loop tunning.	**4**
7.	**Control Equipment and Final Control Elements:** Details of controllers including measurement unit, comparator, actuator and final control elements; Pneumatic, hydraulic and electric actuators; Control valve characteristics; Pneumatic to electric and electric to pneumatic converters, hydraulic and pneumatic power supply system.	**5**
8.	**Programmable Logic Controllers:** Relay controllers and ladder diagrams; Relay sequences; PLC operation and programming.	**3**
9.	**Distributed and Supervisory Controls:** Introduction and relevance of distributed control; Hardware components of distributed control; Introduction and necessity of supervisory control; Master control station and remote terminal units.	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Coughanowr D. R., "Process Systems Analysis and Control", 2nd Ed., McGraw-Hill International Book Company.	**2008**
2.	Johnson C. D., "Process Control Instrumentation Technology", 8th Ed., Prentice Hall of India Private Limited.	**2008**
3.	Harriott Peter, "Process Control", Tata McGraw-Hill Publishing Company Limited.	**2008**
4.	Chemsmond C. J., "Basic Control System Technology", Viva Books Private Ltd.	**2004**
5.	Chemsmond C. J., Wilson and Lepla, "Advanced Control System Technology", Viva Books Private Ltd.	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN- 621** Course Title**:** **Enhanced Power Quality AC-DC Converters**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weight**:** **CWS** **15** **PRS** **25** **MTE** **20** **ETE** **40** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-206 or equivalent**

9. Objective:

To provide knowledge of the harmonics generated by different phase controlled converters and the methods of improving the input performance of various converters.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Review of 2-pulse and 6-pulse converters and their performance with inductive and capacitive loads.	**3**
2.	Harmonic analysis of phase controlled converters, IEEE standards.	**3**
3.	Conventional methods of power factor improvement techniques, controlled free-wheeling operation, asymmetrical triggering, sequence control of phase controlled converters, extinction angle control; PWM converters: Single-pulse and multiple pulse modulation techniques.	**5**
4.	Multi-pulse converters using delta/ zigzag/ Fork /Polygon transformers, analysis and harmonic calculations..	**4**
5.	Configurations of passive filters and their design.	**3**
6.	Shunt, series and hybrid active filters, topologies and their control strategies.	**6**
7.	High quality single-phase and three-phase converters, control techniques, Buck, Boost control, Power, flow control, hysteresis and carrier wave control, space vector control.	**10**
8.	Multi-level converters, topologies and control techniques.	**6**
9.	Snubber circuits and their design.	**2**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Rashid M. H., "Power Electronics Circuits Devices and Applications", 3rd Ed., Pearson Education.	**2008**
2.	Dubey G.K., Doradla S.R., Joshi A. and Sinha R.M.K., "Thyristorised Power Controllers", New Age International Private Limited.	**2008**
3.	Lander Cyril W., "Power Electronics", Prentice Hall of India Private Limited.	**2004**
4.	Mohan N., Undeland T.M. and Robbins W.P., "Power Electronics-Converters, Applications and Design", 3rd Ed., Wiley India.	**2008**
5.	Paice D. A., "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE press.	**1995**
6.	Kazmierkpwski M. P., Krishnan R. and Blaabjerg F., "Control in Power Electronics – Selected Problems", Academic Press.	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-622** Course Title**:** **Power System Instrumentation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** **3** **Practical** **0**

4. Relative Weight**:** **CWS** **25** **PRS** **0** **MTE** **25** **ETE** **50** **PRE** **0**

5. Credits**:** **4** 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-301 and EE-308 or equivalent**

9. Objective:

To provide in-depth knowledge of fast and reliable instrumentation of electrical quantities for power system network and relays for protection of power systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Measurement of Electrical Quantities:** Measurement of voltage, current, phase angle, frequency, active power and reactive power in power plants; Energy meters and multipart tariff meters	**7**
2.	**Voltage and Current Transformers:** Voltage transformers for measurement and protection, errors, transient performance; capacitive voltage transformers and their transient behavior; Current transformers for measurement and protection, composite errors, transient response.	**8**
3.	**Hydro Electric Power-Plant Instrumentation:** Measurement of flow, level, pressure, temperature, hydraulic head and mechanical vibrations; Temperature scanners; Alarm annunciators.	**8**
4.	**Thermal Power-Plant Instrumentation:** Measurement of gas flow; Gas and feed-water analysis; Flame monitoring; Steam turbine instrumentation.	**7**
5.	**Nuclear Power-Plant Instrumentation:** Reactor safety, neutron flux measurement; Reactor power level and coolant measurements.	**7**

S. No.	Contents	Contact Hours
6.	**Proactive Relays:** Organization of protective relay; Single input, two-input and multi-input relays; Electromagnetic, electronic and digital relays.	**5**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	"Modern Power Station Practice, Volume F: Control and Instrumentation", British Electricity International, Peragmon Press.	**1990**
2.	Elliott T. C., "Standard Hand Book of Power Plant Engineering", McGraw-Hill International Book Company.	**1989**
3.	Van A. R. and Warrington C., "Protective Relays- Their Theory and Practice", Vol. 1, Chapman and Hall Ltd.	**1968**
4.	Rao T. S. M., "Power System Protection – Static Relays with Microprocessor Applications", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-624** Course Title**:** **Telemetry and SCADA**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-308 and EE-309 or equivalent**

9. Objective:

To provide knowledge of signal transmission techniques, telemetry, remote control and SCADA.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Meaning and importance of telemetry, remote control, remote signaling and SCADA; Messages and signals; Signal formation; Conversion and transmission.	**3**
2.	**Signal Transmission Techniques:** Analog and digital modulation, Amplitude modulation, AM transmitter and receiver; Frequency modulation, FM transmitter and receiver; Phase modulation; Pulse modulation techniques; Digital transmission techniques, error detecting and correcting codes.	**15**
3.	**Signal Transmission Media:** Wires and cables, Power-line carrier communication, terrestrial and satellite radio links, optical fiber communication, Multiplexing – TDM, FDM and WDM.	**5**
4.	**Telemetry:** Telemetry error; dc, pulse, and digital telemetry methods and systems; multichannel telemetry schemes.	**6**
5.	**Remote Control and Remote Signaling:** Principle of independent messages and combinatorial principle; Multi-wire, FDM and TDM schemes.	**5**

S. No.	Contents	Contact Hours
6.	**Supervisory Control and Data Acquisition:** Layout, functions and operation of SCADA system; Remote terminal unit details; Control centre details; Communication between control centres; Communication between control centre and remote terminal units.	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Karp H. R. (Editor), "Basics of Data Communication", McGraw-Hill International Book Company.	**1976**
2.	Tomasi W., "Electronic Communication Systems: Fundamentals", 5th Ed., Pearson Education.	**2008**
3.	Gruenberg E. L., "Handbook of Telemetry and Remote Control", McGraw-Hill International Book Company.	**1967**
4.	Ginzburg S. A., Lekhtman I. Ya. and Malov V. S., "Fundamentals of Automation and Remote Control", Mir Publishers	**1967**
5.	Cegrell T., "Power System Control Technology", Prentice Hall International Edition.	**1986**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-641** Course Title: **Microcontroller and Its Applications to Power Converters**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 25 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-206, EE-304 and EE-307 or equivalent**

9. Objective:

To provide knowledge of architecture, interfacing and programming of microcontroller and its applications on generation of firing signals for power electronic converters.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Review of 8-bit microprocessor and peripheral devices; Review of power electronic converters; Overview of microcomputer control of power electronic systems.	**3**
2.	**Intel 8051/8052 Microcontroller:** Introduction, architecture, functional diagram, pin description, CMOS and HMOS microcontrollers and their difference, oscillator, CPU Timing, Intel 8031 and 8751.	**3**
3.	**Memory Organization:** Accessing external program and data memory, internal data memory, special function registers, hardware interfacing, timing diagrams, I/O expansion.	**4**
4.	**I/O Ports and Timer:** Internal structure of ports P0, P1, P2 and P3, alternative functions of port P3; Timer and counter operation, TM0, TM1 and TM2, modes of operation; Applications.	**4**
5.	**Programming:** Addressing modes; Instruction set: Data transfer group, arithmetic group, logical group, control group and Boolean processing capability; Programming and erasing EPROM.	**5**
6.	**Interrupts**: Types, interrupt priority and interrupt enable registers, processing of interrupt, single-step operation.	**2**

S. No.	Contents	Contact Hours
7.	**Microprocessor Controlled Converters:** Firing pulse generation of single-phase and three-phase converters, dual converter, PWM converter; Control techniques.	**8**
8.	**Microprocessor Controlled Choppers:** Firing pulse generation of single-quadrant and multi-quadrant choppers; Control techniques.	**5**
9.	**Microprocessor Controlled Inverters:** Firing pulse generation of voltage source PWM inverters, three-timer and four-timer methods, foreground and back ground calculation, current source inverters.	**8**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Dubey G. K., "Power Semiconductor Controlled Drives", Prentice-Hall International Editions.	**2001**
2.	Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.	**2001**
3.	Intel Manual on 8-bit Microcontroller	**--**
4.	Ayala K. J.," The 8051 Microcontroller- Architecture, Programming and Applications", 3rd Ed, Cengage Learning.	**2008**
5.	Hall D.V., "Microprocessor and Interfacing –Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
6.	Mazidi M.A. and Mazidi J.G., "The 8051 Microcontroller and Embedded Systems", 2nd Ed., Pearson Education.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-642** Course Title: **DSP Controlled Electric Drives**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 25 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: Knowledge of power electronics and drives**

9. Objective:

To provide knowledge of microprocessor-based control system for electrical drives with an emphasis on generation of firing signals for power electronic converters, processing of speed and current error in closed loop control of drives.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction**: Overview of DSP control of power electronic systems and electric drives.	**2**
2.	**Firing Signal Generation**: Review of generation of firing pulses for converters, choppers and inverters.	**3**
3.	**DSP Processors:** Review of microcontrollers and microprocessors; Architecture of DSPs, computational building blocks, bus architecture and memory, data addressing, address generation unit, DSP data path arithmetic, precision, overflow, multiplier, accumulator, rounding, programmability and program execution, speed issues, features for external interfacing; Programming of DSP, C language and assembly language; DSP computational errors.	**7**
4.	**Feed Back Signal Processing**: Measurement of electrical and mechanical variables- current, speed and position of motor, signal conditioning.	**4**
5.	**Closed Loop Drive:** Control philosophy, closed loop dc drive fed from dual converter and chopper, VSI, CSI and PWM inverter fed drives.	**8**
6.	**Modeling:** Mathematical modeling, simulation of drives, design of current and speed controllers in continuous and discrete data system, stability studies.	**8**

7.	**Modern Control Theory Applications:** Fuzzy control and ANN control of drives	**10**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Dubey G. K., "Power Semiconductor Controlled Drives", Prentice-Hall International Editions.	**2001**
2.	Bose B. K., "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.	**2001**
3.	Bose B. K., "Microcomputer Control of Power Electronics and Drives", IEEE Press.	**1999**
4.	Toliyat H. A. and Campbell S., "DSP Based Electromechanical Motion Control", CRC Press.	**2004**
5.	Kenjo T., "Power Electronics for the Microprocessor Age", Oxford University Press.	**1994**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN- 650** Course Title**:** **Switch Mode Power Supply**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-206 or equivalent**

9. Objective:

To familiarize students with the concepts, control techniques, protection and design of different configurations of SMPS.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Overview of linear voltage regulators, shunt and series regulators.	**2**
2.	**Switching Concepts**: Ideal switch, practical switch, switching functions.	**4**
3.	**Switching Circuits:** Introduction of switching circuits, harmonic concepts, power computations.	**3**
4.	**Non-Isolated Switch-Mode DC-DC Converters:** Buck, Boost, Buck-Boost converters.	**6**
5.	**Isolated Switch-Mode DC-DC Converters:** Introduction and types of switch mode dc-dc converters.	**8**
6.	**Soft Switched DC-DC Converters**: Series and Parallel resonant circuits, ZCS and ZVS switching topologies.	**10**
7.	**Simulation of Switching Converters.**	**4**
8.	**Switching Converter Design**: Choke and transformer design; driver circuits, snubber circuits; EMI suppression, Input rectifiers with unity input power factor; Reliability, few case Studies.	**5**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Rashid M. H., "Power Electronics Circuits Devices and Applications", 3rd Ed., Pearson Education.	**2008**
2.	Mohan N., Undeland T.M. and Robbins W.P., "Power Electronics-Converters, Applications and Design", 3rd Ed., Wiley India.	**2008**
3.	Whittington H.W., Aflynn B.W. and Macpherson D.E., "Switch Mode Power Supplies – Design and Construction", John Wiley and Songs.	**1997**
4.	Hart Daniel W., "Introduction to Power Electronics", Prentice Hall International Edition.	**1996**
5.	Ang Simon S., "Power Switching Converter", Marcel Dekker Inc.	**1995**
6.	Luo Fang Lin and Ye Hong, "Advanced DC/DC Converters", CRC Press.	**2003**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-623** Course Title**:** **Power Quality Improvement Techniques**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 25 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-206 and EE-301 or equivalent**

9. Objective:

To familiarize students with the reasons of load generated harmonics present in the supply and the methods for their suppression.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Concept of Power Quality**: Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise.	**2**
2.	**Fundamentals of Harmonics:** Representation of harmonics, waveform, harmonic power, measures of harmonic distortion; Current and voltage limits of harmonic distortions: IEEE, IEC, EN, NORSOK	**3**
3.	**Causes of Harmonics**: 2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger.	**7**
4.	**Effect of Harmonics:** Parallel and series resonance, effect of harmonics on static power plant – transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipments and communication systems, power measurement.	**3**

S. No.	Contents	Contact Hours
5.	**Elimination/ Suppression of Harmonics:** High power factor converter, multi-pulse converters using transformer connections (delta, polygon)	**4**
6.	**Passive Filters:** Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design.	**4**
7.	**Active Power Filters:** Compensation principle, classification of active filters by objective, system configuration, power circuit and control strategy.	**2**
8.	**PWM Inverter**: Voltage sourced active filter, current sourced active filter, constant frequency control, constant tolerance band control, variable tolerance band control.	**2**
9.	**Shunt Active Filter:** Single-phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three-phase active filter: Operation, analysis and modelling; Instantaneous reactive power theory..	**8**
10.	**Three-phase Series Active Filter:** Principle of operation, analysis and modelling.	**3**
11.	**Other Techniques:** Unified power quality conditioner, voltage source and current source configurations, principle of operation for sag, swell and flicker control.	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Derek A. P., "Power Electronic Converter Harmonics", IEEE Press.	**1989**
2.	Arrillaga J., Smith B. C., Watson N. R. and Wood A. R., "Power System Harmonic Analysis", 2nd Ed., Wiley India.	**2008**
3.	Arthur R. B., "Power System Analysis", 2nd Ed., Pearson Education.	**2008**
4.	Arrillaga J., Braedlley D. A. and Bodger P. S., "Power System Harmonics", John Wiley and Sons.	**1985**
5.	Dugan R. C., McGranaghan M. F. and Beaty H. W., Electrical Power System Quality", McGraw-Hill International Book Company.	**1996**
6.	Sankaran C., "Power Quality", CRC Press.	**2001**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-625** Course Title**:** **CAD of Power Apparatus**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**:** **EE-202 and EE-303 or equivalent**

9. Objective:

To familiarize students with the design procedure and performance evaluation of rotating machines and transformers with sinusoidal and non-sinusoidal supply system.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Review of design of transformers and rotating machines.	**5**
2.	Calculation of reactance parameters, losses, temperature rise and performance.	**3**
3.	Application of Finite Element Method (FEM) in thermal and field analysis of electrical machines.	**5**
4.	Design consideration for rotating machines fed from non-sinusoidal supply.	**5**
5.	Computer aided design, philosophy and economics, selection of input data and design variables, flow chart for design of transformer and rotating machine.	**12**
6.	Review of optimization techniques, objectives and constraint functions, constrained and unconstrained minimization.	**4**
7.	Flow chart development for design optimization of power apparatus, converter fed drives and energy efficient machines.	**8**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Say M. G., "The Performance and Design of AC Machines", CBS Publishers and Distributors.	**2002**
2.	Veinott C. G., "Computer Aided Design of Electrical Machinery", MIT Press.	**1987**
3.	Sen S. K., "Principle of Electrical Machine Design with Computer Programs", Oxford and IBH Company Pvt. Ltd.	**2001**
4.	Ramamoorthy M., "Computer Aided Design of Electrical Equipment", East West Press.	**2002**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-629** Course Title**:** **Testing and Commissioning of Electrical Equipment**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-202 and EE-303 or equivalent**

9. Objective:

To provide the installation, commissioning, testing and maintenance procedures of large rating transformers, induction machines and synchronous machines.

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10. Details of Course:

S. No.	Contents	Contact Hours
	Transformers	
1.	Terminal marking, construction of transformers, cooling arrangement.	**4**
2.	Routine tests, measurement of winding resistance, impedance, voltage ratio, insulation resistance.	**4**
3.	Type tests, impulse voltage test, measurement of losses, temperature-rise test.	**5**
4.	Installation and commissioning of transformers, foundation, codes of practice, earthing, pre-commissioning test, testing of oil strength.	**4**
	Induction Machines	
5.	Rating and name plate data, installation and foundation, types of coupling, pre and post commissioning checks.	**4**
6.	Routine tests and type tests, resistance measurement, no load and blocked rotor test, load test, temperature rise test, high voltage test.	**5**
7.	Shaft alignment, drying of windings, mechanical tests, air gap symmetry, insulation test, speed and load test, codes of practice, maintenance schedule.	**5**

S. No.	Contents	Contact Hours
	Synchronous Machines	
8.	Installation, commissioning and performance tests, methods of cooling.	**5**
9.	Excitation test, waveform and telephone interference, over-speed test, generator and motor operation, sudden short circuit test, bearing currents.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Fitzgerald A. E., Kingsley C. and Kusko A., "Electric Machinery", 6th Ed., McGraw-Hill International Book Company.	**2008**
2.	Say M. G., "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors.	**2005**
3.	Langsdorf A. S., "Theory of AC machines", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
4.	Transformers: BHEL, Bhopal (Book), Tata McGraw-Hill Publishing Company Limited.	**2008**
5.	BIS Code on Transformers IS-10561	**1983**
	BIS Code on Transformers IS-10028	**1985**
	BIS Code on Transformers IS-3151	**1982**
6.	BIS Code on Motors IS-900	**1992**
	BIS Code on Motors IS-4722	**1992**
	BIS Code on Motors IS-4029	**1967**
	BIS Code on Motors IS-325	**1978**
	BIS Code on Motors IS-7306	**1974**
	BIS Code on Motors IS-7132	**1973**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-635** Course Title**:** **Power System Reliability**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Spring** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-301 or equivalent**

9. Objective:

To introduce the concepts of reliability modeling of generation, transmission and distribution systems and their applications in assessing the system adequacy in terms of relevant reliability indices.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Basic Probability Theory:** Probability concepts, rules for combining probability, probability distributions, random variables, density and distribution functions, mathematical expectations, variance and standard deviation.	4
2.	**Basic Reliability Evaluation:** General reliability functions, probability distributions in reliability evaluation, network modeling and evaluation of series, parallel, series –parallel, network modeling and evaluation of complex systems, cut-set method, tie-set method, discrete Markov chains, continuous Markov process, frequency and duration technique concepts, application to multi-state problems, approximate system reliability evaluation**.**	6
3.	**Generation System Reliability:** Generation system models, capacity outage table, recursive algorithm, loss of load indices, inclusion of scheduled outages, load forecast uncertainty, loss of energy indices, expected energy generation, energy limited systems, Gram-Charlier series and its application to generation system reliability evaluation, generating capacity –frequency and duration method.	10
S. No.	**Contents**	**Contact Hours**
4.	**Interconnected System:** Probability array method in two inter-	6

	connected systems, effect of tie capacity, tie reliability and number of tie lines, equivalent assistance unit method for reliability evaluation of inter-connected system, elementary concepts for reliability evaluation of multi-connected systems.	
5.	**Composite Generation and Transmission System Reliability:** Radial configurations, conditional probability approach, network configuration, state selection, system and load point indices**.**	**6**
6.	**Distribution System Reliability:** Basic technique and application to radial systems, customer–oriented indices, load and energy indices, effect of lateral distributor protection, effect of disconnects, effect of protection failures, effect of load transfer, meshed and parallel networks, approximate methods, failure modes and effects analysis, inclusion of scheduled maintenance, temporary and transient failures, inclusion of weather effects.	**10**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Billinton R. and Ronald N. A., "Reliability Evaluation of Power Systems", Pitman Advanced Publishing Program.	**1984**
2.	Billinton R. and Ronald N. A., "Reliability Evaluation of Engineering Systems Concepts and Techniques", Pitman Advanced Publishing Program.	**1983**
3.	Endrenyi J., "Reliability Modeling in Electric Power Systems", John Wiley and Sons.	**1978**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-641** Course Title**:** **Substation Automation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-301 or equivalent**

9. Objective:

To impart knowledge about substation automation, including components, integration, architecture alternatives and management of the substation data.

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10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Power System Automation:** Basic theory, cost justification, risks/benefits- hard and soft.	2
2.	**Digital Communications:** Elements of digital communication systems, encoding, modulation and demodulation, error handling, communication media, digital multiplexing, ISO seven layer model, Hierarchical/bus/star/ring configuration.	10
3.	**Enterprise Communication:** LAN/WAN integration, hubs, routers, gateways, network, management and security.	4
4.	**Communication Protocols:** DNP, MODBUS, PROFIBUS, IEC 60870-5, Ethernet, TCP/IP.	6
5.	**Object Oriented Technology:** Concepts, use of C++ and Java.	6
6.	**Automation Architecture:** SCADA system- hardware, software, data acquisition, control and features; RTU; PLC; IED; types of architecture; equipment monitoring for reliability and safety, utility integration of communication and control, and protection- examples, wide-area measurement system, synchronized phasor measurements, adaptive protection concepts, IEC standards.	14
	Total	42

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Grigsby L. L., "Electric Power Engineering Handbook", 2nd Ed., CRC Press.	**2007**
2.	Stauss C., "Practical Electrical Network Automation and Communication Systems", Elsevier Eastern Limited.	**2003**
3.	McDonald J. D., "Electric Power Substations Engineering", CRC Press.	**2003**
4.	Brand K., Lohmann V. and Wimmer W., "Substation Automation Handbook", Utility Automation Consulting Lohman.	**2003**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-642** Course Title**:** **Power System Deregulation**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-301 or equivalent**

9. Objective:

To acquaint students with the new deregulation techniques of power system, planning, control, load forecasting, metering and risk assessment.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Competitive market for generation, role of the existing power industry, electricity demand operation and reliability, renewable generation technologies, energy policy and cost, distributed generation, market regulation, connection and use of system charges, traditional central utility model, independent system operator (ISO), retail electric providers.	**8**
2.	Wholesale electricity markets, characteristics, bidding, market clearing and pricing, ISO models, market power evaluation, demand side management, distribution planning.	**8**
3.	Role of the transmission provider, multilateral transaction model, power exchange and ISO - functions and responsibilities, classification of ISO types, trading arrangements, power pool, pool and bilateral contracts, multilateral trades.	**12**
4.	Transmission pricing in open access system, rolled in pricing methods, marginal pricing methods, zonal pricing, embedded cost recovery, open transmission system operation, and congestion management in open access transmission systems in normal operation.	**8**

S. No.	Contents	Contact Hours
5.	Predicting electricity costs, electricity cost derivation, electricity pricing of inter provincial power market, transmission pricing.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Loi L. L., "Power System Restructuring and Deregulation – Trading, Performance and Information Technology", John Wiley and Sons.	**2003**
2.	Fred C. S., Michael C. C., Richard D. T. and Roger E. B., "Spot Pricing of Electricity", Kluwer Academic Publishers.	**1988**
3.	Marija I., Francisco G. and Lester F., "Power Systems Restructuring: Engineering and Economics", Kluwer Academic Publishers.	**1998**

INDIAN INSTITUTE OF TEHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-652** Course Title**:** **Introduction to Robotics**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 25 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: DEC**

8. Pre-requisite**: EE-306 or equivalent**

9. Objective:

To familiarize with the working of robot, its components, position and orientation analysis, robot kinematics, dynamics and control, sensing and vision.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Evolution of robots and robotics, robot anatomy, links, joints, degrees of freedom, arm configuration, wrist configuration, end-effector.	**3**
2.	Mapping between rotated and translated frames, combined rotation and translation of vectors, fundamental rotation matrices.	**4**
3.	Kinematic modeling of the manipulator, Denavit-Hartenberg notation, kinematic relationship between adjacent links, manipulator transformation matrix	**5**
4.	The inverse kinematics, solvability of inverse kinematic model, solution techniques.	**4**
5.	Linear and angular velocity of a rigid body, velocity propagation along links, manipulator Jaccobian, static analysis.	**5**
6.	Dynamic modeling, Lagrange-Euler formulation, Newton- Euler formulation.	**5**
7.	Trajectory planning, joint space techniques, cartesian space formulation.	**4**
8.	Control of manipulator, PID control scheme, computed torque control, force control of robotic manipulators.	**4**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-591** Course Title**:** **System Reliability**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective:

To introduce the concepts of reliability modeling of systems and their applications in assessing the system adequacy in terms of relevant reliability indices.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of Probability Theory:** Probability concepts, rules for combining probability, probability distributions, random variables, density and distribution functions, mathematical expectations, variance and standard deviation.	**3**
2.	**Catastrophic failure models:** Component reliability from test data, MTTF, time dependent hazard models, stress dependent hazard models, treatment of field data	**5**
3.	**Basic Reliability Evaluation:** General reliability functions, probability distributions in reliability evaluation, and evaluation of series, parallel, series –parallel, and complex systems, event space method, cut-set method, tie-set method, and other methods, discrete Markov chains, continuous Markov process, frequency and duration technique concepts, standby and k out of n:G systems, application to multi-state problems, approximate system reliability evaluation**,** fault tree technique	**12**
4.	**Reliability enhancement:** Component improvement, proper design and simplicity, creative design, conservative design and derating, redundancy and redundancy allocation	**10**

S. No.	Contents	Contact Hours
5.	**Drift failures:** Concept of drift failures, failure mechanism, change in device and unit performance with time and loading/stresses, accelerated stress testing, creative design for drift failures.	**5**
6.	**System with repair:** Availability, maintainability, MTBF, MTTR, UTR, k-out of n:G system with repair and installation, preventive maintenance.	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Shooman M.L., Probabilistic Reliability, an Engineering Approach, McGraw Hill	**1968**
2.	Sinha S.K., Reliability and Life Testing, Wiley Eastern Limited	**1986**
3.	Gupta A.K., Reliability, Maintenance and Safety Engineering, University Science Press	**2009**
4.	Fuqua N.B., Reliability Engineering for Electronic Design, Marcel Dekker Inc.	**1986**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-583** Course Title: **Stochastic Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Basic knowledge of Feed Back Control & Probability Theory**

9. Objective: To acquire the knowledge on stochastic signals and the response of feed-back processes for these type of signals and their design using performance indices.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Concepts of probability, random variables and stochastic signals. First & second order statistics of stochastic process. Ergodic hypothesis & correlation functions. Poisson distribution of event points.	**10**
2.	Random variables and their characteristics. CDF & PDF and their properties. Existence theorem. Gaussian RV, Poisson RV, Bernoulli distributed RV and uniformly distributed RV	**6**
3.	Response of a linear system to stochastic signal inputs; power density spectra and basic relationships.	**6**
4.	Analytical design of linear feed-back controls. Parseval's theorem & its generalization. M.S.E. estimation for different cases. Wiener Hopf integral equation and methods of solution.	**10**
5.	Gauss – Markov sequence and process models; optimal prediction, filtering and smoothing for continuous and discrete linear systems	**10**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/

		Reprint
1.	Deuschel Jean-Dominique et al : "Interacting Stochastic Systems", Springer: Berlin, New York	**2005**
2.	Kulkami Vidyadhar G. : "Modeling and Analysis of Stochastic Systems", Chapman and Hall/CRC	**1995**
3.	Medhi J. : "Stochastic Processes", Wiley Eastern Limited	**1982/1984**
4.	Meditch J.S. : " Stochastic Optimal Linear Estimation and Control ", McGraw-Hill, Inc	**1969**
5.	Papoulis A : "Probability, Random variables, and Stochastic Processes", Third edition, McGraw-Hill,	**1991**
6.	Pugachev V.S. et al : " Stochastic Systems: Theory and Applications", RiverEdge,NJ: World Scientific	**2001**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-584** Course Title: **Optimal Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Linear Control System**

9. Objective:

To familiarize with the concept of optimal control of continuous time and discrete time systems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction**: Definitions of Optimal Control, plant, Performance Index, constraints, formulation of optimal control problem, selection of a performance index	4
2.	**Calculus of Variations and Optimal Control:** Basic Concept, Optimum of a Function and a Functional, The Basic Variational Problem, Fixed-End Time and Fixed-End State System, Euler-Lagrange Equation, Different Cases for Euler-Lagrange Equation, The Second Variation, Extrema of Functions with Conditions, Variational Approach to Optimal Control Systems, Terminal Cost Problem	8
3.	**Linear Quadratic Optimal Control Systems:** Problem Formulation, Finite-Time Linear Quadratic Regulator, LQR System for General Performance Index, Analytical Solution to the Matrix Differential Riccati Equation, Infinite-Time LQR System, Stability Issues of Time-Invariant Regulator, Linear Quadratic Tracking System: Finite-Time Case, LQT System: Infinite-Time Case, LQR with a Specified Degree of Stability	10
4.	**Discrete-Time Optimal Control Systems:** Variational Calculus for Discrete-Time, Discrete-Time Optimal Control Systems, Discrete-Time Linear State Regulator, Closed-Loop Optimal Control: Matrix Difference Riccati Equation	4
5.	**Pontryagin Minimum Principle:** Pontryagin Minimum Principle, Dynamic Programming, Principle of Optimality, Optimal Control Using Dynamic Programming, Optimal Control of Discrete-Time Systems, Optimal Control of Continuous-Time Systems, The Hamilton-Jacobi-Bellman Equation, LQR System Using H-J-B	8

	Equation	
6.	**Time-Optimal Control of LTI System:** Problem Formulation and Statement, Solution of the TOC System, Structure of Time-Optimal Control System, TOC of a Double Integral System, Fuel-Optimal Control Systems, Energy-Optimal Control Systems	**8**
	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Kirk Donald E.,"Optimal Control Theory An Introduction", Dover Publication Inc, Mineola, New York.	**2004**
2.	Naidu Desineni Subbaram,"OPTIMAL CONTROL SYSTEMS", CRC PRESS, Boca Raton London New York Washington, D.C.	**2002**
3.	Sage A. P. and White C. C,"Optimum Systems Control", Prantice-Hall,Englewood Cliffs, N.J.	**1977**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-582** Course Title: **Operations Research**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 20 **PRS** 20 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: PCC**

8. Objective: To introduce the students with foundations of Operations Research methodology & tools. It will provide the students the practice of modeling and solving the problems on computer.

9. Details of Course:

S. No.	Contents	Contact Hours
1.	**Linear Programming, Simplex method, Dual simplex method, Sensitivity Analysis.**	10
2.	**Transportation & Assignment Problems.**	5
3.	**Integer Programming**	5
4.	**Probabilistic Decision Making**	5
5.	**Inventory Models**	5
6.	**Game Theory**	5
7.	**Queueing Theory**	5
8.	**Project Scheduling By CPM/PERT**	5

10. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Taha H.A.," Operations Research", Eighth Ed., Macmillan Publishing Co. PHI.	**2009**
2.	Ignizio James. P., " Linear Programming in single & multiple objecting systems", PHI.	**1982**
3.	Bazaraa M.S., Jarvis J.J.," Programming & Network Flows", John Willy & sons.	**1977**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-590** Course Title: **Modelling of Industrial Processes**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: PEC**

8. Pre-requisite**:**

9. Objective:

To introduce the fundamentals of Mathematical Modelling of Process and study the Dynamics of chemical processes in Industry including the idea of advance controllers used in Industry.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Development of a Mathematical Model**: Linear State Space Models. Introduction to Laplace Transforms. Transfer Functions. Need of a mathematical model, State variables and State equations for a Chemical process.	8
2.	**Process Dynamics of Fluid Flow and Heat transfer systems:** Fundamentals of fluid flow. Conservation laws for mass, momentum and mechanical energy. Flow of fluids in conduits. Flow past immersed bodies. Fundamentals of heat transfer	8
3.	**Mathematical Model of Different processes and Distillation column Dynamics:** Continuous Stirred Tank Reactor, Mixing Process, Tabular Heat Exchanger, Distillation column Dynamics, Mathematical model and controller for Two-tank System	8
4.	**Introduction to Process controllers:** Need of process controller, different types of process controllers: Electric controller, Pneumatic controller, Hydraulic controller.	8
5.	**Introduction to Computer Aided process Control:** Different control actions: on-off or two-position control , Proportional control ,Integral control ,Derivative control . Analogue Control Systems, DDC (Direct Digital Control), Supervisory Computer Control (SCADA),Distributed Control System(DCS)	10

	Total	**42**

11. Suggested Books:

S. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1	Coughnowr,D.R.,and Koppel,I.B.,"Process Systems Analysis and Control",2nd Ed.,Mcgraw-Hill,New York	**1991**
2	Johnson, Curtis D.," Process control instrumentation technology", Prentice- Hall of India Pvt. Ltd.	**2006**
3	Luyben W. L. "Process Modeling ,Simulation and Control for Chemical Engineers", McGraw-Hill Book Company,New York	**1973**
4	Seborg,D.E.,Edgar,T.F. and Mellichamp,D.A.,"Process Dynamics and Control",2nd Ed.,John Wiley and Sons	**2004**
5	Singh, S.K," Computer-aided process control", Prentice-Hall of India	**2003**
6	Stephanopoulos.G.,"Chemical process control: An Introduction to theory and practice", Prantice-Hall,Englewood Cliffs, N.J.	**1984**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-585** Course Title: **ADVANCED COMPUTER CONTROLLED SYSTEMS**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: 4 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Basic knowledge of Microprocessors and PC Programming**

9. Objective: To provide sound knowledge in designing and control of Computer Controlled Systems to get an insight to the practical useful tools and techniques for controlling multivariable processes using microcomputers and validation of the computer controlled system design through simulation studies.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview of the execution environment of Pentium processor in PC, FPU and assembly level programming under protected mode operation.	8
2.	Review of Z-transforms, frequency spectrum and reconstruction theorem	4
3.	Pulse transfer functions, Data hold, state transition signal flow diagrams of pulse transfer functions, decomposition and computer simulation. Stability consideration; Routh-Hurwitz criterion and Jury's test	6
4.	Modified Z-transforms, applications and computer simulation of computer controlled processes with transportation lag	4
5.	Direct digital control (DDC) algorithms: digital controller design from analog controllers, PDI control action, method of differentials, bilinear transformation and mapping of poles and zeros.	6

6.	Digital controller design using plant models: Identification of plant model through reaction curve, dead-beat algorithm, Dahlin's method, Kalman's approach and Smith predictor design	**8**
7.	Digital controller structures & PC implementation	**6**

11. Suggested Books:

S. No.	**Name of Authors / Books / Publishers**	**Year of Publication/ Reprint**
1.	Astrom K.J. et al., "Computer Controlled System: Theory and Design", Prentice-Hall	**1997**
2.	Irvine Kip R., "Assembly Language for Intel-Based Computer", Fourth Edition, Pearson Education (LPE)	**2004**
3.	Ogata K., "Discrete Time Control Systems", Prentice-Hall	**1987**
4.	Philips C.L. et al., "Digital Control System, Analysis and Design" , Second Edition, Prentice-Hall	**1990**
5.	Rosenwasser Efim et al., "Multivariable Computer-Controlled Systems: A Transfer Function Approach", London:Springer	**2006**
6.	Smith Cecil L., "Digital Computer Process Control", Intext Education: London	**1972**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-587** Course Title**:** **Data Structures**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 25 **MTE** 20 **ETE** 40 **PRE** 0

5. Credits**:** 4 6. Semester**: Autumn/Spring** 7. Subject Area**: PEC**

8. Pre-requisite**: Basic knowledge of programming**

9. Objective:

To familiarize students with the concept of abstract data type, hardware and software implementations of data structures, various existing data structures and their related operations with the help of different application problems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Need of data structures, hardware and software implementations of data structures, various existing data structures and their related operations**,** compile time memory allocation and dynamic (run time) memory allocation, garbage collection.	**3**
2.	**Linked List:** linked array and pointer representations their advantages and disadvantages, creation traversal, insertion and deletion, sorting, concatenation, merging, searching, header node, link list with grounded header node, circular link list, Josephus doubly linked (two way) link, its advantages and disadvantages.	**7**
3.	**Stack:** Array Representation, overflow and underflow, push and pop operations, recursion its advantages, converting a recursive procedure to a non-recursive procedure.	**2**
4.	Tower of Hanoi problem, Infix, prefix and postfix notations, evaluation a postfix expression using stack, implementing quick sort algorithm using stack,	**2**
5.	**Queue:** Simple queue, addition to a queue, removal from a queue, de-queue, input restricted and output restricted de-queue, addition and removal w.r.t. de-queue.	**3**

S. No.	Contents	Contact Hours
6.	**Tree:** Basic definitions, representation in computer memory, creating a binary tree, traversal algorithms threading in a binary tree, heap tree, creation of heap tree, inserting a node in a heap tree, deleting the root of heap tree, heap sort algorithm, link list representation using binary tree, multi-way search tree, representation in computer memory and its advantages.	**10**
7.	**Graph:** Basic definitions, representation in computer memory, creation of a graph, traversal in a graph, depth first traversal and breadth first traversal, sorting, inserting an arc in a graph, deleting an arc from a graph, searching a node and an arc in a graph.	**7**
8.	**Searching Algorithms:** Sequential search, binary search, efficiency of searching algorithms, improving the efficiency of sequential search by move to front , move forward, indexed sequential search.	**2**
9.	**Table Data Structure:** Hash function and hashing, selection of hash function, collision and collision resolving methodologies, linear probing, quadratic probing, buckets, chaining, storing (inserting) data in table, searching a data record in a table, deleting a data record from a table, efficiency of search.	**4**
10.	**Sorting Algorithms:** Bubble sort, quick sort, heap sort, insertion sort, selection sort, merge sort, efficiency of sorting algorithms.	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Lipschutz S., "Data Structures Schaum's Outline Series", Tata McGraw-Hill Publishing Company Limited.	**2008**
2.	Preiss B. R., "Data Structures and Algorithms with Object Oriented Design Patterns in C++", Wiley India.	**2008**
3.	Rowe G. W., "Introduction to Data Structures and Algorithms With C++", Prentice Hall of India Private Limited.	**2004**
4.	Sahni S., "Data Structures, Algorithms and Application in C++", 2nd Ed., University Press.	**2007**
5.	Tenenbaum A. M., Langsam Y., and Augenstein M. J., "Data structures using C and C++", 2nd Ed., Prentice Hall of India Private Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./ CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-593** Course Title: **Graph Theory and Applications**

2. Contact Hours: **L:** 3 **T:** 1 **P:** 0

3. Examination Duration(Hrs.): **Theory** 3 **Practical** 0

4. Related Weight: **CWS** 25 **PRS** 0 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits: **04** **6.** Semester: **Autumn** **7.** Subject Area: **PEC**

8. Pre-requisite: **Basic Knowledge of State Space Analysis, Circuits ,Optimization & switching Theory**

9. Objective: To familiarize with the basic concepts of graph, tie sets, cut sets and matrix representation of graphs, its applications in the analysis of circuits, switching theory and operation research.

10. Details of Course :

S. No.	Contents	Contact Hours
1.	Definition of graph, types of graphs, sub graph, Graphs and Examples, Connected graph, Undirected and Directed graph, Disjoint graphs, Planar Graphs, Dual Graphs, Complete graph, Isomorphic Graph, Incidence of a branch, Adjacency and Incidence Matrices, Walks, Trails, Paths, Cycles, Bipartite, Degree, Regular, Distance, Eulerian Graphs, Hamiltonian Graphs	**12**
2.	Fundamental circuits, Trees, Counting Trees, Twigs, Links, Cut sets and Tie sets	**8**
3.	Electrical network analysis by graph theory, State space analysis using graph theory	**8**
4.	Network flows, Cut and its capacity, Enumeration of graphs, Graphs in switching and Coding theory	**6**
5.	Graph theory in operations research, Traveling Salesmen problem, Shortest path problem, Minimal cost network problem, Network analysis including PERT and CPM	**8**

11. Suggested Books:

Sr. No.	Name of Books/Authors/Publishers	Year of Publication
1.	Balakrishnan V., **"Theory and Problems of Graph Theory", Schaum's Outline Series,** McGraw-Hill	**2004**
2	Bazaraa M. S., Jarvis J. J., Sherali H. D.,"Linear Programming and Network Flows", 2nd Edition, Willey India Edition	**2008**
3.	Douglas B. West, **"Introduction to Graph Theory", 2nd Edition,** Prentice Hall	**2000**
4.	Narsingh Deo, "Graph Theory with applications in the engineering and computer science"	**1974**
5.	Taha H. A., "Operation Research: An Introduction", 8 edition, Pearson Education	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**: EEN-594** Course Title**: Advanced Microprocessor and Applications**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weight**:** **CWS** 15 **PRS** 25 20 40 0

5. Credits**:** 4 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Basic course on Microprocessors.**

9. Objective:

To expose the students to the architecture, instruction set and assembly language programming of typical 16-bit and higher order microprocessors. The course also provides interfacing details of I/O devices with the processor.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Evolution of Microprocessors:** 8-bit ,16-bit microprocessors, & Intel IA32 processors.	2
2.	**Software Architecture of a 16-bit & 32 bit Microprocessor**: concept of pipelining and memory segmentation, logical address, offset address and physical address; Bus Interface Unit (BIU); Execution Unit (EU), segment registers. Memory reference using descriptors in protected mode.	5
3.	**Operation of 16-bit Microprocessor:** Pin configuration of Intel 8086/8088; Minimum and maximum modes of operation; Address bus, data bus and control bus; Clock generator Intel 8284; Memory organization, memory address space; comparision with 32 bit processor.	5
4.	**Interfacing:** Interfacing concepts, interfacing memory; Input-output techniques, interfacing of I/O devices to the processor.	2
5.	**Generalised instruction set of IA-32 microprocessor;** 8086/8088instruction set as subset of IA-32, Addressing Modes Data related addressing modes- register, immediate, direct, register indirect, based relative, indexed relative and based indexed, branch related addressing modes- intrasegment direct and indirect, intersegment direct and indirect.Machine cycles, data transfer, arithmetic, bit manipulation, string, program execution transfer and processor control instructions.	10
6.	**Assembler Directives:** ASSUME, DB, DD, DQ, DT, DW, DUP, END, EQU, EVEN, ORG, OFFSET, PROC, ENDP, LABEL and PTR. Real variable directives, Assembly Language Programming Macro-assembler, segment definition and models.MODEL approach	5

S. No.	Contents	Contact Hours
7.	**Interrupt Structure:** Interrupt pointer, type numbers, processing of interrupt, internal and external interrupts, interrupt priorities, BIOS routines.	**4**
8.	**Programmable Support Chips**: Interfacing of programmable parallel interface Intel 8255, programmable interval timer Intel 8253, programmable interrupt controller Intel 8259 with 16-bit processor.	**5**
9.	**Coprocessors and Multiprocessing, FPU of Pentium**	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Brey B. B., "Intel 8086, 8088, 80186, 80187, 80286, 80386, 80486, Pentium and Pentium Pro Processors, Architecture, Design and Application", Prentice Hall of India.	**2006**
2.	Hall D. V., "Microprocessor and Interfacing –Programming and Hardware", Tata McGraw-Hill.	**2006**
3.	James L Antonakos,"The Pentium Microprocessors, Pearson Education Asia.	**2002**
4.	Liu Yu-Cheng and Gibson G. A., "Microcomputer Systems; The 808618088 Family", 2nd Ed., Prentice Hall of India	**2007**
5.	Mazidi M. A. and Mazidi J. G., "The 80x86 IBM PC and Compatible Computers (Vol. I and II), Assembly Language, Design and Interfacing", Prentice Hall International Edition.	**2003**
6.	Triebel W. A. and Singh A., "The 8088 and 8086 Microprocessors, Programming Interfacing, Software, Hardware and Applications", 4th Ed., Prentice Hall of India	**2007**

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **DEPARTMENT OF CIVIL ENGINEERING**

1. Subject code: **CEN-105** Course Title: **Introduction to Environmental Studies**
2. Contact Hours: **L: 3 T: 0 P: 0**
3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0
4. Relative Weightage: **CWS:** 15 **PRS:** 0 **MTE:** 35 **ETE:** 50 **PRE:** 00
5. Credits: **3** 6. Semester: **Autumn** 7. Subject Area: **GSC**
8. Pre-requisite: **Nil**
9. Objective: To introduce fundamentals of environmental pollution and its control.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	Overview: Environment and Natural Processes; Development (Resource Utilization & Waste Generation); Environmental issues; Concept of Sustainable Development; Issues affecting future development (population, urbanization, health, water scarcity, energy, climate change, toxic chemicals, finite resources etc.); Environmental units	6
2.	Air –Water interaction: (Liquid phase-gas phase equilibrium) Henry's Law Constant with units, Dimensionless Henry's Law Constant	3
3.	Water –Soil Interaction: Carbonate System (Alkalinity and buffering capacity); Major ions in water; Natural Organic Matter (NOMs); Water quality parameters; Physical processes (Mass Balance): Spatio-temporal variation in quality of river water, lake water, ground water; Water quality standards	9
4.	Wetlands, water treatment and wastewater treatment .	6
5.	Air resources: Atmosphere; Air pollutants; Emissions and control of air pollutants; Atmospheric meteorology and dispersion; Transport of air (global, regional, local); Air/ atmospheric stability; Plume shape; Gaussian modeling; Air quality standards	9
6.	Land pollution and solid waste management	3
7.	Ecosystem: Structure and function; Energy flow in ecosystem; Material flow in ecosystem; Biodiversity and ecosystem health; Bio-amplification and bio-magnification	3
8.	Hazardous Waste: Definition; Classification; Storage and management; Site remediation; Environmental Risk: assessment, and management	3
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Davis M. L. and Cornwell D. A., "Introduction to Environmental Engineering", McGraw Hill, New York 4/e	2008
2.	Masters G. M., Joseph K. and Nagendran R. "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi. 2/e	2007
3.	Peavy H. S., Rowe D.R. and Tchobanoglous G., "Environmental Engineering", McGraw Hill, New York	1986
4.	Mines R. O. and Lackey L. W. ""Introduction to Environmental Engineering", Prentice Hall, New Yark	2009
5.	Miheicic J. R. and Zimmerman J. B. " Environmental Engineering: Fundamentals, Sustainability, Design" John Wiley and Sons, Inc.	2010

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities & Social Sciences**

1. Subject Code: **HS-001A** Course Title: **Communication Skills (Basic)**

2. Contact Hours: **L: 1** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 2 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 00 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 2 6. Semester**: Autumn/Spring** 7. Subject Area**: HSS**

8. Pre-requisite**: NIL**

9. Objective:
The course intends to build the required communication skills of the students having limited communicative abilities, so that they may communicate effectively in real-life situations

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Understanding the Basics of Communication Skills: Listening, Speaking, Reading & Writing, Scope and Importance	**01**
2.	Grammar & Composition: Time and Tense, Agreement, Active-Passive, Narration, Use of Determiners, Prepositions & Phrasal Verbs	**05**
3.	Vocabulary Building & Writing: Word-formation, Synonyms, Antonyms, Homonyms, One-word Substitutes, Idioms and Phrases, Collocations, Abbreviations of Scientific and Technical Words	**02**
4.	Introduction to Sounds (Vowels & Consonants) Organs of Speech, Place and Manner of Articulation, Stress & Intonation, Listening Comprehension (Practical Sessions in Language Laboratory)	**02**

5.	Speaking, Countering Stage-fright and Related Barriers to Communication.	**02**
6.	Reading and Comprehension: Two lessons to be identified by the department.	**02**
	Total	**14**

List of Practicals:

1. Ice-breaking Exercises
2. Assignments on Time and Tense, Agreement, Active-Passive
3. Laboratory Session on Narration, Use of Determiners, Prepositions & Phrasal Verbs, Revisionary Exercises & Quiz
4. Laboratory Session on Synonyms, Antonyms, Homonyms
5. Assignments and Practice Sheets on One-word Substitutes, Idioms and Phrases, Collocations, Abbreviations of Scientific and Technical Words
6. Laboratory Session on Practice of sounds, Intonation and Stress, Listening Comprehension
7. Individual presentation, debates, Extempore & Turncoats
8. Exercises in Composition and Comprehension

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Murphy, Raymond. *Intermediate English Grammar*, New Delhi, Cambridge University Press.	**2009**
2.	Quirk, Randolph & Sidney Greenbaum. *A University Grammar of English*, New Delhi, Pearson.	**2009**
3.	McCarthy, Michael & Felicity O' Dell. *English Vocabulary in Use*, New Delhi, Cambridge University Press	**2010**
4.	Jones, Daniel. *The Pronunciation of English*, New Delhi, Universal Book Stall.	**2010**
5.	Birchfield, Susan M. *Fowler's Modern English Usage*, New Delhi, OUP.	**2004**
6.	Llyod, Susan M. *Roget's Thesaurus of English Words and Phrases*. New Delhi: Penguin.	**2010**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities & Social Sciences**

1. Subject Code: **HS-001B** Course Title: **Communication Skills (Advanced)**

2. Contact Hours: **L: 1** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory** 2 **Practical** 0

4. Relative Weight**:** **CWS** 25 **PRS** 00 **MTE** 25 **ETE** 50 **PRE** 0

5. Credits**:** 2 6. Semester**: Autumn/Spring** 7. Subject Area**: HSS**

8. Pre-requisite**: NIL**

9. Objective: The course intends to train the learners in using both verbal and non-verbal communication effectively.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Advanced Communication Skills: Scope, Relevance, & Importance	**01**
2.	Soft Skills: Interpersonal Communication; Verbal & Non-verbal, Persuasion, Negotiation, Neuro-Linguistic Programming	**03**
3.	Communication and Media (Social and Popular), The Social and Political Context of Communication, Recent Developments and Current Debates in Media	**04**
4.	Cross-cultural and Global Issues in Communication: Race, Ethnicity, Gender & Diaspora	**03**
5.	Rhetoric and Public Communication, Audience Awareness, Emotionality	**03**
	Total	**14**

List of Experiments:

1. Discussion on the Process of Communication in Personal and Professional Life
2. Group Discussion, Case Studies and Role-Play
3. Assignments on E-mail Etiquette, Social Networking, Blog Writing, Discussions on Current Issues
4. Non-Verbal Communication in Cross-Cultural Situations, Case Studies, Group Discussions and Readings on Topics Related to Race, Ethnicity , Gender and Diaspora
5. Individual Presentations (Audience Awareness, Delivery and Content of Presentation)

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Rentz, Kathryn, Marie E. Flatley & Paula Lentz. *Lesikar's Business Communication CONNECTING IH A DIGITAL WORLD*, McGraw-Hill, Irwin	**2012**
2.	Bovee, Courtland L & John V. Thill. *Business Communication Today*. New Delhi, Pearson Education	**2010**
3.	McMurrey, David A. & Joanne Buckley. *Handbook for Technical Writing*, New Delhi, Cengage Learning.	**2009**
4.	Jones, Daniel. *The Pronunciation of English*, New Delhi, Universal Book Stall.	**2010**
5.	Allan & Barbara Pease. *The Definitive Book of Body Language*, New York, Bantam	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Humanities and Social Sciences**

1. Subject Code: **HSN-002** Course Title: **Ethics and Self-awareness**

2. Contact Hours: **L: 01** **T: 0 1** **P: 0**

3. Examination Duration (Hrs.): **Theory 2** **Practical 0**

4.Relative Weight**: CWS:25 PRS:0 MTE:25 ETE:50 PRE:0**

5. Credit **02** 6. Semester**: Autumn** 7. Subject Area**: HSSC**

8. Pre-requisite**: NIL**

9. Objective: To introduce the concepts pertaining to ethical and moral reasoning and action and to develop self - awareness.

10. Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction**: Definition of Ethics; Approaches to Ethics: Psychological, Philosophical, Social.	**1**
2	**Psycho-social theories of moral development**: View of Kohlberg; Morality and Ideology, Culture and Morality, Morality in everyday context.	**3**
3	**Ethical Concerns**: Work Ethics and Work Values, Business Ethics, Human values in organizations.	**3**
4	**Self-Awareness**: Self Concept: Johari Window, Self and Culture, Self Knowledge, Self-Esteem; Perceived Self-control, Self-serving bias, Self-presentation, Self-growth: Transactional Analysis and Life Scripts.	**4**
5.	**Self Development**: Character strengths and virtues, Emotional intelligence, Social intelligence, Positive cognitive states and processes (Self-efficacy, Empathy, Gratitude, Compassion, and Forgiveness).	**3**
	Total	**14**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication
1.	Hall, Calvin S., Lindzey, Dardner., & Cambell, John B.,"Theories of Personality",Hamilton Printing Company.	1998
2.	Car Alan, "Positive Psychology: The Science of Happiness and Human Strengths", Brunner-Routledge.	2004
3.	Leary M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press.	2004
4.	Louis P. P., "The Moral Life: An Introductory Reader in Ethics and Literature", Oxford University Press.	2007
5.	Corey, G., Schneider Corey, M., & Callanan, P., "Issues and Ethics in the Helping Professions", Brooks/Cole.	2011
6.	Snyder, C.R., Lopez, Shane, J., & Pedrotti, J.T., "Positive Psychology" Sage, 2nd edition.	2011

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Mathematics**

1. Subject Code: **MAN-002** Course Title: **Mathematical Methods**
2. Contact Hours: **L: 3** **T: 1** **P: 0**
3. Examination Duration (Hrs.): **Theory : 3** **Practical : 0**
4. Relative Weightage**:** **CWS: 25** **PRS: 0** **MTE : 25** **ETE : 50** **PRE: 0**
5. Credits**: 4** 6. Semester**: Spring** 7. Subject Area**: BSC**
8. Pre-requisite**: Nil**
9. Objective: To provide knowledge of essential mathematical tools applied in solving ordinary and partial differential equations, initial and boundary value problems.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Ordinary Differential Equations:** Solution of linear differential equations with constant coefficients. Euler-Cauchy equations, Solution of second order differential equations by changing dependent and independent variables. Method of variation of parameters, Introduction to series solution method.	**10**
2.	**Partial Differential Equations:** Formation of first and second order partial differential equations. Solution of first order partial differential equations: Lagrange`s equation, Four standard forms of non-linear first order equations .	**6**
3.	**Laplace Transform:** Laplace and inverse Laplace transform of some standard functions, Shifting theorems, Laplace transform of derivatives and integrals. Convolution theorem, Initial and final value theorem. Laplace transform of periodic functions, error functions, Heaviside unit step function and Dirac delta function. Applications of Laplace transform.	**10**
4.	**Z - Transform:** Z – transform and inverse Z-transform of elementary functions, Shifting theorems, Convolution theorem, Initial and final value theorem. Application of Z- transform to solve difference equations.	**5**
5.	**Fourier series:** Trigonometric Fourier series and its convergence. Fourier series of even and odd functions. Fourier half-range series. Parseval`s identity. Complex form of Fourier series.	**5**
6.	**Fourier Transforms:** Fourier integrals, Fourier sine and cosine integrals. Fourier transform, Fourier sine and cosine transforms and their elementary properties. Convolution theorem. Application of Fourier transforms to BVP.	**6**
	Total	**42**

11. Suggested Books:

S.No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Kreyszig, E., "Advanced Engineering Mathematics", Johan Wiley & Sons	2011
2.	Jain, R. K. and Iyenger, S. R. K., "Advanced Engineering Mathematics", Narosa Publishing House	2009
3.	Amarnath, T., "An Elementary Course in Partial Differential Equations", Narosa Publishing House (II Edition)	2012
4.	Hildebrand F. B., "Methods of Applied Mathematics", Courier Dover Publications	1992
5.	Rao, K. S., "Introduction to Partial Differential Equations", PHI Learning Pvt. Ltd. (II Edition)	2010
6.	Sneddon, I. N., " Elements of Partial Differential Equations", McGraw-Hill Book Company	1988
7.	Simmons, G. F. and Krantz, S. G., Differential Equations:Theory, Technique and Practice" , Tata McGraw-Hill Edition	2007

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Mathematics Department**

1. Subject Code: **MAN-001** Course Title: **Mathematics I**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 3 **Practical** 0

4. Relative Weightage**:** **CWS** 25 **PRS** 00 25 50 0

5. Credits**:** 4 6. Semester**: Autumn** 7. Subject Area**: BSC**

8. Pre-requisite**:** **None**

9. Objective: **To provide essential knowledge of basic tools of Differential Calculus, Integral Calculus , Vector Calculus and Matrix Algebra for degree students.**

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Matrix Algebra:** Elementary operations and their use in getting the Rank, Inverse of a matrix and solution of linear simultaneous equations. Orthogonal, Symmetric, Skew-symmetric, Hermitian, Skew-Hermitian, Normal & Unitary matrices and their elementary properties. Eigen-values and Eigenvectors of a matrix, Cayley-Hamilton theorem, Diagonalization of a matrix.	**8**
2.	**Differential Calculus:** Limit, Continuity and differentiability of functions of two variables, Euler's theorem for homogeneous equations, Tangent plane and normal. Change of variables, chain rule, Jacobians, Taylor's Theorem for two variables, Error approximations. Extrema of functions of two or more variables, Lagrange's method of undetermined multipliers	**12**
3.	**Integral Calculus:** Review of curve tracing and quadric surfaces, Double and Triple integrals, Change of order of integration. Change of variables. Gamma and Beta functions. Dirichlet's integral. Applications of Multiple integrals such as surface area, volumes, centre of gravity and moment of inertia..	**12**
4.	**Vector Calculus:** Differentiation of vectors, gradient, divergence, curl and their physical meaning. Identities involving gradient, divergence and curl. Line and surface integrals. Green's, Gauss and Stroke's theorem and their applications.	**10**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors/ Books/Publishers	Year of Publication/Reprint
1.	E. Kreyszig, Advanced Engineering Mathematics, 9th edition, John Wiley and Sons, Inc., U.K.	2011
2.	R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House.	2005
3.	M.D. Weir, J. Hass, F.R. Giordano, Thomas' Calculus, 11th Edition, Pearson Education.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE **:** **PHYSICS**

1. Subject Code**:** **PHN-003** Course Title**:** **Electromagnetic Theory**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory** 0 | 3 **Practical** 0 | 0

4. Relative Weightage**:** **CWS** 25 **PRS** 00 25 50 00

5. Credits**:** 0 | 4 6. Semester**: Autumn** 7. Subject Area**: BSC**

8. Pre-requisite**: None**

9. Objective:
The objective of the course is to present the basic elements of Electrostatics, Magnetostatics, Maxwell's equations, and Electromagnetic Wave propagation.

10. Details of Course:

S.No.	**Particulars**	**Contact Hours**
1	**Vectors and Fields:** Cartesian coordinate System, Cylindrical and Spherical coordinate Systems, Constant coordinate surfaces, Del operator, Gradient, Divergence of a Vector and Divergence Theorem, Curl of a vector and Stoke's theorem, Gradient, Divergence, Curl and Laplacian in the three coordinate Systems, Laplacian of a scalar, Scalar & Vector Fields, Classification of Vector field. Sinusoidally time-varying fields, Complex Numbers and Phasor technique.	**8**
2	**Electrostatics:** Field intensity, Gauss's law & its applications, Maxwell's 1st eqn. (Electrostatics), Electric Energy and potential, the line integral, Potential gradient, the dipole fields, Energy density in an electrostatic field. Current and current density, Continuity of current, Metallic conductors, Conductor properties and boundary conditions, the nature of Dielectric materials and related Boundary conditions, Capacitance, Capacitance of a two-wire line, Current analogies. Electrostatic boundary-value problems, Laplace's and Poisson's equations, Uniqueness theorem, General procedure for solving Laplace's and Poisson's equation, Resistance and capacitance, Method of images.	**10**

3	**Magnetostatics:** Biot-Savart's law, Ampere's circuital law, Applications of Ampere's law, Magnetic flux and magnetic flux density - Maxwell's eqn., Maxwell's eqn. for static electromagnetic fields, Scalar and vector magnetic potentials. Magnetic dipole, Force due to Magnetic field on a differential current element, force between two differential current elements, Force and torque on a closed circuit, The nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Inductors and inductances, Magnetic energy, Magnetic circuits, Potential energy and force on magnetic materials.	**12**
4	**Maxwell's equations and Electromagnetic wave propagation:** Faraday's law, Displacement current, Maxwell's equations in point form, Maxwell's equations in integral form, Kirchoff's Voltage law and Kirchoff's Current law from Maxwell's equations, EM waves in general, EM wave propagation in Lossy Dielectrics, Wave propagation in lossless dielectrics, Plane waves in free space, Plane waves in Good conductors, Power & Poynting Vector, Reflection of a plane wave at normal incidence, Reflection of a plane wave at oblique incidence.	**12**
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication
1.	Engineering Electromagnetics, William H Hayt, Jr., and John A. Buck, Tata McGraw Hill Publishing Company Ltd, New Delhi, 7th edition	**2005**
2.	Elements of Engineering Electromagnetics, Matthew N.O. Sadiku, Oxford University Press, 3rd Edition	**2003**
3.	Elements of Engineering Electromagnetics, Nannapaneni Narayan Rao, Prentice Hall of India, New Delhi, 4th Edition	**2000**
4.	Introduction to Electrodynamics, D.J. Griffiths, Prentice Hall, 3rd Edition	**2000**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN- 351** Course Title**:** **Artificial Neural Networks**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 20** **PRS: 20** **MTE: 20** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

7. Pre-requisite**: Nil**

9. Objective:

To familiarize with the concepts, strength and weaknesses of neural networks in problem solving.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** History of neural networks, biological neurons and information processing in biological neurons; Neural networks, artificial neurons, networks of artificial neurons.	**3**
2.	**Single Layer Perceptron:** Single neuron models, learning and generalization in single layer perceptrons, convergence of perceptron learning rule, Hebbian learning, gradient descent learning, least mean square (LMS), concept of decision boundaries, practical considerations, adaline and madaline, adaptive filtering.	**7**
3.	**Multi-Layer Perceptrons (MLP):** Back-Propagation, learning with momentum, problems with back-propagation networks under-fitting and over-fitting, methods to improve generalization, applications of multi-layer perceptrons, and computational power of multi-layer perceptrons.	**6**
4.	**Radial Basis Function (RBF) Networks:** Introduction, Radial Basis Functions, learning in RBF networks, unsupervised learning of hidden layer, comparison of RBF networks and MLP networks.	**4**
5.	**Attractor Type Networks:** Hopfield networks, dynamics of Hopfield networks, energy concepts, Boltzman machine, brain-state-in a box (BSB) networks, generalized BSB networks, attractor type networks for content addressable memories, solving optimization problem using attractor type networks.	**8**

S. No.	Contents	Contact Hours
6.	**Support Vector Machines (SVM):** Concept of statistical learning, concept of VC dimension, linear SVM, kernels, nonlinear SVM, classification and function approximation using SVM.	**5**
7.	**Unsupervised Learning:** Maxnet, competitive learning, self-organizing feature maps, ART networks, grow when required (GWR) networks, learning vector quantizers (LVQ).	**8**
8.	**Advanced Topics**: Evolving neural networks, fuzzy logic and evolutionary computation applications in neural networks, hidden Markov models (HMM) and hybrid approaches, implementation of neural networks- hardware and optical, spiking neurons and pulsed neural networks (PNN)	**8**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Haykin S., "Neural Networks - A Comprehensive Foundation", 2nd Ed., Prentice Hall International Edition.	**2007**
2.	Mehrotra K., Mohan C. K. and Ranka S., "Elements of Artificial Neural Networks", Penram International.	**2007**
3.	Jacek M. Z., "Introduction to Artificial Neural Systems", Jaico Publishing House.	**2003**
4.	Anderson J. A., "An Introduction to Neural Networks", Prentice Hall of India Private Limited.	**2007**
5.	Hassoun M. H., "Fundamentals of Artificial Neural Networks", Prentice Hall of India Private Limited.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Electrical Engineering**

1. Subject Code**: EEN-352** Course Title**: Digital Image Processing**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**: CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Nil**

9. Objective:

To familiarize with the concepts of 2-D discrete signals, their transformation, design of 2-D digital filters, image enhancement, restoration, segmentation and compression techniques.

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10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Digital Image Fundamentals:** Human visual system and visual perception, image sensing and acquisition, image file types, pixel representation and relationship.	**4**
2.	**2-D Discrete Signals and Systems:** 2-D signals and their representation, linear, shift-invariant, causal and BIBO stable systems.	**6**
3.	**2-D Signal Operations:** Additions, multiplications, shifting, folding, convolution- linear and circular.	**3**
4.	**2-D Signal Transforms:** 2-D continuous and discrete-time Fourier transform, 2-D discrete Fourier transform, 2-D z-transform and stability concepts.	**5**
5.	**Design of 2-D Digital Filters:** Design of 2-D FIR filters, design of 2-D FIR filters.	**4**
6.	**Image Enhancement and Restoration Techniques:** Contrast modification and stretching, histogram equalization, unsharp masking, homomorphic processing, interpolation, mean and median filtering, least square and Wiener filtering.	**7**

S. No.	Contents	Contact Hours
7.	**Image Segmentation Techniques:** Thresholding, edge based segmentation, region based segmentation.	**7**
8.	**Image Compression Techniques:** Fundamentals of image compression, loss-less compression techniques, lossy compression techniques.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Bose T., "Digital Signal and Image Processing", Wiley India.	**2008**
2.	Gonzalez R. C. and Woods R. C., "Digital Image Processing", 2nd Ed., Pearson Education.	**2007**
3.	Jain A. K, "Fundamentals of Digital Image Processing", Prentice Hall of India Private Limited.	**2007**
4.	Sonaka M., Hlavac V. and Boyle R., "Image Processing, Analysis and Machine Vision", 2nd Ed., Cengage Learning.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**: EEN-353** Course Title**: Digital Design with VHDL**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**: CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Digital Systems**

9. Objective:

The course aims to familiarize the students with the VHDL language and the principles of digital system design including CPU. The course also deals with FPGAs and CPLDs which allow rapid prototyping of digital design.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of Logic Design Fundamentals:** Combinational logic, hazards in combinational networks, Mealy and Moore sequential circuit design, sequential circuit timing, setup and hold times.	**4**
2.	**VHDL:** Introduction, VHDL terms, code structure, data types, operators and attributes, concurrent and sequential code, variables and signals, subprograms and procedures, packages and libraries, pre-defined attributes.	**4**
3.	**VHDL Description of Combinational Circuits:** Multiplexers, decoders, encoders, code converters.	**5**
4.	**VHDL Description of Sequential Circuits:** Flip-flops, registers, counters, clock synchronization.	**6**
5.	**Design of Programmable Logic Devices:** Read-only memories, programmable logic arrays, programmable array logics,	**5**
6.	**Design of Circuits with Arithmetic Operations:** Serial adder, binary multiplier, multiplication of signed numbers, binary divider.	**4**
7.	**Design of Memories:** VHDL models for memories and buses, simplified bus model, interfacing memory to a microprocessor bus.	**3**

S. No.	Contents	Contact Hours
8.	**Design with Programmable Gate Arrays:** Introduction of FPGAs, designing with FPGAs and CPLDs.	**5**
9.	**Hardware Testing and Design:** Testing combinational logic, testing sequential logic, scan testing.	**2**
10.	**Case Study:** Design of UART, design of microcontroller CPU, top-level CPU design, sample instruction representation.	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Mano M. M. and Ciletti M. D., "Digital Design", 4th Ed., Pearson Education.	**2008**
2.	Wakerly J. F., "Digital Design – Principles and Practices", 4th Ed., Pearson Education.	**2008**
3.	Perry D. L., "VHDL Programming by Example", 4th Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
4.	Roth C. H., "Digital System Design Using VHDL", Cengage Learning.	**2008**
5.	Brown S. and Vranesic Z., "Fundamentals of Digital Logic with VHDL Design", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
6.	Pedroni V. A., "Circuit design with VHDL", Prentice Hall of India Private Limited.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**: EEN-354** Course Title**: Digital Control Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**: CWS: 25 PRS: 0 MTE: 25 ETE: 50 PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Control Systems**

9. Objective:

To make the students conversant with the techniques of discrete-time control systems being used for industrial control.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Review of z-transform and stability analysis, relationship between the s-plane and the z-plane, inverse z-transform; Theorems of the z-transform, applications of z-transform; Delayed z-transform, Modified z- transform.	**6**
2.	z-Transform design of digital control systems, pulse transfer function, z-transfer function, characteristic equation of closed loop systems; Multirate discrete-data systems.	**6**
3.	State-space analysis of sampled data systems, state equations of discrete data systems, eigenvalues and eigenvectors, state transition matrix, state diagram of discrete-data systems with zero order hold; Controllability and observability of linear time-invariant discrete-data systems.	**6**
4.	Design using state-space techniques; Stability tests of discrete data systems: Bilinear transformation method, Jury's stability test and second method of Lyapunov; Root loci for digital control systems, design of discrete PID, PD and PI controllers, effect of adding poles and zeros, pole-placement design techniques.	**6**

S. No.	Contents	Contact Hours
5.	System identification techniques, estimation of parameters in models of dynamical systems: finite impulse response models, transfer function models, non-linear models and stochastic models.	**6**
6.	Model reference and self tuning control, determination of adaptation gain, design of model reference adaptive system using Lyapunov theory, properties of adaptive systems, robust adaptive controllers, application of adaptive control; Auto-tuning techniques.	**8**
7.	Applications.	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Leigh J. R., "Applied Digital Control – Theory, Design and Implementation", 2nd Ed., Prentice-Hall International.	**2005**
2.	Franklin G. F., Powell J. D. and Workman M. L., "Digital Control of Dynamic Systems", 3rd Ed., Pearson Education.	**2008**
3.	Iserman R., "Digital Control System", 2nd Ed., Springer-Verlag.	**1996**
4.	Strjec V., "State-Space Theory of Discrete Linear Control", John Wiley and sons.	**1981**
5.	Gopal M., "Digital Control and State Variable Methods", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
6.	Kuo B. C., "Digital Control Systems", 2nd Ed., Oxford University Press.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-355** Course Title**:** **Digital Signal Processing**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 20** **PRS: 20** **MTE: 20** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Digital Systems**

9. Objective:

To introduce mathematical models of signals, analysis and filter design concepts.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of Signals and Systems:** An introduction to signals, systems and signal processing, representation of signals in time domain, classification of signals, periodic sampling, sampling theorem. Discrete time signals, discrete time system; linear, time-invariant systems; impulse response, convolution and correlation; linear constant coefficient difference equation, Z-transform and its properties.	**5**
2.	**Mathematical Methods in Signal Processing:** Vector-space geometry, Hilbert spaces, L_P and L_∞ spaces, vector spaces, norms, projections, orthogonality principle, Linear algebra, linear transformations, linear operators, matrix inverses, least squares and minimax error criteria, eigenvalue decompositions, singular value decompositions, Kronecker products, vee operator.	**9**
3.	**Fourier Analysis:** Fourier analysis of continuous and discrete-time signals with periodic and aperiodic nature; discrete Fourier transform and its properties; signal analysis and synthesis based on DFT, fast Fourier transform algorithms: radix-2, radix-3 DIT, DIF FFT algorithms, butterfly structures, relationship between FFT and DFT.	**9**

S. No.	Contents	Contact Hours
4.	**Structure and Design of Digital Filters:** Fundamental structures of digital filters, general considerations for design of digital filters; Internal representation of LTI systems; Design of FIR filters: Low pass, Band pass, High Pass filter designs, Parks-McClellan Method, Half-band FIR filters, Phase response of FIR filters, Analyzing FIR filters; Design of IIR Filters: Pole and zeros to analyze IIR filters, Impulse variant Bilinear transform IIR filter designs, Optimized IIR filter design method, Comparison of FIR and IIR Filters.	**12**
5.	**Digital Signal Processing Techniques:** Discrete Hilbert transform, sample rate conversion, multi-rate systems, comb filters, signal averaging, frequency sampling filters, quantization effects.	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Mitra S. K., "Digital Signal Processing: A Computer – Based Approach", 2nd edition, Tata McGraw Hill.	**2001**
2.	Oppenheim A.V., Schafer R. W. and Buck J. R., "Discrete Time Signal Processing", 3rd edition, Pearson Education.	**2009**
3.	Lyons R. G., "Understanding Digital Signal Processing", 3rd edition, Pearson Education.	**2012**
4.	Moon T. K. and Stirling W. C., "Mathematical Methods and Algorithms for Signal Processing", Prentice Hall, 1999.	**1999**
5.	Haykin S. and Veen B. V., "Signals and Systems", 2nd edition, John Wiley.	**2004**
6.	Lathi B. P., "Principles of Signal Processing and Linear Systems", Oxford International Version..	**2009**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-356** Course Title: **Signals and Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: NIL**

9. Objective:

To introduce signals characteristics and analysis, theory related to systems and its analysis.

10. Details of 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.	**4**
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**

S. No.	Contents	Contact Hours
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.	**5**
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.	**5**
7.	**Applications:**Modulation, types, benefits, window functions, Filtering, digital filters, frequency response, mapping continuous filters to discrete time filters, digital filters and equalizers, simulation examples: signal representation, system response, Fourier spectrum, pole-zero plots in s-domain and z-domain.	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Oppenheim A.V., Willsky A.S., Nawab S.H.,"Signals and Systems", 2nd edition, Prentice Hall.	**1997**
2.	Haykin S., Veen B.V., "Signals and Systems", 2nd edition, John Wiley.	**2004**
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 DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**: EEN- 357** Course Title**: Advanced Microprocessors and Interfacing**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**: CWS: 20 PRS: 20 MTE: 20 ETE: 40 PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Digital Systems**

9. Objective:

The aim is to expose the students to the architecture, instruction set and assembly language programming of typical 16-bit microprocessors. The course also provides interfacing details of I/O devices with the processor.

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10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Evolution of Microprocessors:** 8-bit and 16-bit microprocessors, Intel, Zilog and Motorola processors.	**2**
2.	**Architecture of a 16-bit Microprocessor**: Intel 8086 and 8088 processor, concept of pipelining and memory segmentation, logical address, offset address and physical address; Bus Interface Unit (BIU); Execution Unit (EU), segment registers.	**3**
3.	**Operation of 16-bit Microprocessor:** Pin configuration of Intel 8086/8088; Minimum and maximum modes of operation; Address bus, data bus and control bus; Clock generator Intel 8284; Memory organization, memory address space.	**6**
4.	**Interfacing:** Interfacing concepts, interfacing memory; Input-output techniques, interfacing of I/O devices to the processor.	**2**
5.	**Addressing Modes:** Data related addressing modes- register, immediate, direct, register indirect, based relative, indexed relative and based indexed, branch related addressing modes- intrasegment direct and indirect, intersegment direct and indirect.	**3**
6.	**Instruction Set of 16-Bit Microprocessor**: Machine cycles, data transfer, arithmetic, bit manipulation, string, program execution transfer and processor control instructions.	**8**

S. No.	Contents	Contact Hours
7.	**Assembler Directives:** ASSUME, DB, DD, DQ, DT, DW, DUP, END, EQU, EVEN, ORG, OFFSET, PROC, ENDP, LABEL and PTR.	**2**
8.	**Assembly Language Programming:** Macro-assembler, segment definition and models.	**4**
9.	**Interrupt Structure:** Interrupt pointer, type numbers, processing of interrupt, internal and external interrupts, interrupt priorities, BIOS routines.	**3**
10.	**Programmable Support Chips**: Interfacing of programmable parallel interface Intel 8255, programmable interval timer Intel 8253, programmable interrupt controller Intel 8259 with 16-bit processor.	**5**
11.	**Coprocessors and Multiprocessing.**	**4**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Hall D. V., "Microprocessor and Interfacing –Programming and Hardware", Tata McGraw-Hill Publishing Company Limited.	**2006**
2.	Liu Yu-Cheng and Gibson G. A., "Microcomputer Systems; The 808618088 Family", 2nd Ed., Prentice Hall of India Private Limited.	**2007**
3.	Brey B. B., "Intel 8086, 8088, 80186, 80187, 80286, 80386, 80486, Pentium and Pentium Pro Processors, Architecture, Design and Application", Prentice Hall of India Private Limited.	**2006**
4.	Mazidi M. A. and Mazidi J. G., "The 80x86 IBM PC and Compatible Computers (Vol. I and II), Assembly Language, Design and Interfacing", Prentice Hall International Edition.	**2003**
5.	Triebel W. A. and Singh A., "The 8088 and 8086 Microprocessors, Programming Interfacing, Software, Hardware and Applications", 4th Ed., Prentice Hall of India Private Limited.	**2007**
6.	Intel Manual on 16-bit Microprocessor.	**--**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-358** Course Title**:** **Data Structures**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Programming**

9. Objective:

To familiarize students with the concept of abstract data type, hardware and software implementations of data structures, various existing data structures and their related operations with the help of different application problems.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Need of data structures, hardware and software implementations of data structures, various existing data structures and their related operations**,** compile time memory allocation and dynamic (run time) memory allocation, garbage collection.	**3**
2.	**Linked List:** linked array and pointer representations their advantages and disadvantages, creation traversal, insertion and deletion, sorting, concatenation, merging, searching, header node, link list with grounded header node, circular link list, Josephus doubly linked (two way) link, its advantages and disadvantages.	**7**
3.	**Stack:** Array Representation, overflow and underflow, push and pop operations, recursion its advantages, converting a recursive procedure to a non-recursive procedure.	**2**
4.	Tower of Hanoi problem, Infix, prefix and postfix notations, evaluation a postfix expression using stack, implementing quick sort algorithm using stack,	**2**
5.	**Queue:** Simple queue, addition to a queue, removal from a queue, de-queue, input restricted and output restricted de-queue, addition and removal w.r.t. de-queue.	**3**

S. No.	Contents	Contact Hours
6.	**Tree:** Basic definitions, representation in computer memory, creating a binary tree, traversal algorithms threading in a binary tree, heap tree, creation of heap tree, inserting a node in a heap tree, deleting the root of heap tree, heap sort algorithm, link list representation using binary tree, multi-way search tree, representation in computer memory and its advantages.	**10**
7.	**Graph:** Basic definitions, representation in computer memory, creation of a graph, traversal in a graph, depth first traversal and breadth first traversal, sorting, inserting an arc in a graph, deleting an arc from a graph, searching a node and an arc in a graph.	**7**
8.	**Searching Algorithms:** Sequential search, binary search, efficiency of searching algorithms, improving the efficiency of sequential search by move to front , move forward, indexed sequential search.	**2**
9.	**Table Data Structure:** Hash function and hashing, selection of hash function, collision and collision resolving methodologies, linear probing, quadratic probing, buckets, chaining, storing (inserting) data in table, searching a data record in a table, deleting a data record from a table, efficiency of search.	**4**
10.	**Sorting Algorithms:** Bubble sort, quick sort, heap sort, insertion sort, selection sort, merge sort, efficiency of sorting algorithms.	**2**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Tenenbaum A. M., Langsam Y., and Augenstein M. J., "Data structures using C and C++", 2nd Ed., Prentice Hall of India Private Limited.	**2008**
2.	Lipschutz S., "Data Structures Schaum's Outline Series", Tata McGraw-Hill Publishing Company Limited.	**2008**
3.	Rowe G. W., "Introduction to Data Structures and Algorithms With C++", Prentice Hall of India Private Limited.	**2004**
4.	Sahni S., "Data Structures, Algorithms and Application in C++", 2nd Ed., University Press.	**2007**
5.	Preiss B. R., "Data Structures and Algorithms with Object Oriented Design Patterns in C++", Wiley India.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**: EEN-359** Course Title**: Single Chip Microcontroller and Its Applications**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**: CWS: 15 PRS: 25 MTE: 20 ETE: 40 PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Microprocessors**

9. Objective:

To provide in-depth knowledge of Intel 8051 family microcontrollers, their architectures, operation, instruction set, programming and interfacing.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Review of 8-bit Microprocessor:** State transition diagram, interrupt structure, input/output techniques; Review of peripheral devices- Intel 8255 PPI and Intel 8253 PIT; ADC and DAC chips and their interfacing.	**6**
2.	**Programmable Interrupt Controller**: Intel 8259, pin configuration, functional description and operation in 8-bit and 16-bit environment, initialization and operation control words, operating modes: AEOI, automatic rotation, specific rotation, special mask mode, cascade mode, buffered mode, poll mode, programming.	**5**
3.	**Keyboard and Display Interface:** Intel 8279, concept of display interface and keyboard interface, pin configuration of Intel 8279, functional description, scanned keyboard matrix mode, sensor matrix mode, strobed mode, left entry and right entry display, interfacing, programming.	**4**
4.	**Intel 8051/8052 Microcontroller:** Introduction, architecture, functional diagram, pin description, CMOS and HMOS microcontrollers and their difference, oscillator, CPU Timing, Intel 8031 and 8751.	**4**

S. No.	Contents	Contact Hours
5.	**Memory Organization:** Accessing external program and data memory, internal data memory, special function registers, hardware interfacing, timing diagrams, I/O expansion.	**5**
6.	**I/O Ports and Timer:** Internal structure of ports P0, P1, P2 and P3, alternative functions of port P3; Timer and counter operation, TM0, TM1 and TM2, modes of operation; Applications.	**5**
7.	**Programming:** Addressing modes; Instruction set: Data transfer group, arithmetic group, logical group, control group and Boolean processing capability; Programming and erasing EPROM.	**7**
8.	**Interrupts**: Types, interrupt priority and interrupt enable registers, processing of interrupt, single-step operation.	**3**
9.	**Serial Port**: Modes of operation, programming, multi-processor control.	**3**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Intel Manual on 8-bit Microcontroller	**--**
2.	Ayala K. J.," The 8051 Microcontroller- Architecture, Programming and Applications", 3rd Ed, Cengage Learning.	**2008**
3.	Hall D.V., "Microprocessor and Interfacing –Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited.	**2008**
4.	Mazidi M.A. and Mazidi J.G., "The 8051 Microcontroller and Embedded Systems", 2nd Ed., Pearson Education.	**2008**
5.	Deshmukh A.V., "Microcontroller: Theory and Applications", Tata McGraw-Hill Publishing Company Limited.	**2008**
6.	Peatman J.B., "Design with PIC Microcontrollers", Pearson Education.	**2008**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-360** Course Title**:** **Embedded Systems**

2. Contact Hours: **L: 3** **T: 0** **P: 2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 15** **PRS: 25** **MTE: 20** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Basic course on 8-bit Microprocessors**

9. Objective:

To familiarize the students with the fundamentals of embedded system architecture, its basic hardware and software elements, programming models and software engineering practices that are used during the system development process.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Embedded system, processor in the system, hardware and software components, system-on chip.	**2**
2.	**Review of Processor and Memory**: General-purpose processors, single-purpose processors, application specific processors, CISC and RISC processor architecture, arm processors, memory devices, processor and memory selection for an embedded system, interfacing processor, memory and I/O devices, 8/16 bit microcontrollers.	**8**
3.	**Devices and Buses**: Review of I/O and timer devices, parallel communications using ISA, PCI and other buses, serial communication using I^2C, CAN, USB and advanced buses, interrupt serving mechanism, device drivers.	**8**
4.	**Embedded Programming**: Review of programming in ALP and in C, embedded programming in C++, memory organization, compiler and cross compiler.	**6**
5.	**Embedded Software Development:** Program modelling concepts, modelling processes for software analysis, response time constraint for real time programs, multi-processor systems.	**6**

S. No.	Contents	Contact Hours
7.	**Real Time Operating Systems:** Operating system services, i/o subsystems, network operating systems, embedded system operating systems, interrupt routines in RTOS environment.	**7**
8.	**Hardware-Software Co-design**: Embedded system design and co-design issues, software tools for development of an embedded system	**5**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Kamal R., "Embedded Systems – Architecture, Programming and Design", Tata McGraw-Hill Publishing Company Limited.	**2008**
2.	Vahid F. and Givargis T., "Embedded System Design – A Unified Hardware/Software Introduction", Wiley India.	**2008**
3.	Maxfield C. M., "The Design Warrior's Guide to FPGAs – Devices, Tools and Flows", Newnes.	**2006**
4.	Berger A. S., "Embedded System Design – An Introduction to Processes, Tools and Techniques", CMP Books.	**2001**
5.	Labrosse J. J., "Embedded Systems Building Blocks", 2nd Ed., CMP Books.	**1999**
6.	Barr M., "Programming Embedded Systems in C and C++", O'Reilly.	**1999**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-361** Course Title: **Optimization Techniques**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Objective:

To familiarize students with foundations of optimization techniques & tools for the modeling and solving the engineering problems.

9. Details of Course:

S. No.	Contents	Contact Hours
1.	**Classical Optimization Technique:** Modeling Optimization Problems, Defining the Problem, Formulating a Mathematical Model, Single variable optimization, Concepts and terms related to optimization problem, necessary and sufficient conditions for a multivariable function, Multivariable optimization: without constraints, with equality constraints and with unequality constraints	**5**
2.	**Linear Programming:** Simplex method, Big M method; Two phase Method; Degeneracy; Alternate optima; Unbounded optimal solutions; Infeasible solutions; Duality & sensitivity analysis- dual simples Method, primal dual computations.	**7**
3.	**Transportation Problems:** Determination of starting solution; Iterative computations of algorithm; Assignment problems- Hungarian method & its simplex explanation	**5**
4.	**Integer Programming:** Branch & bound method; Zero-one implicit enumeration algorithm; Cutting plane algorithm.	**5**
5.	**Non-Linear Programming I:** Constrained and unconstrained optimization problems. Concept of Lagrange multipliers and its application to unconstrained optimization problem. Solution of unconstrained minimization problem using, Gradient descent method, Steepest descent method, Newton's method. Davison-Fletcher-Powell method, Exterior point method.	**8**

S. No.	Contents	Contact Hours
6.	**Non-Linear Programming II:** Solution of constrained minimization problems using Karush-Kuhn-Tucker (KKT) necessary and sufficient conditions. Understanding of • convex sets, convex and concave functions, • properties of convex function. • definiteness of a matrix and test for concavity of function. convex optimization, quadratic optimization, constrained quadratic optimization	**7**
7.	**Non-Linear Programming III:** Solution of quadratic programming problems using KKT necessary condition, Basic concept of interior penalties and solution of convex optimization problem via interior point method.	**5**
	Total	**42**

10. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Taha H.A.," Operations Research", Eighth Ed., Macmillan Publishing Co. Prentice Hall of India.	**2009**
2.	Ignizio J. P., "Linear Programming in single & multiple objecting systems", Prentice Hall of India	**1982**
3.	Bazaraa M.S., Jarvis J.J.," Programming & Network Flows", John Willy & sons.	**1977**
4.	Arora J. S., "Introduction to optimum design", Elsevier.	**2006**
5.	Ravindran A., Ragsdell K. M. and Reklaitis G. V.," Engineering Optimization: Methods and Applications", Wiley India Edition.	**2006**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-363** Course Title: **Fuzzy Logic Systems**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Control Systems**

9. Objective:

To familiarize students to identify, formulate, and solve engineering problems in the areas of knowledge representation, uncertainty handling, artificial intelligence and control.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Basic Concepts :** Classical sets and fuzzy sets, operations on fuzzy sets, properties of classical sets, fuzzy sets operations, properties of fuzzy sets, membership formulation and parameterization, derivatives of parameterized MFs, Parameterized T-norm and T-conorm.	4
2.	**Fuzzy Relations and Approximate Reasoning**: Extension principle, fuzzy relations, operations on fuzzy relation, linguistic variables, fuzzy if-then rules, compositional rule of inference, fuzzy reasoning.	4
3.	**Fuzzy Logic Control:** Basic concept of fuzzy logic control, reasoning with an FLC, relationship to PI, PD and PID control,design of FLC:determination of linguistic values, construction of knowledge base, inference engine, tuning, fuzzification and defuzzification	6
4.	**Fuzzy Systems Models:** Linguistic models as a tool for complex system representation, Mamdani type models, linguistic models for dynamic systems: state space approach, input-output fuzzy models of dynamic systems, Takagi-Sugeno-Kang (TSK) fuzzy models.	6
5.	**Nonlinear and Adaptive Fuzzy Control:** Fuzzy controller as a nonlinear transfer element, computational structure, sliding mode fuzzy logic controller, adaptive fuzzy control, the adaptation mechanism, membership function tuning using gradient descent, self-organizing controller, model based controller.	6

S. No.	Contents	Contact Hours
6.	**Stability of Fuzzy Control Systems:** Stability and robustness indices, the state space approach, input-output stability, circle criterion.	**5**
7.	**Neuro-Fuzzy Modeling:** Basics of neural networks, adaptive neuro-fuzzy inference systems (ANFIS), hybrid learning algorithm, extreme ANFIS.	**4**
8.	**Fuzzy Classification and Pattern Recognition:** Classification by equivalence relations, cluster analysis, c-means clustering, fuzzy c-means algorithm, feature analysis, partitions of the feature space, multi-feature pattern recognition, syntactic recognition.	**7**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Yager R. R. and Filev D. P., "Essentials of fuzzy modeling and control", John Wiley and Sons.	**1994**
2.	Driankov, Hellendoorn, Reinfrank, "An Introduction to Fuzzy Control", Narosa Publishing House.	**1993**
3.	Timothy J. R., "Fuzzy Logic with Engineering Applications", 3rd edition, John Wiley and Sons	**2011**
4.	Jang S. R., Sun C.T. and Mizutani E., "Neuro-fuzzy and soft computing: a computational approach to learning and machine intelligence", Prentice-Hall of India	**2004**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT./CENTRE: **Department of Electrical Engineering**

1. Subject Code**:** **EEN-364** Course Title**:** **Utilization and Traction**

2. Contact Hours: **L: 3** **T: 1** **P: 0**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 25** **PRS: 0** **MTE: 25** **ETE: 50** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Electrical Machines**

9. Objective:

To familiarize with important industrial applications of electrical energy such as electric traction, illumination, electric welding, electric heating and electrolytic process.

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10. Details of Course:

S. No.	Contents	Contact Hours
	Electric Traction	
1.	Classification of electric traction services, operational constraints of main line and suburban trains, electric power supply system.	**2**
2.	Nature of traction load, coefficient of adhesion, duty cycle, driving axle code.	**3**
3.	Types of dc motors used in traction and their series-parallel connections for sharing load.	**2**
4.	Calculation of tractive effort and energy consumption, maximum allowable tractive effort.	**5**
5.	Traction dc motor control, conventional and semiconductor converter control, different topologies.	**5**
6.	Poly-phase motors in traction drives, different topologies.	**3**
7.	Diesel electric traction.	**1**
	Illumination	
8.	Nature of sunlight, definition of lighting terms, luminous efficiency, production of light, electric discharge, fluorescent and filament lamps, polar curves.	**4**
9.	Lighting calculation, solid angle, square law, cosine cube law, light flux method.	**3**
10.	Design of flood lighting, design of street lighting.	**3**

S. No.	Contents	Contact Hours
11.	**Electric Welding and Heating** Advantages and methods of electric heating, resistance ovens, induction heating, dielectric heating, arc furnace, heating of buildings, electric welding.	**6**
12.	**Electrolytic Process** Fundamental principles, extraction and refining of metals, electro-deposition, power supply for electrolytic processes.	**5**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors /Books / Publishers	Year of Publication/ Reprint
1.	Dubey G. K., "Fundamentals of Electric Drives", 2nd Ed., Narosa Publishing House.	**2007**
2.	Taylor E. O., "Utilisation of Electric Energy (in SI units)", Orient Longman, Revised in S.I. units by Rao, V.V.L	**1999**
3.	Hancock N. N., "Electic Power Utilisation", Wheelers.	**1979**
4.	Pratap H., "Modern Electric Traction", Dhanpat Rai and Sons.	**2007**

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT. /CENTRE: **Department of Electrical Engineering**

1. Subject Code: **EEN-365** Course Title: **Digital Signal Procesors**

2. Contact Hours: **L: 3** **T: 1** **P: 2/2**

3. Examination Duration (Hrs.): **Theory: 3** **Practical: 0**

4. Relative Weight**:** **CWS: 20** **PRS: 20** **MTE: 20** **ETE: 40** **PRE: 0**

5. Credits**: 4** 6. Semester**: Both** 7. Subject Area**: PEC**

8. Pre-requisite**: Knowledge of Signal Processing**

9. Objective:

To familiarize students with the architecture, programming and applications of DSP processors.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction DSP Processors:** Microcontrollers, Microprocessors, digital signal processors, DSP requirements, analysis tools for DSP systems, circular buffering, fixed and floating point, c language and assembly language; Number formats for representation of signals and coefficients, dynamic range and precision, sources of errors in a DSP Implementation, A/D and D/A conversion errors, DSP Computational errors.	**5**
2.	**DSP Architecture:** Basic architectural features, Von Neumann architecture, Harvard architecture, superscalar architecture, computational building blocks, Bus architecture and memory, data addressing, address generation unit, DSP data path arithmetic, precision, overflow, multiplier, accumulator, rounding, programmability and program execution, speed issues, features for external interfacing.	**6**
3.	**Programmable Digital Signal Processors:** The architecture of digital signal processors, addressing modes, memory spaces, program control, instructions and programming, On-chip peripherals, interrupts, pipeline operation.	**7**

S. No.	Contents	Contact Hours
4.	**DSP Development Tools:** The DSP development tools, DSP System design kit, Software for development, initialization, vector file, linker command file, assembler and the assembly source file, linker and memory allocation, C Compiler, Code composer studio.	**4**
5.	**Implementations of DSP Algorithms:** FIR and IIR filters, interpolation filters, decimation filters, PID controller, adaptive filters, 2-D Signal Processing, FFT algorithm for DFT computation, butterfly computation, overflow and scaling, bit-reversed index generation, computation of signal spectrum.	**7**
6.	**Interfacing to DSP's :** Parallel interfacing to DSP processors, memory space organization, memory and I/O signals, memory interface, parallel I/O, programmed I/O, interrupts and I/O, direct memory access, reading data from memory mapped peripheral ADCs, writing data to memory mapped peripheral DACs, serial interfacing to DSP processors, interfacing to I/O ports, Analog front ends, and codes to DSPs, DSP system interface.	**7**
7.	**Applications** Speech processing system, ECG processing, image processing system.	**6**
	Total	**42**

11. Suggested Books:

S. No.	Name of Authors / Books / Publishers	Year of Publication/ Reprint
1.	Lapsley P., Bier J., Shoham A. and Lee E. A., "DSP Processor Fundamentals: Architectures and Features", Berkeley Design Technology, Inc.	**1996**
2.	Singh A. and Srinivasan S., "Digital Signal Processing", 1st edition, Cengage Delmar Learning India.	**2004**
3.	Kumar B. P., "Digital Signal Processing Laboratory", 2nd edition, CRC press.	**2010**
4.	Kehtarnavaz N., "DSP System Design: Using the TMS320C6000", Prentice-Hall.	**2001**
5.	Kehtarnavaz N., "C6x-Based Digital Signal Processing", Prentice-Hall.	**2000**
6.	Chassaing R., "Digital Signal Processing and Applications with the C6713 and C6416 DSK", John Wiley and sons.	**2005**
7.	Smith S. W., "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing.	**1997**