Tripura University

(A Central University)

Curriculum
For
B.Tech in Electrical & Computer Science Engineering
(ECSE)

(6^{th} Semester)

2021

6th SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Program Core-21	PC ECS601	Control System Engineering	3	0	0	3	3	100
2.	Program Core-22	PC ECS602	Electrical Power System	3	0	0	3	3	100
3.	Program Core-23	PC ECS603	Industrial Electronics	3	0	0	3	3	100
4.	Program Core-24	PC ECS604	Renewable & Sustainable Energy System	3	0	0	3	3	100
5.	Program Core-25	PC ECS605	Control System Engineering Lab	0	0	2	2	1	100
6.	Program Core-26	PC ECS606	Industrial Electronics Lab	0	0	2	2	1	100
7.	Program Core-27	PC ECS607	Power System Lab	0	0	2	2	1	100
8.	Program Elective-1	PEECS 608/1	Sensor Technology	3	0	0	3	3	100
		PEECS 608/2	Artificial Intelligence						
		PEECS 608/3	Digital Signal Processing						
9.	*Project - 1*	*PR ECS 609*	*Mini Project*	*0*	*0*	*6*	*6*	*3*	*100*
			Total :	15	0	12	27	**21**	**900**

Control System Engineering

Course Code	PC ECS 601
Course Title	Control System Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Physics, Basic Electrical Engineering
Course Category	Program Core (PC)
Number of classes	38 Hours

<u>Course Outcome</u>: After completing the course in Control System Engineering, the students will be able to

CO Number	CO Description	K-level
CO-1	Organize modeling and analysis of electrical and mechanical system	K4
CO-2	Analyze control system by block diagrams and signal flow graph technique.	K4
CO-3	Demonstrate the analytical and graphical techniques to study the stability.	K3
CO-4	Illustrate the frequency domain and state space analysis.	K3

<u>Course Content:</u>

Module 1: Introduction & Modeling of physical system (10 Hours)

Control systems: Introduction, open loop and closed loop systems, examples, mathematical models and differential equations of physical systems, concept of transfer function, translational and rotational mechanical systems, electrical systems, force voltage and force current analogy. Block Diagrams: Block diagram representation of various systems, block diagram algebra, characteristics of feedback systems DC servomotors, signal flow graph, Mason's gain formula.

Module 2 Time & frequency response analysis (12 Hours)

Time response analysis : Standard test signals, shifted unit step, ramp and impulse signal, Unit step response of first and second order system, time domain specifications, steady state error and error constant effects of PI, PD and PID controllers
Frequency domain analysis: Introduction, frequency domain specifications, stability analysis from Bode plot, polar plot, Nyquist plot, calculation of gain margin and phase margin, determination of transfer function from bode plot, correlation between time and frequency responses. Compensators: Lag, lead, lag lead networks.

Module 3: Stability Analysis (08 Hours)

Concept of stability: Necessary and sufficient conditions for stability, Routh's and Routh Hurwitz stability criterions and limitations.
Root locus technique: Introduction, root locus concept, construction of root loci, graphical determination of 'k' for specified damping ratio, relative stability, effect of adding zeros and poles on stability.

Module 4: State variable analysis **(08 Hours)**

State Space Analysis of Continuous Systems: Concepts of state, state variables and state model, Derivation of state models from block diagrams, Diagonalization, Solving the time invariant state equations, State Transition Matrix and it's properties, Concepts of Controllability and observability.

References / Suggested Learning Resources:

1. S. Hasan Saeed, "Automatic control system", KATSON book publishers
2. I J Nagrath, M Gopal, "Control Systems Engineering", New Age International Publications, 3rdEdition, 2007.
3. N C Jagan, "Control Systems", BS Publications, 1st Edition, 2007.
4. K Ogata, "Modern Control Engineering", Prentice Hall, 4th Edition, 2003.
5. A Anand Kumar, "Control Systems", PHI Learning, 1st Edition, 2007.
6. S Palani, "Control Systems Engineering", Tata McGraw Hill Publications,1st Edition, 2001.

Electrical Power System

Course Code	PC ECS-602
Course Title	Electrical Power System
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Network Theory.
Course Category	Program Core (PC)
Number of classes	38 Hours

Course Outcome:

After completing the course in Electrical Power System, the students will be able to:

CO Number	CO Description	K-level
CO-1	Outline of power system along with its various components.	K2
CO-2	Determine different line parameters.	K3
CO-3	Analyze various load flow methods.	K4
CO-4	Analyze power system control and stability.	K4
CO-5	Differentiate between power system protection schemes.	K4

Course Content:

Module 1: Introduction to Power Systems **(10 Hours)**

Basic power generation concepts: Thermal, hydro, nuclear and gas power plants, electrical supply system, comparison of AC and DC systems, overhead versus underground systems, overhead transmission lines: mechanical design, line support, types of conductors; overhead line insulators, types of insulators pin, suspension and strain insulators, insulator string; calculation of voltage distribution and string efficiency, brief details of corona.

Module 2: Characteristics and Performance of Transmission Lines (12 Hours)

Line parameters: Effect of earth on capacitance of overhead transmission lines, short and medium transmission lines, line performance, analysis of long transmission lines, ABCD constants, Ferranti effect, and system representation: single line representation, review of per unit calculations, Load Flow: introduction, bus classification, nodal admittance matrix (Y Bus), Formation of static load flow equations, solution of load flow problem by Gauss-Seidel, Newton-Raphson (polar and rectangular) and fast decoupled techniques.

Module 3: Short circuit & power system stability analysis (10 Hours)

Review of symmetrical components, sequence networks, fault calculations for balanced and unbalanced short circuit faults using Z_{BUS}, analysis of open conductor fault, reactors, 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.

Module 4: Power system protection (06 Hours)

General requirements of circuit breakers, arc build up and quenching theory, auto reclosing features, different types of arc quenching medium, testing of circuit breaker; isolators, bus-bar arrangement, necessity of grounding of system neutral, methods of grounding, fundamental principle of protective relays, various types of electromechanical relays, construction and principle of operation and characteristic, directional, static relays, differential, distance and other types of relay; over current and over voltage relay, primary and back-up protection, transformer, motor &generator protection schemes, lightning arresters and surge absorber for surge protection.

References / Suggested Learning Resources:

1. Grainger J. J. and Stevenson W.D., "Elements of Power System Analysis", Tata McGraw-Hill Publishing Company Limited, 2008.
2. C. L.Wadhwa, "Electrical power systems", New Age International, 2010.
3. Nagrath I. J. and Kothari D. P., "Modern Power System Analysis", 3rd Tata McGraw-Hill Publishing Company Limited.
4. Chakraborthy, Soni,Gupta & Bhatnagar, "Power System Engineering", Dhanpat Rai & Co.
5. S.S. Rao., "Switchgear &Protection", Khanna Publishers.
6. Saadat H., "Power System Analysis" Tata McGraw-Hill Publishing Company Limited.
7. Ravindranath B. and Chander M., "Power System Protection and Switchgear", New Age International Private Limited.
8. Roy S., "Electrical Power System- Concepts, Theory and Practices", Prentice Hall of India Private Limited, 2007.

Industrial Electronics

Course Code	PC ECS-603
Course Title	Industrial Electronics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Electrical Engineering, Analog Electronic Circuits
Course Category	Program Core (PC)
Number of classes	38 Hours

Course Outcome:

After completion of the course, the students will be able to-

CO Number	CO Description	K-level
CO-1	Design and develop an illumination system for domestic, industry and commercial sites.	K5
CO-2	Differentiate between concept of Power level devices and signal level devices & analyze controlled rectifier circuits& dc-dc converters	K3
CO-3	Develop the skill to design and analyze Voltage source inverters	K5
CO-4	Simulate and analyze the series and shunt compensators for power factor improvement in drive system.	K3

Module 1: Illumination Systems **(10 Hours)**

Illumination:Nature of light, Basic laws of illumination, Light sources and their characteristics, Light production by excitation and ionization, Incandescence and fluorescence, Different types of lamps, Their construction, Operation and characteristics, Applications, Latest light sources, Design of a lighting scheme for a residential and commercial premises, flood lighting.

Module 1: Power Electronic Switching Devices & Converters **(10 Hours)**

Power Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

AC- DC converters: Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

DC-DC converters: Power circuit of a buck, boost and buck-boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

<u>Module 3</u>: Voltage source inverters **(08 Hours)**

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle. Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle.

<u>Module 4</u>: **(10 Hours)**

Power factor Control: Static reactive power compensation, Shunt reactive power compensator, Application of static SCR controlled shunt compensators for load compensation, Power factor improvement and harmonic control of converter fed systems, Methods employing natural and forced commutation schemes, Methods of implementation of forced commutation.
Motor Control: Voltage control at constant frequency, PWM control, Synchronous tap changer, Phase control of DC motor, Servomechanism, PLL control of a DC motor.

References / Suggested Learning Resources:

1. Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).
2. Paul, B., Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).
3. J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of Ac Motors, Pergamon (1990).
4. Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).
5. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
6. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co.,1997.
7. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
8. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
9. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
10. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Renewable and Sustainable Energy System

Course Code	PC ECS 604
Course Title	Renewable and Sustainable Energy System
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Science, Basic Electrical Engineering.
Course Category	Program Core (PC)
Number of classes	38 Hours

<u>Course Outcome:</u>

After the completion of this course students will able to -

CO Number	CO Description	K-level
CO-1	Describe about Sustainable energy and energy scenario	K2
CO-2	Illustrate the solar and Wind Renewable energy.	K3
CO-3	Illustrate the the Bio gas and OTEC Renewable energy.	K3
CO-4	Analysis the Different type of renewable energy sources.	K4

Course Content:

Module 1: Introduction **(06 Hours)**

Introduction of Sustainable Energy, Current Global Energy Uses, Indian energy consumption, Lifetime of Fossil Fuels, Important of sustainable energy system, Sustainability and Energy Use, Energy Conversion Technologies, conventional and non-conventional sources.

Module 2: Renewable Energy (Solar and Wind) **(12 Hours)**

Solar thermal energy conversion: Solar radiation on the earth surface, Measurement of solar radiations, concentrating and non-concentrating types of solar collectors, various solar thermal applications. Solar electrical energy conversion: Construction and working of solar cells and PV modules, Photovoltaic system components and different applications. Wind energy: Basic principle of wind energy conversion system, site selection consideration, basic components of WECS, classification of WEC systems, applications of wind energy.

Module 3: Renewable Energy (Bio gas and OTEC) **(08 Hours)**

Biogas: - Principle of bio gas generation, constructional, factors affecting generation of biogas, methods of obtaining energy from biomass**.** Ocean energy: ocean thermal electric conversion, open and closed cycle of OTEC, basic principles of tidal power & components of tidal power plants, Wave energy conversion devices. Geothermal energy.

Module 4: Hydro power and other renewable energy sources **(10 Hours)**

Conventional Hydroelectric power generation, Pumped storage hydropower generation, Fuel cell technology, Fuel processing, concept to product, Characterization and durability of fuel cells Technologies, Hydrogen Energy: Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, Flywheels and super capacitors. Hybrid electric power generation.

References / Suggested Learning Resources:

1. “Renewable Energy Sources and Emerging Technologies” , by D.P. Kothari, K.C. Singal, Rakesh Ranjan, PHI learning Private Limited, 2016.

2. “Energy Conversion Systems” , by Rakosh Das Begamudre, New Age International (P) Limited, 2014.

3. Biogas Technology – A Practical Handbook, by Khandelwal, K.C., Mahdi, S.S., Tata McGraw-Hill, 1986.

4. Solar Energy – "Fundamentals Design, Modeling & Applications", by Tiwari. G.N., Narosa Publishing House, New Delhi, 2002.

5. "Wind Energy Conversion Systems", by Freris. L.L., Prentice Hall, UK, 1990.

6. Principles of Solar Energy, by Frank Krieth & John F Kreider John Wiley, New York.

7. Non-conventional energy Sources by G.D.Rai.

Control System Engineering Laboratory

Course Code	PC ECS 605
Course Title	Control System Laboratory
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Physics, Basic Electrical Engineering
Course Category	Program Core (PC)
Number of classes	20 Hours

Course Outcome:

At the end of this course students will able to –

CO No	CO Description	K-level
CO-1	Identify different characteristics of transducers and controllers	K1
CO-2	Compare error and steady state error, position control using PI, PD, PID controller	K4
CO-3	Determination of transfer function, error of system	K3
CO-4	Apply the concept of position control, velocity feedback etc	K3

Course Content:

List of experiments:

1. Study of Characteristics of Synchro Transmitter, Receiver and differential Transducer (Transmitter).

2. Determination of Transfer function of D.C. Servo Motor by applying Step input.

3. Verification of Transfer function from frequency response graph of D,C. Servomotor (at different Mechanical loadings) as in Experiment No. 2.

4. Determination of error / steady state error of DC Servomechanism due to Step, Ramp and Parabolic inputs.

5. Position Control of second order DC Servomechanism and determination of

Parameters of the System from the experimental Results.
6. Study the effect of Velocity feedback on Position control of DC Servomechanism and determination of Parameters due to velocity feedback at different values.
7. Position control of D.C. Servo Mechanism using P, P+I, P+D, P+I+D Controllers to study the characteristics of second order System and indication of Position Control using Gray-coded disk.
8. Experimentation for Speed Control of a DC Servo Motor with PI Controller+ derivative output Compensation technique.

References / Suggested Learning Resources:

1. S. Hasan Saeed, "Automatic control system", KATSON book publishers
2. I J Nagrath, M Gopal, "Control Systems Engineering", New Age International Publications, 3rdEdition, 2007.
3. N C Jagan, "Control Systems", BS Publications, 1st Edition, 2007.
4. K Ogata, "Modern Control Engineering", Prentice Hall, 4th Edition, 2003.
5. A Anand Kumar, "Control Systems", PHI Learning, 1st Edition, 2007.
6. S Palani, "Control Systems Engineering", Tata McGraw Hill Publications,1st Edition, 2001.

Industrial Electronics Laboratory

Course Code	PC ECS 606
Course Title	Industrial Electronics Laboratory
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Industrial Electronics
Course Category	Program Core (PC)
Number of classes	24 Hours

Course Outcome :-

After completion of the course in Industrial Electronics Laboratory, students will be able to-

CO No	CO Description	K-level
CO-1	Analyze Switching characteristics of SCR, MOSFET and IGBT.	K3
CO-2	Compare the functionality of various ac-dc converters, dc-dc converters and understand the difference in their operation.	K4
CO-3	Design electrical circuits based on the concept of industrial electronic devices.	K5
CO-4	Assess the functionality and performance of various circuit designs after test and operation.	K6

List of Experiments:

Lab Experiments:

1. To study and analyze the VI characteristics of an SCR.
2. To Find the Holding Current & Latching Current for SCR.
3. To study and analyze the Switching Characteristics of MOSFET & IGBT.
4. To study the characteristics of a single phase uncontrolled rectifier with R, RL and RLE load.
5. To study the characteristics of an SCR based single phase fully controlled bridge converter using Microcontroller based Gate Triggering.
6. To study the characteristics of 3 –Phase Line commutated Thyristor Converter.
7. To study the triggering circuit of DC chopper.
8. To study the operation of Class A commutation chopper.
9. To study the characteristics of Buck Converter, Boost Converter & Buck-Boost Converter.
10. To study the operation of (i) single phase half bridge converter (ii) Single phase full bridge converter.

Practical Circuit Design:

1. To design square wave & Triangular wave generator Circuit using OPAMP.
2. To design Astable Multivirator using OPAMP.
3. To design On-OFF switching Circuit Using 555 Timer.
4. To design a fire alarm circuit Using 555 Timer and a Thermistor.
5. To design a PWM generator Circuit Using 555 Timer.

References/ Suggested Learning Resources :-

1. Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).
2. Paul, B., Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).
3. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
4. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co.,1997.
5. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009
6. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
7. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
8. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Power System Laboratory

Course Code	PC ECS-607
Course Title	Power System Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Power System.
Course Category	Program Core (PC)
Number of classes	22 Hours

Course Outcome:

At the end of this course students will able to –

CO Number	CO Description	K-level
CO-1	Identify, formulate, and analyze complex electrical engineering problems.	K2
CO-2	Design solutions for complex electrical engineering problems & system components.	K3
CO-3	Create, select, and apply appropriate techniques, resources, IT tools to complex electrical engineering activities.	K4
CO-4	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	K4
CO-5	Understand the impact of the professional electrical engineering solutions.	K4

Course Content:

List of experiments:

1. Study on AC load flow using Gauss-seidel method.
2. Study on AC load flow using Newton-Raphson method.
3. Dielectric strength test of insulating oil.
4. Measurement of earth resistance by earth tester.
5. Determination of the generalized constants ABCD of a long transmission line.
6. Testing on- (i) Under Voltage Relay (ii) Over Voltage Relay (iii) Earth Fault Relay, and (iv) Differential Relay.
7. Polarity, Ratio, and Magnetization characteristics Test of CT & PT.
8. To study various effects on transmission line simulator:
a) Ferranti effect simulation for an unloaded line.
b) Shunt Reactor Compensation for Unloaded Line.
c) Loading of Transmission line.
d) Shunt capacitive compensation of transmission line (To improve voltage profile).
e) Parallel operation of transmission line
f) Simulation of 3-Phase fault.
g) Simulation of LG, LLG and LL fault.
h) Effect of Parallel line on Fault Current.
9. To study the characteristics of the operation of Buchholz relay.
10. To study characteristics of electromechanical earth fault relay.

References / Suggested Learning Resources:

1. Grainger J. J. and Stevenson W.D., "Elements of Power System Analysis", Tata McGraw-Hill Publishing Company Limited, 2008.
2. C. L.Wadhwa, "Electrical power systems", New Age International, 2010.

3. Nagrath I. J. and Kothari D. P., “Modern Power System Analysis”, 3rd Tata McGraw-Hill Publishing Company Limited.
4. Chakraborthy, Soni,Gupta & Bhatnagar, “Power System Engineering”, Dhanpat Rai & Co.
5. S.S. Rao., “Switchgear &Protection”, Khanna Publishers.
6. Saadat H., “Power System Analysis” Tata McGraw-Hill Publishing Company Limited.
7. Ravindranath B. and Chander M., “Power System Protection and Switchgear”, New Age International Private Limited.
8. Roy S., “Electrical Power System- Concepts, Theory and Practices”, Prentice Hall of India Private Limited, 2007.

Sensor Technology

Course Code	PE ECS 608/1
Course Title	Sensor Technology
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Electrical and Electronics engineering, Electrical measurement.
Course Category	Program Elective (PE)
Number of classes	38 Hours

Course Outcome:

After the completion of this course students will able to -

CO Number	CO Description	K-level
CO-1	Generalize the fundamental terminology of Sensor.	K2
CO-2	Compute the Physical principle of Sensing.	K3
CO-3	Analyze the sensor interfacing with electronics component.	K4
CO-4	Able to distinguish the sensor materials technologies with smart application.	K4

Course Content:

Module 1:Fundamental of Sensor (10 Hours)

Introduction of sensor, Sensor terminology. Transducer, Transmitter, Actuator, factor that make the transducer different from Sensor and Actuator, Classification, Performance and Types, Characterization of Various types of sensor, Calibration of Sensor. Sensor reliability, Sensor range, sensitivity, accuracy, repeatability, noise. Smart sensor.

Module 2: Sensing physical principle (10 Hours)

Thermal, Pressure, Velocity, Acceleration, Density, Motion and viscosity, Electric Charges, Fields, and Potentials; Capacitance; Magnetism, Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements.

Module 3: Interface with Electronics component. (10 Hours)

Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors, Advanced Interface Circuits and Systems for Smart Sensors

Module 4: Sensor Materials Technologies (08 Hours)

Materials, MEMS Nano Technology. Electrochemical sensors for environmental and high-temperature applications,Chemical sensors for breath and skin Implantable biosensors, Basic Sensor for Robotics, Devices for artificial olfaction.

References / Suggested Learning Resources:

1. Shawhney A. K., (2007) "Electrical And Electronics Measurements And Instrumentation",
2. Fraden, J. (2010). Handbook of Modern Sensors. Fourth edition. Springer. London.
3. Jon S. Wilson (2004). Sensor Technology Handbook
4. D. Nikolelis, G. P. Nikoleli (2018) 1st edition Nanotechnology and Biosensors
5. **Czichos,** Horst, (2018), Measurement, Testing and Sensor Technology

Artificial Intelligence

Course Code	PE ECS 608/2
Course Title	Artificial Intelligence
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic programming in Python, Data science
Course Category	Program Elective (PE)
Number of classes	38 Hours

Course Outcome:

After the completion of this course students will able to -

CO Number	CO Description	K-level
CO-1	Build intelligent agents for search and games	K2
CO-2	Solve AI problems through programming with Python	K3
CO-3	Learning optimization and inference algorithms for model learning	K4
CO-4	Design and develop programs for an agent to learn and act in a structured environment.	K4

Module 1:INTRODUCTION(10 Hours)

Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.
Search Algorithms : Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

Module 2:Probabilistic Reasoning(10 Hours)

Probability, conditional probability, Bayes Rule, Bayesian Networks- representation, construction and inference, temporal model, hidden Markov model.

Module 3:Markov Decision process(08 Hours)

MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

Module 4:Markov Decision process(10 Hours)

Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.

References / Suggested Learning Resources:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach" , 3rd Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
3. Trivedi, M.C., "A Classical Approach to Artifical Intelligence", Khanna Publishing House, Delhi.
4. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011
5. David Poole and Alan Mackworth, "Artificial Intelligence: Foundations for Computational Agents", Cambridge University Press 2010.

Digital Signal Processing

Course Code	PE ECS 608/3
Course Title	Digital Signal Processing
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Set Theory
Course Category	Program Elective (PE)
Number of classes	38 Hours

Course Outcome:

After the completion of this course students will able to -

CO Number	CO Description	K-level
CO-1	Distinguish the concept of Discrete Fourier Series and Discrete Fourier Transform	K2
CO-2	Compute the DFT bt FFT	K3
CO-3	Analyze FIR and IIR system	K4
CO-4	Design digital FIR and IIR filters	K6
CO-5	Interpret the digital signal processor architecture	K2
CO-6	Simulate DSP algorithms by using TMS320 series	K3

Module 1:Fourier analysis of Discrete Time Signals (10 Hours)

Review of discrete fourier series and discrete time fourier transform, Frequency domain sampling, Discrete fourier transform, Properties, Circular convolution, Linear convolution using DFT, Linear filtering of long data sequence, Overlap add and overlap save methods, Computation of DFT by FFT, Decimation in time and Decimation in frequency algorithms.

Module 2:Structures for realization of Discrete time system (10 Hours)

Structures for realization of Discrete time systems, Signal flow graph representation, Structures for FIR and IIR systems, direct form, cascade form, parallel form, lattice and transposed structures representation of numbers & errors due to rounding and truncation, Quantization of filter coefficients, round off effects in digital filters.

Module 3:Design of Digital filters (12 Hours)

Design of digital filters, Types pf digital filters, FIR and IIR filters, Specification of digital filters, Design of FIR filters, Linear phase characteristics : Window method, Optimal method and frequency sampling method, Design of IIR filters from analog filters, Impulse invariant and bilinear transformation methods, Frequency transformation in the analog and digital domains.

Module 4:Computer Architectures for Signal Processing (10 Hours)

Computer Architectures for Signal Processing. Harvard Architecture, Pipelining, Multiplier, Accumulator, Special instructions for DSP, General purpose DSP processors, Implementation of DSP algorithms for various operations, Special purpose DSP hardware, Hardware digital filters and FFT processors, Case study and overview of TMS320 series processor.

References / Suggested Learning Resources:

1.J.G. Proakis & D.G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, PHI/Pearson
2. Chen, Digital Signal Processing, OUP
3. Meyer-Basse U, Digital Signal Processing with FPGA, Springer India
4. Ingle, Digital Signal Processing using MATLAB, Vikas
5. Babu R, Digital Signal Processing, Scitech

6. S. Salivahanan et al, Digital Signal Processing, TMH
7. S.K Mitra, Digital Signal Processing, A Computer based approach, TMH

Mini Project

Course Code	PR ECS 609
Course Title	Mini Project
Number of Credits	3 (L: 0, T: 0, P: 6)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	70 Hours

Course Outcome:-
After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a through and systematic understanding of project contents	K2
CO-2	Identify the methodologies and professional way of documentation and communication	K3
CO-3	Illustrate the key stages in development of the project	K2
CO-4	Develop the skill of working in a Team	K3
CO-5	Apply the idea of mini project for developing systematic work plan in major project	K3

Course Content:-

The mini project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Perform detailed study about various components of a project.
2) Study about methodologies and professional way of documentation and communication related to project work.
3) Develop idea about problem formulation.
4) Knowledge of how to organize, scope, plan, do and act within a project thesis.
5) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
6) Demonstrate the implementation of a mini project work.

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