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| **KERALA TECHNOLOGICAL UNIVERSITY**  http://ktu.edu.in/images/logo_final.png  **SCHEME AND SYLLABUS**  **FOR**  **M. Tech. DEGREE PROGRAMME**  **IN**  **ELECTRICAL AND ELECTRONICS ENGINEERING**  **WITH SPECIALIZATION**  **INDUSTRIAL INSTRUMENTATION AND CONTROL**  **CLUSTER 05 (ERNAKULAM II)**  **KERALA TECHNOLOGICAL UNIVERSITY CET Campus, Thiruvananthapuram Kerala, India -695016**  **(2015 ADMISSION ONWARDS)** |

**KERALA TECHNOLOGICAL UNIVERSITY**

**SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME**

**Branch: ELECTRICAL AND ELECTRONICS ENGINEERING**

**Specialization: INDUSTRIAL INSTRUMENTATION AND CONTROL**

**SEMESTER I**

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| ***Exam Slot*** | ***Course No*** | ***Subjects*** | **L-T-P** | **Internal Marks** | **End Semester Exam** | | **Credits** |
| Marks | Duration  (hrs) |
| A | 05EE 6201 | Transducers and Measurements | 3-1-0 | 40 | 60 | 3 | 4 |
| B | 05EE 6203 | Linear Control Theory | 3-1-0 | 40 | 60 | 3 | 4 |
| C | 05EE 6205 | Discrete Time Control systems | 3-1-0 | 40 | 60 | 3 | 4 |
| D | 05EE 6207 | Advanced engineering Mathematics | 2-1-0 | 40 | 60 | 3 | 3 |
| E | 05EE 621x | Elective I | 2-1-0 | 40 | 60 | 3 | 3 |
|  | 05EE 6277 | Research Methodology | 1-1-0 | 100 | 0 | 0 | 2 |
|  | 05EE 6291 | Instrumentation and control Lab I | 0-0-2 | 100 | 0 | 0 | 1 |

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| **Elective – I** | |
| **Course No** | **Subjects** |
| 05EE 6211 | Embedded systems and Real Time systems |
| 05EE 6213 | Robotics and Automation |
| 05EE 6215 | Energy Management and Auditing |

**SEMESTER – II**

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| ***Exam Slot*** | ***Course No*** | ***Subjects*** | ***L-T-P*** | ***Internal Marks*** | ***End Semester Exam*** | | ***Credits*** |
| Marks | Duration  (hrs) |
| A | 05EE 6202 | Non Linear Control Systems | 3-1-0 | 40 | 60 | 3 | 4 |
| B | 05EE 6204 | Control of Industrial Drives | 2-1-0 | 40 | 60 | 3 | 3 |
| C | 05EE 6206 | Optimal Control Theory | 2-1-0 | 40 | 60 | 3 | 3 |
| D | 05EE 622x | Elective II | 2-1-0 | 40 | 60 | 3 | 3 |
| E | 05EE 623x | Elective III | 2-1-0 | 40 | 60 | 3 | 3 |
|  | 05EE 6266 | Seminar I | 0-0-2 | 100 | 0 | 0 | 2 |
|  | 05EE 6288 | Mini project | 0-0-4 | 100 | 0 | 0 | 2 |
|  | 05EE 6292 | Instrumentation and Control Lab II | 0-0-2 | 100 | 0 | 0 | 1 |

21

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| **Elective – II** | |
| **Course No** | **Subjects** |
| 05EE 6222 | Process Control and Instrumentation |
| 05EE 6224 | Advanced Control system Design |
| 05EE 6226 | Advanced Microprocessors and Microcontrollers |

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| **Elective – III** | |
| **Course No** | **Subjects** |
| 05EE 6232 | Optimization Techniques |
| 05EE 6234 | Analog and Digital Instrumentation |
| 05EE 6236 | Fuzzy Logic Neural Network and Control |

**SEMESTER – III**

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| ***Exam Slot*** | ***Course No*** | ***Subjects*** | ***L-T-P*** | ***Internal Marks*** | ***End Semester Exam*** | | ***Credits*** |
| Marks | Duration(hrs) |
| A | 05EE 724x | Elective IV | 2-1-0 | 40 | 60 | 3 | 3 |
| B | 05EE 725x | Elective V | 2-1-0 | 40 | 60 | 3 | 3 |
|  | 05EE 7267 | Seminar II | 0-0-2 | 100 | 0 | 0 | 2 |
|  | 05EE 7287 | Project (Phase1) | 0-0-8 | 50 | 0 | 0 | 6 |

14

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| **Elective – IV** | |
| **Course No** | **Subjects** |
| 05EE 7241 | Optical Instrumentation |
| 05EE 7243 | Robust Control Systems |
| 05EE 7245 | Reliability and Safety Engineering |

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| **Elective – V** | |
| **Course No** | **Subjects** |
| 05EE 7251 | Advanced Digital Signal Processing |
| 05EE 7253 | Bio Medical Instrumentation |
| 05EE 7255 | Adaptive Control Systems |

**SEMESTER – IV**

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| ***Exam Slot*** | ***Course No*** | ***Subjects*** | ***L-T-P*** | ***Internal Marks*** | ***End Semester Exam*** | | ***Credits*** |
| Marks | Duration(hrs) |
|  | 05EE 7288 | Project (Phase 2) | 0-0-21 | 70 | 30 | - | 12 |
| Total Credit 68 | | | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6201** | | **TRANSDUCERS AND MEASUREMENTS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   * To understand the concepts of measurement systems, their classification, operation and application * To identify the types of transducers required for the measurement of electrical elements * To get an overview on special transducers * To identify the various pressure, temperature and pH measurement methods   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * To explain the functional elements of a general measurement system * To identify the type of transducers required for the measurement of resistance, capacitance and inductance * To identify the transducers required for special purpose applications * To select the most suitable method for the measurement of pressure, temperature and pH | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | General concepts of measurement systems-classification of types of measurement applications- Generalized configuration and functional description of measuring instruments- functional elements of an instrument,active and passive transducers- Analog and digital modes of operation- Null and deflection methods- Generalized input-output configuration of instruments and measurement systems | | | | 9 |
| **INTERNAL TEST 1(Module 1)** | | | | | |
| **II** | Sensors and transducers-Introduction-Classification-Selection and specification-Static and dynamic characteristics of transducers.Resistive transducer- Potentiometer, Strain gauge, Resistive thermometer, Thermistor.Variable inductance transducer- LVDT, Synchro. Capacitive transducers | | | | 9 |
| **INTERNAL TEST 2(Module 2)** | | | | | |
| **III** | Special transducers-Piezoelectric transducer, Magnetostrictive transducer, Thermoelectric sensor (Thermocouple), Electromagnetic transducer, Ultrasonic transducer, Hall effect transducer, Photoelectric transducer, smart/intelligent transducer. | | | | 10 |
| **IV** | High pressure measurement-Electrical pressure transducer, Bourdon tubes-Low pressure measurement-Thermocouple vacuum gauge, Pirani gauge, Ionization type vacuum gaugeLevel measurement-Electrical methods-Resistive, capacitive, inductive methods-Mechanical methods-float type, displacer type, pressure gauge method-Radiation typeTemperature measurement-Expansion thermometer, filled system thermometer, radiation methodpH measurement- working principle-construction of electrodes- glass electrode pH measurement | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Doeblin E. O., Measurement Systems, McGraw-Hill,1990. 2. A course in Electrical and Electronic Measurements and Instrumentation- A.K. Sawhney, DhanpatRai& Co. 3. Patranabis D., Sensors and Transducers, Wheeler Publishing Company, New Delhi, 2002 4. Moorthy D. V. S., Transducers and Instrumentation, PHI, New Delhi, 2004 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6203** | | **THEORY OF ELASTICITY** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   * To understand the concepts of physical systems and feedback control systems. * To teach about the concept of PI, PID controllers, stabilizability, controllability and observability * To teach about SISO systems and feedback gain * To study about asymptotic observers and compensators.   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Design compensators for feedback control systems * Design conventional controllers and realize systems in various forms * Calculate the controller gain using different methods and analysis of SISO systems and transfer functions * Design full order and reduced order observer for given systems | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction-Mathematical modelling of physical systems-Electrical and mechanical systems-Design of feedback control systems-Compensators-Performance measures-Cascade compensation networks-phase lead and lag compensator design using both bode plot and root locus | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Systems using integration networks-PI,PID controllers-Systems with prefilter- PID tuning Analysis of stabilization by pole cancellation-Canonical realization-Parallel and cascade realization-Reachability and constructability – Stabilizability – Controllability-Observabilitygrammians | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Linear state variable feedback for SISO systems-Analysis of stabilization by output feedback- - formulae for feedback gain-significance of controllable canonical form-Ackerman’s formula-feedback gains in terms of eigen values-Mayne Murdoch formulae-Transfer function approach-state feedback and zeroes of the transfer function | | | | 10 |
| **IV** | Asymptotic observers and compensators-Asymptotic observers for state measurement-open loop observers-closed loop observers-formulae for observer gain-calculation of transfer function-implementation of observers-full order and reduced order observer-Separation principle-Combined observer controller | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Katsuhiko Ogata , Modern Control Engineering, 5th Edition, PHI publishers  2. Thomas Kailath. *"Linear System1,* Prentice Hall, Inc. Eaglewood Cliffs. NJ. 1998  3. Benjamin C Kuo, *'Control Systems',* Tata McGraw Hill, 2002  4. M Gopal, *'Control Systems-Principles and Design',* Tata McGraw Hill  5. Richard C Dorf& Robert H Bishop, *"Modern Control Systems',* Addison -Wesley,  8th Edition, 1998 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE6205** | | **DISCRETE TIME CONTROL SYSTEMS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   * To study about the stability tests- Jury’s test and Schur Cohn test * To study pole zero matching and direct design methods of Ragazzini * To learn about controllability, observability and design via pole placement * To understand the designing of observers in discrete systems   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Do the stability analysis and system analysis in w-plane * Design discrete control systems using different methods * Represent the discrete control system in state space * Design full order and reduced order observers. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Z transforms- sample and hold-pulse transfer function-mapping between s-plane and z-plane-stability analysis-Jury’s test and Schur Cohn test-Bilinear transformation-Routh Hurwitz methods in w-plane-Bode plot in w-plane | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Discrete equivalents via numerical integration-pole zero matching-Design of discrete control systems-root locus method, frequency response method-direct design methos of Ragazzini | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | State space representation of discrete control systems-controllability-observability-design via pole placement | | | | 10 |
| **IV** | Observers-full order observer-reduced order observer-regulator design-separation principle-control system with reference input | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| REFERENCES:  1. K. Ogata, ‘Discrete-Time Control Systems’, Pearson Education, Asia, 2013.  2. Gene F. Franklin, J. David Powell, Michael Workman, Digital Control of Dynamic Systems,Pearson, Asia, 2000.  3. J. R. Liegh, Applied Digital Control, Rinchart& Winston Inc., New Delhi, 2010.  4. Frank L. Lewis, Applied Optimal Control & Estimation, Prentice-Hall, Englewood Cliffs NJ,1992.  5. Benjamin C. Kuo, Digital Control Systems, 2nd Edition, Saunders College publishing, Philadelphia, 1992.  6. C. L. Philips, H. T. Nagle, Digital Control Systems, Prentice-Hall, Englewood Cliffs, NewJersey, 1995.  7.R. G. Jacquot, Modern Digital Control Systems, Marcel Decker, New York, 1995.  8. M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill, 1997. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE6207** | | **ADVANCED ENGINEERING MATHEMATICS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To understand about the fundamentals of linear algebra * To familiarize with the concept of special function * To teach about the concept of integral equations and partial differential equations * To understand the concept of probability, random variable and estimation   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Apply various mathematical techniques and vector spaces. * Apply concepts of special functions to various engineering problems * Find out the solutions for various engineering problems using partial differential equations and integral equations * To use different statistical procedures in their field of studies | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Vector space, subspace, Linear independence of Vectors, Dimension and Basis( Definitions, theorems without proof and problems), Linear transformations, rank and nullity, Inner product, norm of a vector, orthogonal vectors. Gram Shchmidtorthogonalization process. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Bessel function, recurrence relation, properties, generating functions, Orthogonality property, Legendre function, Rodrigues formula, Legendre polynomials, Recurrence relations(without proof), Orthogonality and generating function. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Solution of integral of second kind by transform methods, convolution type, method of successive approximation and iterative method.Solution of P.D.E using Laplace Transform method | | | | 10 |
| **IV** | Concept of random variables( discrete and Continuous), Joint probability Distribution of discrete and continuous random variables(definition and problems), Marginal and conditional probability functions , estimation of parameters(point and interval)-unbiasedness, consistency, efficiency and sufficiency. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Serge Lang, 'Linear Algebra'  2. Peter V.O.Niel, 'Advanced Engineering Mathematics', 4th edition, Brooks Cole Publications.  3.Greenberg’Advanced Engineering Mathematics, Pearson Edn.  4. G.F Simmons,'Differetial Equation with historical notes'  5. N.P Bali and Iyengar,'Engineering Mathematics,Laxmi Publications  6.Vasista and Gupta, 'Integral Transforms'.  7. Shanti Swaroop, 'Integral Equations  8. Gupta and Kappor, 'Foundations of Mathematical Statistics  9. Murray R. Spiegel, 'Linear Algebra, Schaum Outline Series | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6211** | | **EMBEDDED SYSTEMS AND REAL TIME APPLICATIONS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To give a knowledge about 8051 microcontroller and interfacing with various peripherals * To introduce basic concepts of real time systems like task scheduling and inter task communication * Introduction of PIC 16F877 and interfacing with various peripherals * To learn the general DSP architecture, its assembly language program.   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Understand working of 8051micro controllers and to implement various embedded applications based on 8051 * Understand the operation of real time systems * Understand the working of PIC 16F877 * Understand the basics of TMS 320F2407 DSP | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | 8051 Microcontroller - Assembly language programming and C programming- Instruction set –Interrupts - Timers – Memory- I/O ports – Serial communication - Interfacing –Key board -LED display - External memory – ADC – DAC – LCD - RTC – Typical applications- DC motor speed control - speed measurement - Temperature control - Stepper motor control -PID control. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Real-time Systems - Introduction to real time systems- Interrupt driven systems-Contexts witching-Scheduling-round robin-Preemptive-rate monotonic-Foreground and background systems- Inter task communication- Buffering data-Mailboxes-Critical regions Semaphores-Deadlock-Process stack management- Dynamic allocation-Response time calculation-Interrupt latency. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | PIC Processors - RISC concepts - PIC processors- Overview-16F877 - Architecture –Elementary assembly language programming- Interrupts – Timers – Memory – I/O ports –SPI – I2C bus - A/D converter - USART- PWM – Interfacing . | | | | 10 |
| **IV** | DSP Architecture - Introduction to DSP architecture- Computational building blocks – Address generation unit- Program control and sequencing- Speed issues- Harvard architecture –Parallelism – Pipelining - TMS 320F2407- Architecture- Addressing modes- I/O functionality – Interrupts – ADC – PWM - Event managers- Elementary assembly language programming- Typical applications-Buck boost converter- Stepper motor control- Software and hardware development tools. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Mazidi&Mazidi , Embedded System Design using 8051 Microcontroller, Pearson  2. Ajay V DeshMukh, Microcontrollers -Theory and Applications, TMH  3. Phillip A Laplante, Real Time Systems Design and Analysis, PHI  4. Daniel W Lewis, Fundamentals of Embedded Software, Pearson  5. Sen M Kuo, WoonSengGan, Digital Signal Processors-Architecture, Implementation  and Applications, Pearson  6. H A Toliyat, S Campbell, DSP Based Electro Mechanical Motion Control, CRC Press,  7. Avtar Singh, S Srinivasan, Digital Signal Processing, Thomson Brooks  8. Phil Lapsley, Bler, Sholam, E A Lee, DSP Processor Fundamentals, IEEE Press  9. Wayne Wolf, FPGA Based System Design, Pearson  10. Scott Hauck, The Roles of FPGAs in Reprogrammable Systems, Proceedings of the IEEE,  Vol. 86, No. 4, pp. 615-639, April, 1998. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE6213** | | **ROBOTICS AND AUTOMATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To understand the fundamentals of robotic systems and its components * To understand various robotic transformations * To understand various robotic motions and its properties * To study about robotic programming language   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * To identify various components in a robotic system * Apply various transformations while designing a robotic system * Apply various calculations in determining robotic motions and its properties * Program a robotic system and will have the ability to design a robust robotic system | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Robot definition - Robot classification - Robotic system components – Notations – Positiondefinitions - Coordinate frames - Different orientation descriptions - Free vectors-Translations- Rotations and relative motion - Homogeneous transformations. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Link coordinate frames- Denavit-Hartenberg convention - Joint and end-effector Cartesian  space-Forward kinematics transformations of position- Inverse kinematics ofposition-Translational and rotational velocities -Velocity transformations-Manipulator jacobian -Forward and inverse kinematics of velocity-Singularities ofrobot motion-Static forces-Transformations of velocities and static forces -Joint and endeffect or force/torque transformations | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Manipulator Dynamics- Transformations of acceleration- Trajectory planning- Control-Lagrangian formulation- Model properties - Newton-Euler equations of motion-Derivation for two link planar robot arm as example- Joint space-based motionplanning - Cartesian space-based path planning-Independent joint control –Feedforwardcontrol - Inverse dynamics control. | | | | 10 |
| **IV** | Robot Sensing and Vision Systems – Sensors - Force and torque sensors - Low level vision -  High level vision- Robot Programming languages-Introduction to Intelligent Robots-Robots in manufacturing automation. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Fu, K.S., R.C. Gonzalez, C.S.G. Lee, Robotics: Control, Sensing, Vision & Intelligence,  McGraw-Hill, 1987.  2. Groover, Mikell P., Automation, Production Systems & Computer Integrated manufacturing,  Prentice hall India, 1996.  3. Gray J.O., D.G. Caldwell(Ed), Advanced Robotics & Intelligent machines, The Institution of  Electrical Engineers, UK, 1996.  4. Craig, John J., Introduction to Robotics: Mechanics & Control, 2nd Edition, Pearson  Education, 1989.  5. GrooverMikell P., M. Weiss, R.N. Nagel, N.G. Odrey, Industrial Robotics, McGrawHill,  1986.  6. Janakiraman, P.A., Robotics & Image Processing, Tata McGrawHill, 1995.  7. Sciavicco, L., B. Siciliano, Modelling & Control of Robot Manipulators, 2nd Edition,  Springer Verlag, 2000.  8. Robin R. Murphy, “An introduction to AI Robotics”, MIT Press, 2008.  9. Oliver Brock, Jeff Trinkle and Fabio Ramos, Robotics-Science and Systems, Vol. IV, MIT  Press, 2009. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE6215** | | **ENERGY MANAGEMENT AND AUDIT** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To enable students aware about energy conservation act 2001 * To get an outlook on various instruments used for energy audit * To get a detailed knowledge about energy conservation techniques on motors and lighting system * To get a detailed idea about energy conservation techniques in thermal systems   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Efficiently take part in energy audit. * Conduct energy conservation tests and analysis * Apply conservation techniques on motors and lighting system * Apply conservation techniques on thermal systems | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Importance of energy management – overview of energy conservation act(2001) – energy auditing – objectives – methodology – steps in energy management – analysis of past data – mass and energy balances – types of energy audit – preliminary energy audit – detailed energy audit – energy audit report writing – energy economics – payback period – potential energy and cost savings from energy conservation measures – barriers for energy efficiency. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Measurements and measuring instruments for energy audit – electrical measuring instruments, Combustion analyzer, thermometers, flow meter, tachometer, Lux meter. Electrical Systems: Tariff systems – billing elements – load curve analysis – load management – power factor correction – electrical demand and load factor improvement – load scheduling/shifting – Demand side management (DSM) - case study. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Electric motors: Motors efficiency, idle running - motor selection – factors affecting motor performance, efficiency at low load – high efficiency motors - reduce speed/variable drives – different types of VFD, load reduction - high-starting torque, rewound motors, energy efficiency in transformers - Case studies. Lighting: Lighting lux levels – efficient options – control of lighting - lighting standards – light meter audit – case study – summary of different lighting technologies – methods to reduce costs – day lighting – timers. | | | | 10 |
| **IV** | Steam Systems: Boiler – efficiency testing – steam distribution and use thermal insulation -Basic principles only. Energy conservation in pumps – fans (flow control) – compressed air systems – Refrigeration and air conditioning systems. Cogeneration – concept – options (steam/gas turbines/diesel engine based) – selection criteria – control strategy. Heat exchanger networking – basic concept of pinch analysis. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. W. C. Turner, Energy Management Handbook, Wiley, New York, 1982.  2. L. C. Witte, P. S. Schmidt, D. R. Brown , Industrial Energy Management and  Utilization, Hemisphere Publishers, Washington,1988.  3. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.  4. I. G. C. Dryden, The Efficient Use of Energy, Butterworths, London, 1982.  5. Larry C. Whit et al, Industrial Energy Management & Utilization.  6. Energy Management Guide Books, Bureau of Energy Efficiency, India,  (http://www.beeindia.in/content.php?page=energy\_managers\_auditors/ema.php?id=4)  7. T.D. Eastop, D.R. Croft, Energy Efficiency for Engineers and Technologists,  Logman Scientific & Technical, ISBN-0-582-03184, 1990. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6277** | | **RESEARCH METHODOLOGY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To familiarize the students with different stages of research process. * To get an idea about descriptive and inferential statistics. * To familiarize the students with the nature of research and scientific writing.   **COURSE OUTCOMES:**   * The students should be able to understand the basic concepts of research and its methodologies. * Students are able to understand different statistical test and parameters. * The student should be able to define appropriate research problem and write a research report. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to research methodology. Types of research, research methods Vs methodology – stages of research process. Literature review — Problem definition- Research design for exploratory, descriptive and experimental research — Brief introduction to completely randomized design, randomized block design and Latin square designs (description only). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Sampling fundamentals -Types of sampling: probability and non-probability sampling. Sampling theory, sampling distribution and sample size determination. Tools and techniques of data collection: Questiormaire and schedule for field surveys, interview, observation, simulation, experimental and case study methods. Collection, recording, editing, coding and scaling of data. Scale classification and types. Measurement of validity, reliability and practicality.Cronbach’s Alpha | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Descriptive and inferential statistics - Data analysis and interpretation —testing of hypothesis, testing of population mean, variance and proportion —Z test — t test — F test - chi square test. Test for correlation and regression —standard error of the estimate. Testing goodness of fit.Brief introduction to non parametric tests, factor analysis, discriminant analysis and path analysis (description only).Use of SPSS and other software. | | | | 10 |
| **IV** | Meaning of interpretation and inference: importance and care for interpreting results. Presentation of reports: popular reports and technical reports - structure and style. Oral and written presentations: Parts of a research report. Guidelines for writing research papers and reports — Writing different sections of a research paper — Introduction, Iviethodology, Results, Discussion, Conclusion, Abstract — Writing the title. Methods of giving references and appendices: referencing styles. Ethics in research.Use of computers and internet in research. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. C. R. Kothari, Research Methodology, Methods and techniques ,New Age International Publishers, New Delhi, 2004.  2. R. Panneersekivam Research Methodology ,Prentice Hall of India, New Delhi, 2011.  3. Ranjit Kumar, Research Methodology, A step by step approach (Pearson Publishers, New Delhi, 2005.  4. Management Research Methodology : K. N. KrishnaswamjAppalyer and M Mathirajan, Pearson Education Delhi, 2010  5. Hand Book of Research Methodology : M N Borse, SreeNivas Publications Jaipur, 2004  6. Business Research Methods: William G Zikmund, South — Western Ltd, 2003  7. Research Methods in Social Science: P K Majumdar, Viva Books Pvt Ltd, New Delhi, 2005  8. Analyzing Quantitative Data: Norman Blaikie, SAGE Publications, London, 2003  9. SPSS for Windows: Pearson Education New Delhi, 2007 | | | | | |
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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 6291** | **Instrumentation and Control Lab I** | 0-0-2-2 | 2015 |
| COURSE OBJECTIVES:   * To impart knowledge in the simulation of different control systems using MATLAB/LABVIEW  COURSE OUTCOMES:  * Ability for easy simulation and analysis of systems in a various ways with a lesser programming effort.     **LIST OF EXPERIMENTS**  **LABVIEW**   * Basic arithmetic operations * Boolean operations * Sum of n numbers using for loop * Factorial of a given number using for loop * Sorting of even numbers using while loop * Array maximum and minimum * Creation of SUB VI   **· MATLAB**   * Eigen values and pole zero plot * Closed loop transfer function using MATLAB/SIMULINK * Satellite control system using Matlab * Design of Lag, Lead, Lag-Lead Compensators * *In addition to the above, the Department can offer a few newly developed experiments in the Control and Instrumentation Laboratories.* | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6202** | | **NONLINEAR CONTROL SYSTEMS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:   * To learn about the various non-linearity and apply describing function technique.. * To extend the analysis to phase portrait techniques. * To analyse system with inherent non-linearity for stability and performance. * To provide the necessary methods for designing controllers for Non-linear systems*.*   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Conduct the describing function analysis of nonlinear systems. * Gain insight into phase plane analysis, singular points and equilibrium points * Analyse stability of non linear system using various techniques. * Use a complete treatment of design concepts for linearization via feedback. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Describing functions of saturation, dead zone, on-off non-linearity, backlash, hysteresis-Describing function analysis of non-linear systems-Limit cycles | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Concept of phase portraits-Singular point characterization-Phase plane analysis of non-linear systems-Stable and unstable equilibrium points | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Lyapunov Stability-absolute stability-zero input and BIBO stability-construction of Lyapunov function for non-linear systems-Lure’s problem-Popov’s criterion-KalmanYakubovich lemma | | | | 10 |
| **IV** | Non-linear control system design-concept of variable structure control and sliding mode control-switching control laws-state feedback design-feedback linearization | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Jean-Jacques E. Slotine&Weiping Li, 'AppliedNonlinear Control9, Prentice-Halh, NJ, 1991  2. Hassan K Khalil. 'Nonlinear Systems', Macmillan Publishing Company, NJ  3. M Vidyasagar. teNonlinear Systems Analysis', Prentice-Hall, India, 1991  4. Shankar Sastry, ‘Nonlinear System Analysis, Stability and Control’, Springer, 1999  5. Ashok D Belegundu, Timpathi R Chandrupatla, ‘Optimization concepts and Applications in  Engineering', Pearson Education, Delhi, 2002  6. John E Gibson, 'Nonlinear Automatic Control', Me Graw Hill, NevvYork | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE 6204** | | **ADVANCED CONCRETE TECHNOLOGY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To create general awareness about components and functioning of electric drives * To study about various DC motor drives and their characteristics * To learn about stator side control techniques of induction motor drives * To create an indepth knowledge about the rotor side control of induction motor drives and various control techniques of synchronous motor drives.   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Do the analysis of various load-torque components and four quadrant operation of drives * Do the transient analysis of DC motor drives * To perform the stator control methods to explain the rotor side control methods. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Components of electrical Drives – electric machines, power converter, controllers - dynamics of electric drive - torque equation - equivalent values of drive parameters- components of load torques types of load - four quadrant operation of a motor –– steady state stability - load equalization – classes of motor duty- determination of motor rating. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | DC motor drives – dc motors & their performance (shunt, series, compound) – braking – regenerative, dynamic braking, plugging – Transient analysis of separately excited motor – converter control of dc motors – analysis of separately excited & series motor with 1-phase and 3-phase converters – dual converter – analysis of chopper controlled dc drives –closed loop control - transfer function of self, separately excited DC motors – linear transfer function model of power converters. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Induction motor drives – stator voltage control of induction motor – torque-slip characteristics – operation with different types of loads – operation with unbalanced source voltages and single phasing – analysis of induction motor fed from non-sinusoidal voltage supply – stator frequency control – variable frequency operation – V/F control, controlled current and controlled slip operation – effect of harmonics and control of harmonics. | | | | 10 |
| **IV** | PWM inverter drives – multiquadrant drives – rotor resistance control – slip torque characteristic – torque equations, constant torque operation – slip power recovery scheme – torque equation – torque slip characteristics – power factor – methods of improving power factor – limited sub synchronous speed operation – super synchronous speed operation.  Synchronous motor drives –adjustable frequency operation of synchronous motors – principles of synchronous motor control – voltage source inverter drive with open loop control – self controlled synchronous motor with electronic commutation – self controlled synchronous motor drive using load commutated thyristor inverter. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**  References  1. R. Krishnan, Electical Motor Drives, PHI  2 GK Dubey, Fundamentals of Electrical Drives, Narosa  3. GK Dubey, Power Semi-conductor Controlled Drives, Prentice Hall  4. Bimal K Bose, Modern Power Electronics & AC Drives, PHI  5. S A Nasar, Boldea, Electrical Drives, CRC press  6. M A Elsharkawi, Fundamentals of Electrical Drives, Thomson Learning  7. W Leohnard, Control of Electric Drives, Springer  8. Murphy and Turnbill, Power Electronic Control of AC motors, Pergamon Press  9. VedamSubarhmanian, Electric Drives, TMH |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6206** | | **OPTIMAL CONTROL THEORY** | 3-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To learn about optimality problems * To study about dynamic programming principle of optimality * To study about calculus of variation, necessary condition for optimal control. * To learn about pontryagin’s minimum principle and its application   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able:   * To formulate the optimality problem and do the analysis * To design linear regulator * To do various problems based on calculus of variation * To have in depth knowledge about the various minimization problems*.* | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Optimality problems in control theory-state variable representation-selecting a performance measure-classification of problem constraints-problem formulation-examples | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Dynamic programming-the optimal control law-principle of optimality-Application to decision making-routing problem-interpolation-Discrete linear regulator problems-Hamilton-Jacobi-Bellman equation-Continuous linear regulator problems | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Calculus of variations-fundamental concepts-functionals-variation of functional-extremals-fundamental theorem of calculus of variations-Euler equation-piecewise smooth extremals-necessary conditions for optimal control | | | | 10 |
| **IV** | Pontryagin’s minimum principle-Minimum time problems-minimum fuel problem-minimum control effort problem-singular intervals | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. D.E. Kirk, ‘Optimal Control Theory - An Introduction’, Dover Publications, New York,  2004.  2. AlokSinha, Linear Systems - Optimal and Robust Controls, CRC Press, 2007.  3. Daniel Liberzone, Calculus of variations and Optimal control theory, Princiton University  press, 2012  4. Frank L. Lewis, Applied optimal control & Estimation- Digital design and implementation,  Prentice Hall and Digital Signal Processing Series, Texas Instruments, 1992 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6222** | | **PROCESS CONTROL AND AUTOMATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To provide knowledge on the role of PID controllers in an industrial background. * To provide an insight of various advanced control techniques. * To give an overview of the different control structures used in process control. * To give an in depth knowledge on industrial automation-SCADA and PLC.   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Design and tune PID controllers for a system. * Model a process control system and analyse its performance. * Write simple ladder programs for simple industrial automation. * Apply various controllers for industrial automation. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to process dynamics: Physical examples of first order process-first order systems in series-dynamicbehavior of first and second order systems - Control valves and transmission lines, the dynamics and control of heat exchangers.  Level control, flow control, dynamics, Stability and control of chemical reactors, Control modes: on-off, P, PL PD, PID, Controller tuning- Zeigler Nichols self tuning methods. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Advanced control techniques: Feed forward control, Cascade control. Ratio control. Adaptive  control, Override control, Control of nonlinear process. Control of process with delay. Hierarchical control, Internal mode control, Model predictive control. Statistical process control. Digital controllers Effects of sampling-implementation of PID controller-stability and tuning-digital feed forward control. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Introduction to automation tools PLC, DCS, and SCADA. Programmable logic controllers  (PLC): hardware and software aspects, architecture PLC vs. PC, ladder diagram, ladder diagram  examples, timers/counters, shift register, PLC Communication and networking-selection and installation of PLC. | | | | 10 |
| **IV** | Introduction to SCADA- Data acquisition systems. Evolution of SCADA, Communication technologies. Monitoring and supervisory functions, SCADA applications in Utility Automation,  Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED),Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. George Stephanopoulos, *"Chemicalprocess control",* Prentice-Hall of India  2. Donald R Coughnour, *'Process System analysis and Control",* McGraw-Hill, 1991  3. DE Seborg, T F Edger, *'Process dynamics and control'*, John Wiley, 1998  4. Enrique Mandado, Jorge Marcos, Serafin A Perrez, *'Programmable Logic Devices and*  *Logic Controllers',* Prentice-Hall, 1996  5. DobrivojePopovic, Vijay P Bhatkar, Marcel Dekker, *'Distributed Computer Control for*  *Industrial Automation",* INC, 1990  6. B.G.Liptak, *'Handbook of Process Control9*', 1996  7- Ronald A.Reis, *'Programmable logic Controllers Principles and Applications',* Prentice-Hall  of India  8. Stuart A Boyer. *SCADA-Supervisoiy Control and Data Acquisition',* Instrument Society of  America Publications. USA. 1999.  9. Gordan Clarke, Deon *RzynAzvs;Practical Modern SCADA Protocols: DNP3, 60870J and*  *Related Systems',* Newnes Publications, Oxford, UK,2004 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6224** | | **ADVANCED CONTROL SYSTEM DESIGN** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To formulate basic control system problems * To learn about various MIMO system and various design techniques * To learn about various control system design techniques*.*   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able:   * To analyse performance measures with specific application to aircraft problems * To design state estimator and do various transformation * To design a LQG full and reduced order controllers, Kalman estimator*.* | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Describing system and evaluating its performance: problem formulation - state variable representation of the system-performance measure-the carrier landing of a jet aircraft-dynamic programming | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Linear quadratic optimal control: formulation of the optimal control problem- quadratic integrals  and matrix differential equations-optimum gain matrix –steady state solution-disturbances and  reference input: exogenous variables general performance integral –weighting of performance at  terminal time, concepts of MIMO system. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Representations of MIMO systems- Equivalent transformations- Canonical  forms- Solution of state equations- System response- Controllability and pole allocation- Observability and state estimator- System characterization by transfer matrix- Noninteractive and model matching control design. | | | | 10 |
| **IV** | Linear quadratic Gaussian problem :Kalman identity-selection of the optimal LQ performance  index-LQR with loop shaping techniques-linear quadratic Gaussian problem-kalman state  estimator -property of the LQG based controller-reduced order LQG control law design  -concept of robust control | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. BernadFriedland, Control System Design, McGraw-Hill, 2012. 2. Ching-Fang-Lin , Advanced Control System Design, Prentice Hall, 1994. 3. Krick D. E., Optimal Control Theory, Dover Publications, 2004. 4. Apte Y.S., Linear Multivariable Control Theory, Tata McGraw Hill Publishing Co. Ltd., 1994. 5. Chen C.T., Linear System Theory and Design, Holt Reinhart and Winston Inc., 1984 6. Wolovich W.A., Linear Multivariable Systems, Springer- Verlag , New york- Heidelberg- Berlin, 1974. 7. Thomas Kailath, Linear Systems, Prentice Hall Inc., Englewood Cliffs, N.J. , 1980 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6226** | | **CONSTRUCTION PERSONNEL MANAGEMENT** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To provide experience to design digital and analog hardware interface for microcontroller based systems. * To provide in depth knowledge of higher bit processors   **COURSE OUTCOMES:**   * Upon successful completion of this course, students will be able to use microprocessors and microcontrollers for different applications*.* | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Internal architecture of 8086 CPU, instruction set and programming, assembly language programming on IBM PC, ROM bios and DOS utilities. 8086 basic system concepts, signals, instruction queue, MIN mode and MAX mode, bus cycle, memory interface, read and write bus cycles, timing parameters. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Input/output interface of 8086, I/O data transfer, I/O bus cycle. Interrupt interface of 8086, types of interrupts, interrupt processing. DMA transfer, interfacing and refreshing DRAM, 8086 based  multiprocessing system, 8087 math coprocessor. Typical 8086 based system configuration, keyboard interface. Introduction to higher bit processors, 80286, 80386, 80486, Pentium | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | History of microcomputers. Over view of 8051, 8096, 6811, 6812 and 8051 architecture.  Hardware system, Mode of operation, Hardware pin assignments, Programming model. | | | | 10 |
| **IV** | A typical 16 bit Microcontroller with RISC architecture and Integrated A-D converter e.g. PIC 18Cxxx family: Advantages of Harvard Architecture, instruction pipeline, analog input, PWM output, serial I/O, timers, in-circuit and self programmability. Instruction set. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Ray A. K., Bhurchandi K. M., Advanced Microprocessor and Peripherals, Architecture,  Programming and Interfacing, TMH, 2006  2. Hall D.V., Microprocessor & Interfacing – Programming & Hardware – 8086, 80286,  80386, 80486’, TMH, 1992  3. Rajasree Y., Advanced Microprocessor, New Age International Publishers, 2008  4. Brey B. B. ‘The Intel Microprocessor 8086/8088, Pentium , Pentium Processor, PHI, 2008  5. Ayala K. J., The 8086 Microprocessor, Thomson Delmar Learning, 2004.  6. Kenneth J. Ayala, The 8051 Micro-controller, West Publishing, 2004  7. Muhammad Ali Mazidi, Janice GillispieMazidi, ‘The 8051 Microcontroller and Embedded  Systems’, Pearson Education, 2004  8. Deshmukh, Microcontrollers : Theory and Application, TMH, 2005 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6232** | | **OPTIMIZATION TECHNIQUES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To provide knowledge   * About optimization problems and applications * About sensitivity analysis to linear programming problem * About integer programming methods and non linear programming   **COURSE OUTCOMES:**  Upon successful completion of this course, students will   * Have basic knowledge about formulation and solution of linear programming problem * Be able to solve problems having different constraints in linear programming * Be able to use various optimization techniques and formulating integer programming problems*.* | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Classification of optimization problems and applications-Basic concepts of design vectors-design constraints-constraint surface and objective function surfaces-Formulation and solution of linear  programming problem-Karmarkar's method-Simplex Method-Two phase simplex method- Duality theory, Duel Simplex method | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Sensitivity analysis to linear programming problem changesin constants of constraints-changes in cost coefficients-changes in the coefficients ofconstraints-addition of new variables and addition of new constraints | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Introduction to Integer Programming methods-Branch and bound method-Gomory's cutting plane method for integer and mixed integerprogramming-lnteger polynomial programming-sequential linear discrete programming andnonlinear programming-Nonlinear programming-Properties of single and multivariable functions-Optimality criteria-Direct Search Methods-Gradient based methods-Newton's method- ConjugateGradient Methods-Quasi - Newton Methods | | | | 10 |
| **IV** | Constrained optimality criteria-Lagrange Multipliers-KKT Conditions-interpretation of KKT Conditions, Second order optimality Conditions-Linearization methods for constrained problemsmethodof feasible directions-GRG methods-Quadratic approximation methods for constrained problems-Variable metric methods for constrained optimization-Quadratic Programming-Dynamic programming | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1.G V Reklaitiss A Ravindran& K M Rajsdell, "Engineering optimization, Methods and  Applications'John Wiley & Sons  2. Singiresu S Rao9 John, "Engineering Optimization Theory and Practices', 3rd Edition, Wiley and Sons, 1998  3. A Ravindran, Don T Philips and Jamer J Solberg, 'Operations Research - Principles and Practice, John Wiley & Sons  4. P G Gill, W Murray and M H Wright, 'Practical Optimization', Academic Press, 1981  5. Fredrick S Hiller and G J Liberman, 'Introduction to Operations Research', McGraw-HillIncl995  6. Ashok D Belegundu, Tirupathi R Chandrapatla, 'Optimization Concepts and Applications inEngineering', Pearson Education, Delhi, 2002 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6234** | | **ANALOG AND DIGITAL INSTRUMENTATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To provide a clear knowledge on analog to digital converter * To acquire clear knowledge in data acquisition systems * To provide knowledge in interfacing and data transmission systems * To provide knowledge in various buses and process measurements   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be:   * Familiar with different types and characteristics of analog to digital converters * Become aware of modern data acquisition systems * Able to explain the interfacing systems and different modulation schemes * Familiar with the various bus architecture, communication protocol and pc based process measurements | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Basic blocks- Overview of A/D converter, types and characteristics-Understanding Data acquisition, A/D and S/H terms-passive support and Active support components-Single and Multi-slope, Low cost A/D conversion techniques, types-Electromechanical A/D converter. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Data acquisition systems Objective - Building blocks of Automation systems – Multi, Single channel Data Acquisition systems, PC based DAS, Data loggers- Sensors based computer data systems. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Interfacing and data transmission Data transmission systems- 8086 Microprocessor based system design - Peripheral Interfaces – Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications. PC based instrumentation Introduction - Evolution of signal Standard - HART Communication protocol -Communication modes - HART networks - control system interface – | | | | 10 |
| **IV** | Field bus –Introduction - General field bus architecture - Basic requirements of field bus standard-field bus topology - Interoperability – interchangeability - Instrumentation buses-Mod bus -GPIB - Network buses – Ethernet - TCP/IP protocols Case studies PC based industrial process measurements like flow, temperature, pressure and level – PC based Instruments development system. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Kevin M. Daugherty, Analog - Digital conversion: A Practical Approach, Tata McGraw-  Hill International Editions, 1995  2. N. Mathivanan, Microprocessors, PC Hardware and Interfacing, Prentice Hall India, 2003.  3. Krishna Kant, Computer- based Industrial Control, Prentice Hall India Pvt. Ltd., 2004.  4. H. S. Khalsi, Electronic Instrumentation, Technical Education Series Tata McGraw-Hill,  2004.  5. Buchanan, Computer busses, Arnold, London, 2000 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 6236** | | **FUZZY LOGIC NEURAL NETWORK AND CONTROL** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To provide concepts of soft computing and design controllers based on ANN and Fuzzy   Systems.  **COURSE OUTCOMES:**  Upon successful completion of the course, students will be able to:   * Implement soft computing techniques. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Neural network- Biological foundations - ANN models - Types of activation function - Introduction to Networkarchitectures -Multi Layer Feed Forward Network (MLFFN) - Radial Basis Function Network(RBFN) - Recurring Neural Network (RNN). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Learning process- Supervised and unsupervised learning - Error-correction learning - Hebbian learning – Boltzmen learning - Single layer and multilayer perceptrons - Least mean square algorithm - Back propagation algorithm - Applications in pattern recognition and other engineering problems Case studies - Identification and control of linear and nonlinear systems using Matlab-Neural network toolbox. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Fuzzy sets-Fuzzy set operations - Properties - Membership functions - Fuzzy to crisp conversion -fuzzification and defuzzification methods - applications in engineering problems. | 10 |
| **IV** | Fuzzy control systems-Introduction - simple fuzzy logic controllers with examples - Special forms of fuzzy logic models- classical fuzzy control problems - inverter pendulum - image processing - home heating system- Adaptive fuzzy systems - hybrid systems - Adaptive Neuro fuzzy Inference System (ANF1S)controllersGenetic Algorithm Introduction - basic concepts | 8 |
| **END SEMESTER EXAM (All Modules)** | | |
| **REFERENCES:**  1. J. M. Zurada, ‘Introduction to Artificial Neural Systems’, Jaico Publishers, 1992.  2. Simon Haykins, ‘Neural Networks - A Comprehensive Foundation, Mcmillan College’,  Proc., Con., Inc., New York. 1994.  3. D. Driankov. H. Hellendorn, M. Rein frank, ‘Fuzzy Control - An Introduction, Narora  Publishing House’, New Delhi, 1993.  4. H. J. Zimmermann, ‘Fuzzy Set Theory and its Applications’, 111 Edition, Kluwer Academic  Publishers, London.  5. G. J. Klir, Boyuan, ‘Fuzzy Sets and Fuzzy Logic’, Prentice Hall of India (P) Ltd, 1997.  6. Stamatios V Kartalopoulos, ‘Understanding Neural Networks And Fuzzy Logic Basic  Concepts And Applications’, Prentice Hall of India (P) Ltd, New Delhi, 2000.  7. Timothy J. Ross, ‘Fuzzy Logic With Engineering Applications’, McGraw Hill, New York.  8. SuranGoonatilake, SukhdevKhebbal (Eds.), ‘Intelligent Hybrid Systems’, John Wiley &  Sons, New York, 1995.  9. Vose Michael D., ‘Simple Genetic Algorithm - Foundations and Theory’, Prentice Hall of  India.  10. Rajasekaran&Pai, ‘Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and  Applications’, Prentice-Hall of India, 2007.  11. J. S. Roger Jang, C. T. Sun and E. Mizutani, ‘Neuro Fuzzy and Soft Computing’, Prentice  Hall Inc., New Jersey, 1997. | | |
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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 6266** | **Seminar II** | 0-0-2-2 | 2015 |
| COURSE OBJECTIVES:   * To improve the professional competency and research aptitude. * To motive and energize talent. * To improve presentation skills.   **COURSE OUTCOMES:**  After successful completion of the seminar presentation, the students will be able to analyse and present technological and research topics more effectively  Each student shall present a seminar on any topic of interest related to the courses offered in the M.Tech Programme. He / she shall select the topic based on the references from international journals of repute, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator / Faculty member in charge of the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 6288** | **MINI PROJECT** | 0-0-4-2 | 2015 |
| COURSE OBJECTIVES:   * To improve professional competency, research aptitude and team work skills. * To motive and energize talent. * To develop an aptitude to deliver commitments and manage time and stress pressures.   **GUIDELINES:** | | | |
| A list of Mini Projects should be prepared by the faculty before the commencement of the semester. The specifications and time plan should be clearly defined. The students should select a Project from the specified list and it can be done individually or in a group of two. The same project should not be selected by more than one group. Hardware design and fabrication is mandatory for all the projects.  The sequence of tasks may be   1. Schematic design and simulation 2. PCB layout design 3. Software/Firmware design and simulation 4. System integration and demonstration 5. Mini project report preparation | | | |
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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 6292** | **INSTRUMENTATION AND CONTROL LAB – II** | 0-0-2-1 | 2015 |
| **COURSE OBJECTIVES**   * To study the analysis and design of control systems in MATLAB/LABVIEW platform.   **LEARNING OUTCOMES**   * The students will be able to simulate and analyse system in various ways and in particular reference to process control industries   **EXPERIMENTS**   * **Data acquisition using LABVIEW.** * Measurement of temperature and control * Measurement of level and control * Measurement of pressure and control * **MATLAB** * Dynamic system models * Sate space models for continuous and discrete system. * Design of State Feed Back Controller * Design of Observer   In addition to the above, the Department can offer a few newly developed experiments in the Control and Instrumentation Laboratories | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 7241** | | **OPTICAL INSTRUMENTATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To provide knowledge   * About LED’s and classification * About opto electronic theory and optoelectronic devices * About different thermal detectors and transportation media * About sensing principles of different optic sensors   **COURSE OUTCOMES:**  Upon successful completion of this course, students will have   * An idea about constructional features and characteristics of LED * An idea about optoelectronic sensors and modulators * An idea about holographic measurement. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Review of P-N jn-characteristics – semiconductor-hetero junction-LEDs (-spontaneous emission-LED structure-surface emitting-Edge emitting-Injection efficiency- recombination efficiency-LED characteristics-spectral response-modulation-Band width. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Introduction to Electromagnetic field theory, Ray and wave optics, Polarization and Isotropic and  an-isotropic media. Opto electronics devices: Sources-LED, Laser, Laser diode, Broadband  calibration sources, Detectors-Photodiode-P-N, P-I-N, Photo multiplier tubes and ADP,. Optical  fibre as cylindrical wave guide, Optical fibre Characteristics- Application and dispersion, fibreoptic polarizer. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Broadband thermal detector: Modulators-Intensity, Polarization, Phase, Read out schemes for  modulation-Polarimeter, interferometer. Transportation media: Wave-guide theory-Slab wave  guide, scalar wave equation .Opto electronic sensors and system as a modulator, bulk modulator,  fibre-optic modulator. | | | | 10 |
| **IV** | Sensing Principles-Electro-optic and magneto-optic (Polarimetric and Interferrometric),  magnetostriction based sensors, Distributed Fibre- Optic sensors-OTDR and OFDR principles in  temperature measurement, Fibre –optic Gyro. Holographic measurement and its biomedical  applications. Optoelectronic integrated circuits and integrated optic sensor. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1.G. Lifante, ‘Integrated Photonics: Fundamentals’, John Wiley & Sons, 2003  2.MorrisTischler: ‘Optoelectronics: Fiber Optics and Lasers’, A Lab Text Manual, 2nd  Edition, McGraw-Hill, 1992.  3. Frederic C. Allard: ‘Fiber Optics Handbook for Engineers & Scientists (Optical &  Electrooptical Engineering Series)’, McGraw-Hill, 1990.  4. John M. Senior, ‘Optical Fiber Communications, Principles & Practice’, 2nd edition,  Prentice Hall of India, 1996.  5. Subir Kumar Sarkar, ‘Optical Fibers&Fiber Optic Communication Systems’, S. Chand | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 7243** | | **ROBUST CONTROL SYSTEMS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To study about the basics of robust control and perturbations * To learn about the various theorems dealing with robust control * To learn about state space representation of robust systems and minimization problems * To get an insight about various controllers in analyzing robust systems.   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Design robust control system with perturbations * To analyse stability and perform various stability tests * To perform model matching problems and get an idea about stability margins * Design various robust controllers such as H∞ , H2 etc. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction- Definition of robust control-Classification of robust control-Elements of robust control theory-Modeling-Design objectives and specifications-Additive and multiplicative  perturbations-Plant-controller configuration-Shaping the loop gain. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Modeling of Parametric Uncertain Systems- Modeling systems with parameter uncertainty-  General concepts-Generalization of several control concepts to parametric uncertain systems-  Stability-Controllability and observability-Robust stability analysis- Pole spread and gridding-Principle of argument and Rouche’s theorem-Boundary crossing theorem-Stability-  Gamma stability boundaries-Gamma stability radius-Schur stability test-Hurwitz stability test. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Parameterization of stabilizing controllers- Well-posedness internal stability parameterization  approach-Coprime factorization of plant- Coprime factorization of controller-State space  realization-Strong stabilization sensitivity minimization and robust stabilization- Sensitivity  minimization-Problem formulation-Model matching problem-Trade-offs for multivariable  plants-Design limitations due to right half plane zeros-Plant uncertainty and robustnessrobust  stability-Robustness under perturbations-Small gain theorem- Stability margins- 1-2  stability, 1-infinity and 1-1 stability margins. | | | | 10 |
| **IV** | Robust stabilizing controllers-Stabilizing P controllers-Stabilizing PI controllers- Stabilizing PID  controllers H2 and H optimization -LQG methodology-Separation principle-Algebraic Riccati  Equation-Solution of LQG problem-Robustness properties of the LQG solution- H  optimization techniques-State space formulation H control-H filter-Generalized H regulator.  Basic concepts of H∞ and μ – Synthesis controllers. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Richard.C.Dorf and R.T Bishop, Modern Control System, P.H.I.  2. S P Bhattacharya, L H Keel, H Chapellat, Robust Control: The Parametric Approach,  Prentice-Hall, 1995  3. P C Chandrasekharan, Robust Control of Linear Dynamical Systems, Academic Press, 1996.  4. Michael Green, David J N Limebeer, Linear Robust Control , Prentice-Hall, 1995  5. Kemin Zhou, Essentials of Robust Control, Prentice-Hall, 1998 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 7245** | | **RELIABILITY AND SAFETY ENGINEERING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To understand the concept and importance of reliability, maintenance and safety in the field of engineering.   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be able to:   * Identify the maintenance methods and safety measures for the proper operation of various systems | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Reliability: Definition and basic concepts, Failure data, failure modes and reliability in terms of hazardrates and failure density function. Hazard models and bath tub curves.Applicability of Weibull distribution. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Reliability calculation for series , parallel, parallel-series and K-out-M systems. Use of redundancy and system reliability improvement methods.  Maintenance: Objectives, Types of maintenance, preventive, condition based and reliability centeredmaintenance. Terotechnology and total productive maintenance.(TPM). | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Maintainability: Definition, basic concepts, Relationship between reliability, maintainability and  availability : corrective maintenance time distributions and maintainability demonstration. Designconsiderations for maintainability. Introduction to life-testing-estimation of parameters for exponential andWeibell distributions, component reliability and MIL standards | | | | 10 |
| **IV** | Safety: Causes of failure and unreliability. Human reliability and operator training. Origins of consumerismand importance of product knowledge, product safety, product liability and product safety improvementprogramme. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Charls O. Smith, - Introduction to Reliability In Design, Mc. Graw Hill.  2. Blanchard B.S – Maintainability  3. SinhaAnd Kale – Introduction to Life Testing, Willey Eastern  4. Smith and Davis – Reliability Engineering.  5. Gloss, D.S. and Wardle, M.G- Introduction to Safety Engineering , John Wiley.and sons, New  York.  6. Brown, D.B.- Systems Analysis and Design Of Safety, PHI, New Delhi  7. Billinton, R and Allan, R- Reliability Evaluation of Engineering Systems, Pitman Books Limited, | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 7251** | | **ADVANCED DIGITAL SIGNAL PROCESSING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To learn about the fundamentals of discrete time systems * To learn about digital filter designing * To learn about fundamentals of multirate signal processing * To learn about the architecture and programming of digital signal processings   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be   * Able to carry out different operations on signals * Able to design digital filter * Able to design multirate systems * Able to program a digital signal processor. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Review of DTS-Discrete time Signals-Sequences –Stability and Causality –Frequency domain  Representation of Discrete time Systems and Signals ––Z-Transform –Z- Transform Theorems and Properties –Structures for discrete time system– Direct, cascade and parallel forms –Lattice structure. Representation of Periodic Sequences-the Discrete Fourier Series –Properties of the discrete Fourier series –Sampling, Z-transform –discrete Fourier transform –properties of discrete Fourier Transform –Linear Convolution –Decimation –in- Time and Decimation in- Frequency –FFT Algorithms- discrete Fourier Transform Computations | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Digital Filter Design Techniques-Introduction – Design of IIR Digital Filters from Analog Filters  – Analog –Digital Transformation –Properties of FIR Digital Filters –Design of FIR Filters  Using Windows –A Comparison of IIR and FIR Digital Filters. Finite Register Length Effects-  Introduction - Effects of coefficient on Quantization –Quantization in Sampling -Analog Signals  - Finite Register Length effects in realizations of Digital Filters | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Time frequency analysis, the need for time frequency analysis, Time frequency distribution,  Multirate digital signal processing: Basic multirate operation (up sampling, down sampling), Efficient structures for decimation and interpolation, Decimation and interpolation with polyphase filters, Noninteger sampling rate conversion | | | | 10 |
| **IV** | Efficient multirate filtering Applications, Oversampled A/D and D/A converter .Introduction to Digital Signal Processors-Commercial DSP devices – TMS C240 processor and ADSP 2181 processor –Architecture – Addressing modes – Program control – Instruction and programming –Simple programs. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Emmanuel C. Ifeachor, Barrie W. Jervis, Digital Signal Processing: A Practical Approach,  Pearson Education India Series, New Delhi, 2nd Edition, 2004  2. Sanjit K. Mitra, Digital Signals Processing: A Computer Based Approach, Tata McGraw-  Hill Publishing Company Limited, 2nd Edition, 2004.  3. Alan Oppenheim V., Ronald W. Schafer, ‘Digital Signal Processing’, Prentice Hall of  India Private.Limited.New Delhi, 1989.  4. John G. Proakis and Manolakis. D.G, ‘Digital Signal Processing: Principles Algorithms  and Applications’, Prentice Hall of India, New Delhi, 2004.  5. Oppenheim V. and Ronald W. Schafer, ‘Discrete Time Signal Processing’, Prentice Hall of  India Private Limited., New Delhi, 2001.  6. Leon Cohen, ‘Time Frequency Analysis’, Prentice Hall, 1995.  7. P. P. Vaidyanathan, ‘Multirate systems and Filter Banks’, Prentice Hall, 1993  8. Avatar Singh and Srinivasan S., ‘Digital Signal Processing: Implementation using DSP  Microprocessors with Examples from TMS 320C54XX’, Thompson Brooks/Cole, 2004. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 7253** | | **BIO MEDICAL INSTRUMENTATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To create a general awareness about the human physiology and bio medical recorders * To learn about various bio medical signal analysis techniques * To have the concepts of CT and MRI scanning and bio informatics   **COURSE OUTCOMES:**  Upon successful completion of this course, students will be:   * Able to discuss the various bio medical recorders * Able to explain the various signal processing techniques * Able to discuss the various imaging techniques*.* | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Review of human physiology - Cardiovascular System – Respiratory System and Nervous System- Electro physiology- Bioelectric signals–origin –Resting and Action potentials- Propagation of Action Potential-Biomedical Recorders-ECG –EEG and EMG- Measurement of Heart Rate-Pulse Rate- Blood Pressure monitoring systems- Biomedical telemetry- Single channel systems- ECG telemetry system- Multichannel wireless telemetry system-Telemetry of ECG & Respiration- Patient Safety-Electric shock hazards-Effects of Electric current on the human body-Electrophysiology of ventricular Fibrillation-Electrical Safety analyzer. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | General Considerations for signal conditioners- Biomedical signal analysis techniques-FFT – Signal Processing techniques-Effects of artifacts on ECG recordings-Computerized analysis of EEG—Frequency/Amplitude analysis-Display format-Compressed Spectral Array(CSA)- Frequency Response and Damping Adjustment of systolic and diastolic blood pressure- Cardiac Arrhythmias – Arrhythmia Monitor. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | ECG QRS Detection and analysis – Power spectrum of ECG, QRS detection algorithm, STsegmentanalyzer-ST Arrhythmia Algorithm-Data Compression and Processing of the ECG signal by AZTEC (Amplitude-Zone-Time-Epoch-Coding).  Modern Imaging Systems- X– rays – Basis of diagnostic radiology- nature -production and visualization of X-rays- X- ray Machine | | | | 10 |
| **IV** | Computerized Tomography (CT) –basic principle system components- scanning ,processing, viewing and storage unit- Magnetic Resonance Imaging (MRI/NMR) System-principle- Imaging sequences-basic NMR components-Advantages and Limitations of MRI - Ultrasonic imaging – Ultrasonic waves – Basic pulseecho-A Scanner  Concepts of Bio informatics- Genetic material-nucleotides-orientation-Base pairing-Central dogma-Gene structure and information content | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Khandpur R. S, “Handbook of Biomedical Instrumentation”, 2/e.TMH.  2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, Biomedical Instrumentation andMeasurements, Prentice Hall of India, New Delhi.  3. Dan .E. Krane, Michael L. Raymer ,Fundamental Concepts of Bioinformatics  4. Joseph J Carr & John M Brown, Introduction to Biomedical Equipment Technology, PearsonEducation.  5. T. K. Attuwood& D J Pary Smith, Introduction to Bioinformatics, Pearson Education,  2006.  6. Claverie&Notredame, Bioinformatics - A Beginners Guide, Wiley-Dreamtech India. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05EE 7255** | | **ADAPTIVE CONTROL SYSTEM** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:   * To provide the fundamentals concepts of adaptive control theory.   **COURSE OUTCOMES:**   * Upon successful completion of this course, students will have an idea about various adaptive control strategies. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction-Adaptive ComroI-elYects of process variation-Adaptive schemes-Adaptive Control problem-Applications Real-Time Parameter Estimation -Introduction-Least Squares and Regression Models-Estimating-Parameters in Dynamical Systems-Experimental Conditions-Simulation of Recursive Estimation Model-Reference Adaptive Systems -Introduction-The MIT Rule-Determination of the Adaptation Gains | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Lyapunov Theory-Design of MRAS Using Lyapunov Theory-Bounded-Input-Bounded-Output Stability-Applications to Adaptive control-Output Feedback Self Tuning Regulators -Introduction-Pole Placement Design-Indirect Self-tuning Regulators-Continuous Time Self-tuners- Direct Self-tuning Regulators-Disturbances with Known Characteristics-Relations between MRAS and STR Adaptive Predictive Control | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Stochastic and Predictive Self-Tuning Regulators-Introduction-Design of Minimum-Variance and Moving-Average controllers-Stochastic Self-Tuning Regulators-Unification of Direct Self-tuning Regulators-Linear Quadratic STR | | | | 10 |
| **IV** | Robust Adaptive Laws--Introduction-Plant Uncertainties and Robust Control. Instability-Phenomena in Adaptive Systems-Modifications for Robustness-Simple Examples-Robust Adaptive Laws-Summary ofRobust Adaptive Laws Gain Scheduling -Introduction-The Principle-Design of Gain-Scheduling controllers-Nonlinear Transformations applications of Gain Scheduling | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES**  1. Karl JhonAstrom&BjomWittenmark, 'Adaptive Control\* ,Addison Wesley, 2003  2. Shankar Sastry, 'Adaptive Control', PHI( Eastern Economy Edition), 1989  3. Karl JhonAstrom, 'Adaptive Control', Pearson Education, 2001  4. Petros A Ioannou, Jing, 'Robust Adaptive Control', Prentice-Hall, 1995  5. Eykhoff P, 'System Identification: Parameter and'State Estimation9, 1974  6. Ljung, 'System Identification Theory for the User\*, Prentice-Hall, 1987  4. Sabins, Floyd F. Jr., “Remote Sensing Principles and Interpretation”, W.H. Freeman and Company, San Francisco  5. Burrough P.A, “Principles of Geographical Information System for Land Resource Assessment”, Oxford University Press  6. SatheeshGopi, “Global Positioning System – Principles and Applications”, Tata McGraw Hill. Pub. Comp. Ltd.  7. Current Literatures and publications. | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 7267** | **Seminar II** | 0-0-2-2 | 2015 |
| Each student should present a seminar on any topic related to the core / elective courses offered in the first semester of the M. Tech. Programme. The selected topic should be based on the papers published in reputed international journals preferably IEEE/ACM. The selected paper should be approved by the Programme Co-ordinator / Faculty member before presentation. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 7287** | **PROJECT PHASE I** | 0-0-8-6 | 2015 |
| In Project Phase-I, the students are expected to select an emerging research area in Instrumentation/control or related fields, after conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Master’s Thesis. It is expected that the students should refer National and International Journals and conference proceedings while selecting a topic for their thesis. He/She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.  Students should submit a copy of Phase-I thesis report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the thesis.  The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation, by a panel of examiners. This panel can be a committee headed by the head of the department with two other faculty members in the area of the project, of which one shall be the project supervisor .If the project is done outside the college, the external supervisor associated with the student will also be a member of the committee. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Phase–II of the thesis. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05EE 7288** | **PROJECT PHASE II** | 0-0-21-12 | 2015 |
| In the fourth semester, the student has to continue the thesis work and after successfully finishing the work, he / she have to submit a detailed thesis report. The work carried out should lead to a publication in a National / International Conference or Journal. The papers received acceptance before the M.Tech evaluation will carry specific weightage.  Final evaluation of the project will be taken up only on completion of the project. This shall be done by a committee constituted for the purpose by the principal of the college. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department, project supervisor and external supervisor, if any, of the student and an external expert either from an academic /R&D organization or from industry as members. | | | |