BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA ROURKELA

M.Tech. in Automation and Robotics

SEMESTER- I

(Applicable to the students admitted from the Academic year 2013 – 2014 onwards)

Code No.	Course Title	L	T	P	C
THEORY					
	Professional Core				
RBPC101	Robotics: Analysis & Systems	3	1	0	4
RBPC102	Industrial Automation	3	1	0	4
RBPC103	Advance Microprocessor & Microcontroller.	3	1	0	4
	Professional Electives -I (Any one)				
RBPE101	Modeling, Simulation & Analysis of Manufacturing System	3	1	0	3
RBPE102	Mechanical Measurement & Control System	3	1	0	3
RBPE103	Mechatronics	3	1	0	3
	Professional Electives –II (Any one)				
RBPE104	Applied Mathematics	3	1	0	3
RBPE105	Finite Element Methods	3	1	0	3
PRACTICAL					
RBPR101	Simulation & Modeling Lab	0	0	3	4
RBPT101	Pre Thesis Work related Seminar	0	0	3	2
	Total Credit -24				

RBPC101 ROBOTICS: ANALYSIS & SYSTEMS

Module-1

Introduction. Construction of manipulators, advantages and disadvantages of various kinematic

structures. Applications, Non servo robots, motion planning. Feed back systems, encoders Kinematics, homogeneous coordinates solution of the inverse kinematic problem, multiple solutions, jacobian, work envelopes.

Module-2

Trajectory planning. Joint Interpolated Trajectory, Link joints and their Manipulator dynamics and force control. Sensors: Vision, ranging, laser, acoustic, tactile. Developments in sensor technology, sensory control.

Module-3

Programming Language: VAL, RAIL, AML. Mobile robots, walking devices. Robot reasoning.

Text Books / References:

1. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
2. Y. Koren, Robotics for Engineers, McGraw Hill, 1985
3. J.J. Craig, Robotics, Addison-Wesley, 1986.
4. Saeed B. Niku, “Introduction to Robotics –Analysis, Systems and Application”:PHI 2006
5. Richard D, Klafter, Thomason A Chmiel Owski, Michel Nagin “Robotics Engg-an Integrated Approach” PHI 2005
6. R.K. Mittal & I.J. Nagrath, “Robotics & Control” TMH-2007

RBPC102 INDUSTRIAL AUTOMATION

Module-I

Nature of Industrial Process: continuous & discrete state sequential process, process variables and their classification.

Introduction to Process Control Philosophies: type of relays, ladder logic methodology, ladder symbols.

Introduction to Programmable Logic Controllers: advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC.

Module-II

PLC programming methodologies: ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC.

PLC functions: bit logic instructions, ladder diagram examples, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions on-delay timer, off-delay timers, retentive on-delay timers, pulse timers, timer examples, up-counter, down-counter and up-down counter, counter examples, register basics.

PLC Data Handling: data move instructions, table and register moves, PLC FIFO & LIFO functions**.**

Module-III

PLC arithmetic and logical functions: addition, subtraction, multiplication, division instructions, increment decrement, trigonometric and log functions, AND, OR, XOR, NOT functions, PLC compare and convert functions.

PLC program control and interrupts: jumps, subroutine, sequence control relay, watchdog.

Analog value processing: types of analog modules, analog input and output examples, PID control of continuous process.

Text/References:

- JOHN WEBB: Programmable Logic Controllers Principles & applications, PHI

T. A. HUGHES: Programmable Controllers

- C. D. JOHNSON: Process Control Instrumentation

RBPC103 ADVANCED MICROPROCESSOR AND MICROCONTROLLER

Module I

(Prerequisite: A basic course on 8 bit ups such as 8085)

16-bit microprocessor(one well known processor, say 8086 to 68000 to be taken as case study)-quick overview of the instruction set, Assembly language programming. Interrupt structure, Interfacing memory and I\O devices. Memory organizations.

Standard peripherals and their interfacing-(s\w and h\w aspects) color graphic terminals and ASCII keyboards, mouse, floppy and hard disc drive, other storage media (optical disks, Digital Audio Tapes etc.)

Module II

Data transfer techniques-Asynchronous and synchronous. Serial and parallel interface standards. Communication media and adapters. Modems and their interfacing.

Bus structures and standards-basic concepts. Example of a bus standard (PC\-VME bus).

Salient features of other processors (80286\386\486 or 68020\68030\68040). Microcontrollers and digital signal processors. I\O processors and arithmetic coprocessors.

Logic design for microprocessor-based systems-design of state.

Module III

Introduction to Microcontrollers - Motorola 68HC11 - Intel 8051 - Intel 8096 - Registers - Memories - I/O Ports - Serial Communications - Timers - Interrupts.

Text/References

1. John.F.Wakerly: Microcomputer Architecture and Programming, John Wiley and Sons.
2. Ramesh S.Gaonker: Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India).
3. Yu-Cheng Liu and Glenn A.Gibson: Microcomputer systems: The 8086/8088 Family Architecture, Programming and Design, Prentice Hall of India.
4. Raj Kamal: The Concepts and Features of Microcontrollers, Wheeler Publishing

RBPE101 MODELING, SIMULATION & ANALYSIS OF MANUFACTURING SYSTEM

Module I

Basic simulation modeling, Discrete event simulation, Simulation of queuing and te Carlo simulations. inventory systems, Continuous, Discrete-continuous and Mon Statistical models in simulation, Discrete and continuous distributions, Poisson process, Empirical distribution, Generation of pseudo random numbers, Analysis of simulation data, Parameter estimation, Goodness-of-fit tests, Multivariable time series models.

Module II

Overview of feedback control systems, Dynamics of mechanical systems, Differential equations and state variable form, Models of electromechanical, Heat-and fluid flow models, Linearization and scaling, Models from experimental data, Dynamic response using pole-zero locations, Time domain specifications, Classical 3-term controllers and its digital implementation, Stability analysis by Routh Criterion.

Modules III

Simulation of manufacturing and material handling systems, Goals and performance measures, Modeling downtime and failures, Trace driven models, Case studies.

Text Books :

1. Discrete-Event system simulation by Jerry Banks, J.S. Carson, B.L. Nelson and D.M. Nicol (Pearson Publications).
2. Feedback control of dynamic systems by G.F. Franklin, J.D. Powell, A-Naeini, Pearson Publications.
3. Simulation modeling and analysis by A.M. Law, W.D. Kelton, Tata McGrawHill

RBPE102 MECHANICAL MEASUREMENT & CONTROL SYSTEM

Module I

Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Brief Description of the Functional Elements of the Instruments, Classification of Instruments, Microprocessor -Based Instrumentation, Standards and Calibration. Static and Dynamic Characteristics of Instruments: Static Performance Parameters, Impedance Loading and Matching, Selection and Specifications of Instruments, Dynamic Response, Compensation.

Transducer Elements: Analog Transducers, Digital Transducers, Basic detector transducer elements : Electrical transducer, Sliding Contract devices, Variable-inductance transducer elements, the differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducer, electronic transducer element.

Intermediate Elements:

Amplifier, Operational Amplifier, Diffential and Integrating Elements, Filters, A-D and D-A Converters The simple current sensitive circuit, the ballast circuit, The voltage-dividing potentiometer circuit, The voltage balancing potentiometer circuit, Resistance bridges.

Indicating, Recording and Display Elements:

Meter Indicators. The vacuum tube voltmeter, CRO, Electronic Switch, CRO recording techniques, Oscillographs. Digital Recorders

Module II

Strain Measurement

The electrical resistance strain gauge. The metallic resistance strain gauge, Selection and Installation factors for metallic strain gauge, Circuitry, metallic strain gauge. The strain gauge ballast circuit, the staring gauge bridge circuit, Temperature compensation.

Measurement of Pressure

Pressure measurement systems, Pressure measurement transducers, Elastic diaphragms, strain gauge pressure cells, measurement of high pressure, Measurement of low pressures, dynamic characteristics of pressure measuring systems.

Measurement of Fluid Flow

Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturi meter and Pitot tube, The variable-area meter, Turbine Flow meters.

Temperature Measurement

Use of bimetals pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.

Force, Power, Speed and Torque Measurement :

Load Cell, Dynamometers, Tachometer and Tacho-generator, Stroboscope, The seismic instrument.- Vibrometers and accelerometers

Module III

Description of open and closed loop control systems and their block diagrams. Use of block diagram and signal flow graph to find overall transfer function.

1st and 2nd order systems and their response to step and sinusoidal input, error analysis, static and dynamic error coefficients. Routh's stability criterion. The Root-Locus method, Bode Plot and Nyquist plot, Gain margin and phase margin.

Textbooks

1. Instrumentation Measurement and Analysis, B.C.Nakra and KK.Chaudhry, TMH,3rd Ed.

Reference :

1. Mechanical Measurements, T.G. Beckwith and N. Lewis Buck, Oxford and IBH Pub Co.

2. Modern Control Engineering, K.K. Ogata, prentice Hall India

RBPE103 MECHATRONICS

Module 1

Evolution of Mechatronics, components of mechatronic system, types of mechatronic products, Signal theory, signal analysis and processing, Laplace transformation, Z-transformation modulation and de-modulation. Electrical components and Electronic device – Resister, inductor and capacitor, reactance and impedance. Basic electronics devices junction diodes, Bipolar transistors

Module II

Basic Digital Technology : Digital number system, Binary number system, Hexadecimal number system, Binary addition, Boolean Algebra, Logic function, Universal GATES, FLIP-FLOP, Registers counters. System modeling : Frequency response, Mechanical system, electrical system, Thermal system, Fluid system.

Module III

Actuators- Electric motors; D.C. Motors, Stepper motor, , Hydraulic actuators, Pneumatic actuators Transducer and Sensors : Principles, difference between transducer and sensors, transducer types – photo emissive, photo conductive, photovoltaic, thermistors, Thermocouple, Inductive, capacitive, Peizoelectric, Hall effect transducers, Ionization transducer, Encoders- Incremental encoder, Optical encoder, Bimetallic strip, Strain gauge, load cell. Programmable Logic controller : Basic Structure - Programming : Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling , Analog input / output , PLC Selection &Application. Microprocessor ad Microcontroller : Microprocessor based Digital control, registers, Program counter, Intel -8085 microprocessor

Text Books

1. A Text Books of Mechatronics, R.K.Rajput, S.Chand & company
2. Mechatronics, N.G. P.C Mahalik, Tata McGraw Hill
3. Mechatronics, D.G. Alciator, M.B. Histand, Tata McGraw Hill

Reference Books :

1. Mechatronics, A.Smaili & F Mrad, Oxford University Press
2. Mechatronics, K.P.ramchandran, G,K Vijay Raghavan, M. S Balachandra
3. Mechatronics An Intigrated approach, Clarence W de Sliva, CRC Press

RBPE104 APPLIED MATHEMATICS

Module-1: Complex Numbers:-

Powers and Roots of Exponential and Trigonometric,Circular functions of complex number and Hyperbolic functions.InverseCircular and Inverse Hyperbolic functions. Logarithmic functions, Separation of real and Imaginary parts of all types of Functions.Expansion of $\sin^n\theta$,$\cos^n\theta$ in terms of sines and cosines
of multiples of θ and Expansion of $\sin^n\theta$, $\cos^n\theta$ in powers of sinθ, cosθ

Module-2: Matrices and Numerical Methods:-

Types of Matrices(symmetric, skew- symmetric, Hermitian, Skew

Hermitian,Unitary, Orthogonal Matrices and properties of Matrices).Rank of a Matrix using Echelon forms, reduction to normal form, PAQ forms, system of homogeneous and non –homogeneous equations, their consistency and solutions. Linear dependent and independent vectors.: Solution of system of linear algebraic equations, by (1) Gauss
Elimination Method (Review) (2) Guass Jordan Method (3) Crouts Method (LU) (4) Gauss Seidal Method and (5) Jacobi iteration **(Scilab programming for above methods is to be taught during lecture hours)**

Module-3:Differential Calculus:-

3.1: Successive differentiation: nth derivative of standard functions. Leibnitz's Thoerem (without proof) and problems.
3.2: Partial Differentiation: Partial derivatives of first and higher order, total differentials, differentiation of composite and implicit functions.
3.3: Euler's Theorem on Homogeneous functions with two and three independent variables (with proof)deductions from Euler's Theorem
4.1.: Maxima and Minima of a function of two independent variables.

Lagrange's method of undetermined multipliers with one constraint. Jacobian,

Jacobian of implicit function. Partial derivative of implicit function using

jacobian.

Recommended Books:

1: A text book of Applied Mathematics, P.N.Wartikar and J.N.Wartikar,Vol – I and –
II by Pune Vidyarthi Graha.
2: Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
3: Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited,9th Ed.
4: Matrices by Shanti Narayan.
5: Numerical by S.S.Sastry, Prentice Hall

RBPE105 FINITE ELEMENT METHOD

Module – I

Review of 2-D and 3-D stress analyses, vibration, fluid flow and heat conduction problems.

FEM fundamental concepts, Variational principles, Rayleigh Ritz and Galerkin Methods.

Finite Element Modeling of one dimensional problems.

Finite Element Analysis of 2-D and 3-D framed structures.

Module – II

FEM formulation of 2-D and 3-D stress analysis problems.

Axisymmetric solids subjected to axisymmetric loadings.

Two-dimensional isoparametric elements and numerical integration.

Module – III

FE modeling of basic vibration problems

Finite element modeling of fluid flow and heat conduction problems

Computer programs: preprocessing and post processing.

Exposure to commercial FE codes such as ANSYS, NASTRAN and IDEAS etc.

Text Books

1. Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI
2. The Finite Element Method – Its Basis & Fundamentals, Zienkiewicz, Taylor and Zhu, Elsevier, 6th Edn

Reference

1. Introduction to Finite Element Method, C.Desai and J.F.Abel, CBS publishers
2. Introduction to Finite Element Method, J.N.Reddy, Tata McGraw Hill
3. Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI
4. Concepts & Applications of Finite Element Analysis,Cook, D.S.Malkus & M.E.Plesha, Wiley
5. The Finite Element Method in Engineering, S.S.Rao, Elsevier
6. A First Course in the Finite Element Method, D.L.Logan, Cengage Learning
7. Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill