### 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)

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Course Title</th>
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<th>P</th>
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<tr>
<td><strong>THEORY</strong></td>
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<tr>
<td>RBPC101</td>
<td>Robotics: Analysis &amp; Systems</td>
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<td>RBPE101</td>
<td>Modeling, Simulation &amp; Analysis of Manufacturing System</td>
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<td>Mechatronics</td>
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<td>RBPE105</td>
<td>Finite Element Methods</td>
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<td>Pre Thesis Work related Seminar</td>
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**Total Credit -24**
Module-1

Module-2

Module-3

Text Books / References:
Module-I

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
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
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

Text/References
2. Ramesh S.Gaonker: Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India).
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.
Module I
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:
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

Text Books
1. A Text Books of Mechatronics, R.K.Rajput, S.Chand & company

Reference Books :
1. Mechatronics, A.Smaili & F Mrad, Oxford University Press
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 $\theta$ and Expansion of $\sin^n\theta, \cos^n\theta$ in powers of $\sin\theta, \cos\theta$

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


Recommended Books:
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.Chandrupatla and A.D.Belegundu, PHI

Reference
1. Introduction to Finite Element Method, C.Desai and J.F.Abel, CBS publishers
3. Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI