BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ORISSA

SYLLABUS FOR

M. TECH

ELECTRONICS

&

INSTRUMENTATION ENGINEERING

M.Tech in Electronics & Instrumentation Engineering

Semester	Subject	Credit	Details of Subjects
I	PC-1	4	Instrumentation Devices and Systems
	PC-2	4	Process Dynamics and Control
	PC-3	4	Analytical Instrumentation
	EL-1	3	Digital Instrumentation
	(***any one***)		Industrial Automation and Robotics
			Digital Integrated Circuit Design
			Computational Intelligence
	EL-2	3	Adaptive Signal Processing
	(***any one***)		Statistical Signal Processing
			Digital and Adaptive Control
			Fibre-Optic and Laser Instrumentation
	Lab-1	4	Instrumentation Devices and Process Control Lab
	Seminar-1	2	Seminar on Pre-thesis Work-1
Semester Credits:		**24**	
II	PC-4	4	Control System Design
	PC-5	4	Modeling and Simulation
	EL-3	3	Virtual Instrumentation
	(***any one***)		Communication Protocols in Instrumentation
			Industrial Telematics
			Non-linear Systems
	EL-4	3	Real Time Instrumentation
	(***any one***)		PC Based Instrumentation
			Bio-Medical Instrumentation and Signal Processing
	EL-5	3	Embedded System Design
	(***any one***)		Microsystems – Principles, Design and Application
			Reliability Engineering
	Lab-2	4	Modeling and Simulation Lab
	Seminar-2	2	Seminar on Pre-thesis work-2
	Viva-1	2	Comprehensive Viva-Voce - I
Semester Credits:		**25**	

Semester	Subject	Credit	Details of Subjects
III	**Open Elective (any one)**	**3**	Project Management / Project Costing / Technology Management / Research Methodology / Optimization Techniques / Computational Intelligence /
	Thesis-1	**14**	Thesis – I
Semester Credits:		**17**	
IV	Thesis -2	20	Thesis – II
	Seminar-2	2	Seminar
	Viva-2	2	Comprehensive Viva-Voce – II
Semester Credits:		**24**	
Total Credits		**90**	

Instrumentation Devices and Systems (3-1-0) Credit : 4

Module – I **(12 Hours)**

Chemical Sensors

Physical Sensors – Surface Micro Machined Capacitive Pressure sensor, Integrated flow sensor, Chemical and Biochemical Sensors – Conductivity sensor, Hydrogen Sensitive MOSFET, Tri-Oxide Sensors, Schottky diode type sensor, Solid Electrolyte, Electrochemical Sensors. Sensor Matrix for Two dimensional measurement of concentrations.

Module – II **(14 Hours)**

Optical Sensors

Holography, Echolocation and bio holography, Sensors used in space and environmental applications. Application in meteorology, natural resources application sensor used in Instrumentation methods.

Biomedical Sensors

Biological Sensors in Human Body – Different types of Transducer system – Physiological Monitoring – chemo receptors – Hot and cold receptors – sensors for smell, sound, vision taste.

Module – III **(14 Hours)**

Aerospace Sensor

Gyroscope laser and fibre optic gyroscopes, accelerometers. Laser, Aerospace application of laser, Resolvers, Altimeters, Angle of attack sensors, servos.

Advanced Sensor Design

Sensor design a sensor characteristics, Design of signal conditioning devices for sensors. Design of 2& 4 wire transmitters with 4 – 20 mA output. Pressure Sensor using SiSi bonding, Catheter pressure sensors, TIP pressure sensors, Highpressure sensors, Silicon accelerometers.

Textbooks:

1. *Sabaree Soloman,* ***Sensors Hand Book****, McGraw Hill, 1998.*
2. *J.G. Webster,* ***Medical instrumentation Application and Design****, Houghton Mifilin Co.*
3. *Carr and Brown,* ***Introduction to Medical Equipment Technology****, Addison Wesley, 1999.*

Recommended Reading:

1. *Culshaw B and Dakin J (Eds),* ***Optical Fibre Sensors****, Vol. 1 & 2, Artech House, Norwood, 1989.*
2. *P. Garnell,* ***Guided Weapon Control Systems****, Pergamon Press, 1980.*

Process Dynamics and Control (3-1-0) Credit : 4

Module – I **(13 Hours)**

Design aspects of Process Control System

Classification of variables, Design elements of a control system, control aspects of a process. The input – output model, degrees of freedom and process controllers. Modes of operation of P, PI and PID controllers. Effect of variation of controller variables. Typical control schemes for flow, pressure, temperature and level processes.

Module – II **(13 Hours)**

Control System components:

I/P and P/I converters - Pneumatic and electric actuators - valve positioner - control valve Characteristics of control valve - valve body - globe, butterfly, diaphragm ball valves - control valve sizing - Cavitation, flashing in control valves - Response of pneumatic transmission lines and valves. Actuators – Pneumatic, Hydraulic, Electrical/ Electronic.

Module – III **(14 Hours)**

Dynamic behavior of feedback controlled process:

Stability considerations. Simple performance criteria, Time integral performance criteria: ISE, IAE, ITAE, Selection of type of feedback controller. Adaptive Control, Gain Scheduling Adaptive Control, Model – reference adaptive control, self tuning regulator. Logic of feed forward control, problems in designing feed forward controllers, feedback control, Ratio Control, Cascade Control.

Textbooks:

1. Curtis Johnson, ***Process Control Instrumentation Technology*****,** Prentice Hall of India.
2. George Stephanopoulos, ***Chemical Process Control*****,** Prentice Hall of India.
3. F.G. Shinkskey, ***Process Control Systems*****,** McGraw-Hill Publications.

Analytical Instrumentation (3-1-0) Credit : 4

Module – I (12 Hours)

Introduction

Introduction to Chemical Analysis, Classical and Instrumental Methods, Classification of Instrumental Techniques, Important Considerations in Evaluating an Instrumental Method.

Absorption Methods

(a) Spectrometric UV and VIS Methods: Laws of Photometry, Instrumentation.

(b) IR Spectrometry: Correlation of IR Spectra with Molecular Structure, Instrumentation.

(c) Atomic Absorption Spectrometry: Principle, Instrumentation.

Emission Methods

Flame, AC/DC Arc, Spark, Plasma Excitation Sources, Instrumentation**.**

Module – II (14 Hours)

Spectro-Fluorescence and Phosphorescence Spectrometer

Instrumentation, Raman Spectrometer.

Mass Spectrometer

Ionization Methods, Mass Analyzers, Mass Detectors, FTMS.

Chromatography

Classification, Gas Chromatography, Liquid Chromatography, Instrumentation.

Module – III (14 Hours)

X-ray and Nuclear Methods

X-ray Absorption, Fluorescence and Diffractometric Techniques, Electron-Microscope and Microprobe, ESCA and Auger Techniques, Nuclear Radiation Detectors.

NMR Spectroscopy

Principle, Chemical Shift, Spin-Spin Coupling, Instrumentation, Types of NMR.

Elector-Analytical Methods

Potentiometry, Voltammetry, Coulometry Techniques.

Textbooks:

1. *Galen W. Ewing, **Instrumental Methods of Chemical Analysis**, 5th Edition, McGraw-Hill.*
2. *Willard, Merritt, Dean and Settle, **Instrumental Methods of Analysis**, 7th Edition, CBS Publishers, New Delhi.*

Digital Instrumentation

(3-0-0) Credit : 3

Module – I **(11 Hours)**

Introduction

Digital Codes, Memory Devices, Basic Building Blocks: Gates, FF and Counters, Discrete Data Handling: Sampling, Sampling Theorem, Aliasing Errors, Reconstruction, Extrapolation, Synchronous and Asynchronous Sampling.

Digital Methods of Measurements

Review of A/D, D/A Techniques, F/V and V/F Conversion Techniques, Digital Voltmeters and Multimeters, Automation and Accuracy of Digital Voltmeters and Multimeters, Digital Phase Meters, Digital Tachometers, Digital Frequency, Period and Time Measurements, Low Frequency Measurements, Automatic Time and Frequency Scaling, Sources of Error, Noise, Inherent Error in Digital Meters, Hidden Errors in Conventional AC Measurements, RMS Detector in Digital Multimeters, Mathematical Aspects of RMS.

Module – II **(11 Hours)**

Digital Display and Recording Devices

Digital Storage Oscilloscopes, Digital Printers and Plotters, CDROMS, Digital Magnetic Tapes, Dot Matrix and LCD Display CROs, Colour Monitor, Digital Signal Analyser and Digital Data Acquisition.

Signal Analysis

Amplifiers, Filters, Transmitter, Receiver, Wireless Base and Mobile Station Test Sets, Noise Figures Meters, RF Network Analyser and High Frequency Signal Sources.

Module – III **(12 Hours)**

Current Trends in Digital Instrumentation

Introduction to Special Function Add-on Cards, Resistance Card, Input and Output Cards, Counters, Test and Time of Card and Digital Equipment Construction with Modular Designing, Interfacing to Microprocessor, Micro-controllers and Computers, Computer Aided Software Engineering (CASE) Tools, Use of CASE Tools in Design and Development of Automated Measuring Systems, Interfacing IEEE Cards, Intelligent and Programmable Instruments using Computers.

Textbooks:

1. Bouwens, A.J., ***Digital Instrumentation***, McGraw Hill, 1984.
2. John Lenk, D., ***Handbook of Micro-computer Based Instrumentation and Control***, PHI, 1984.
3. Doebelin, ***Measurement System, Application and Design***, McGraw-Hill, 1990.

Recommended Reading:

1. "***Product Catalogue***", Hewlet Packard, 1996.

Industrial Automation and Robotics (3-0-0) Credit : 3

Module – I **(12 Hours)**

Basic Concepts

Definition and origin of robotics, Different types of robotics, Various generations of robots, Degrees of freedom, Asimov's laws of robotics, Dynamic stabilization of robots.

Power Sources and Sensors

Hydraulic, pneumatic and electric drives, Determination of HP of motor and gearing ratio, Variable speed arrangements, Path determination, Micro machines in robotics, Machine vision, Ranging, Laser, Acoustic, Magnetic, Fiber optic and tactile sensors**.**

Module – II **(12 Hours)**

Manipulators, Actuators and Grippers

Construction of manipulators, Manipulator dynamics and force control, Electronic and pneumatic manipulator control circuits, End effectors, Various types of grippers, Design considerations.

Module – III **(14 Hours)**

Kinematics and Path Planning

Solution of inverse kinematics problem, Multiple solution jacobian work envelop, Hill climbing techniques, Robot programming languages.

Case Studies

Multiple robots, Machine interface, Robots in manufacturing and non-manufacturing applications, Robot cell design, Selection of robot.

Textbooks:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., ***Industrial Robotics***, McGraw-Hill Singapore, 1996.
2. Ghosh, ***Control in Robotics and Automation: Sensor Based Integration***, Allied Publishers, Chennai, 1998.

Recommended Reading:

1. S.R. Deb, ***Robotics technology and flexible Automation***, John Wiley, USA 1992.
2. C.R. Asfahl, ***Robots and Manufacturing Automation***, John Wiley, USA 1992.
3. R.D. Klafter, T.A. Chimielewski, and M. Negin, ***Robotic Engineering – An Integrated Approach***, Prentice Hall of India, New Delhi, 1994.

Digital Integrated Circuit Design (3 – 0 – 0) Credits: 3

MODULE – I (11 hours)

Introduction, Design Metrics and Manufacturing Process:

A Historical Perspective, Issues in Digital Integrated Circuit Design, Quality Metrics of a Digital Design, Introduction to Manufacturing Process, Manufacturing CMOS Integrated Circuits, Design Rules – The Contract between Designer and Process Engineer, Packaging Integrated Circuits

The Devices:

Introduction, The Diode, The MOS(FET) Transistor, The Wire, Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, SPICE Wire Models

The CMOS Inverters and CMOS Logic Gates – the Static View:

Introduction to CMOS Inverter, The Static CMOS Inverter – An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter, Introduction to Static CMOS Design, Complementary CMOS, Ratioed Logic, Pass-Transistor Logic

CMOS Inverter – the Dynamic View:

Performance of CMOS Inverter: The Dynamic Behavior, Power, Energy, and Energy-Delay, Perspective: Technology Scaling and its Impact on the Inverter Metrics

MODULE – II (11 hours)

Dynamic CMOS Logic, Timing Metrics:

Dynamic CMOS Design, CMOS Logic Design Perspectives, Timing Metrics: Timing Metrics for Sequential Circuits, Classification of Memory Elements

Static and Dynamic Sequential Circuits:

Static Latches and Registers, Dynamic Latches and Registers, Alternative Register Styles: Pulse Registers and Sense-Amplifier Based Registers, Pipelining: An Approach to Optimize Sequential Circuits – Latch Vs Register-Based Pipelines and NORA-CMOS – A Logic Style for Pipelined Structures, Nonbistable Sequential Circuits

Coping with Interconnect:

Introduction, Capacitive Parasitics, Resistive Parasitics, Inductive Parasitics, Advanced Interconnect Techniques, Networks-on-a-Chip

Timing Issues in Digital Circuits:

Introduction, Timing Classification of Digital Systems, Synchronous Design – An In-depth Perspective, Self-Timed Circuit Design, Synchronisers and Arbiters, Clock Synthesis and Synchronisation Using a Phase-Locked Loop, Future Directions and Perspectives

MODULE – III **(12 hours)**

Designing Arithmetic Building Blocks:

Introduction, Datapaths in Digital Processor Architecture, The Adder, The Multiplier, The Shifter, Other Arithmetic Operators, Power and Speed Trade-off's in Datapath Structures, Perspective: Design as a Trade-off

Designing Memory and Array Structures:

Introduction, The Memory Core, Memory Peripheral Circuitry, Memory Reliability and Yield, Power Dissipation in Memories, Case Studies in Memory Design: The PLA, A 4-Mbit SRAM and A 1-Gbit NAND Flash memory, Perspective: Semiconductor Memory Trends and Evolution

Validation and Test of Manufactured Circuits:

Introduction, Test Procedure, Design for Testability, Test Pattern Generation

Textbooks:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, ***Digital Integrated Circuits – A Design Perspective*****,** 2nd edn., Pearson Education, 2003. ISBN: 8178089912.

Recommended Reading:

2. K. Eshraghian, and N.H.E. Weste, ***Principles of CMOS VLSI Design – a Systems Perspective***, 2nd edn., Addison Wesley, 1993.
3. Wayne Wolf, ***Modern VLSI Design System – on – Chip Design***, 3rd edn., Pearson Education, 2003.
4. M. Michael Vai, ***VLSI Design***, CRC Press, 2001.
5. John P. Uyemura, ***CMOS Logic Circuit Design***, Springer (Kluwer Academic Publishers), 2001
6. Ken Martin, ***Digital Integrated Circuit Design***, Oxford University Press, 2000.

Computational Intelligence

(3 – 0 – 0) Credits: 3

Introduction to Soft Computing: Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing characteristics.

Fuzzy Sets, Fuzzy Rules and Fuzzy Reasoning: Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement, Extension principle and fuzzy relations, Fuzzy If-Then rules, Fuzzy reasoning.

Fuzzy Inference System: Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Least Square Method for system Identification: System Identification , Basic of matrix manipulations and calculus, Least-square estimator, Geometric interpretation of LSE, Recursive least-square estimator, Recursive LSE for time varying systems, Statistical Properties and maximum likelihood estimator, LSE for nonlinear models.

Derivative-based optimization: Descent methods, the method of steepest descent, Newton's methods, Step size determination, conjugate gradient methods, Analysis of quadratic case, nonlinear least-squares problems, Incorporation of stochastic mechanism.

Derivative-free optimization: Genetic algorithm simulated annealing, random search, Downhill simplex search, Swarm Intelligence, genetic programming.

Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule: combing steepest descent and LSE.

Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Basic Function networks.

Learning from reinforcement: Failure is the surest path to success, temporal difference learning, the art of dynamic programming, Adaptive heuristic critic, Q-learning, A cost path problem, World modeling, other network configurations, Reinforcement learning by evolutionary computations.

Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self-organizing networks, learning vector quantization, Hebbian learning, principal component networks, and the Hopfield network.

Adaptive Neuro-fuzzy inference systems: ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, ANFIS as universal approximator, Simulation examples, Extensions and advance topics.

Coactive Neuro-fuzzy modeling: towards generalized ANFIS: Framework, Neuro functions for adaptive networks, Neuro-Fuzzy spectrum, Analysis of adaptive learning capability.

Books:

1. J.S.R. Jng, C.T. Sun and E. Mizutani,"Neuro-fuzzy and Soft Computing", PHI.

2. S. Rajasekaran, G.A. Vijaylakshmi Pai,:Neural Networks, Fuzzy Logic, and Genetic Algorithms," PHI.

Adaptive Signal Processing (3 – 0 – 0) Credits: 3

MODULE – I (11 hours)

Adaptive System

Definition and Characteristics, Areas of Application, Example of an Adaptive System, Adaptive Linear Combiner, The Performance Function, Gradient and Minimum Mean-Square Error, Alternative Expression of the Gradient, Decorrelation of Error and Input Components. [Read Widrow: Chapter 1 and 2]

Winer Filter

Linear Optimum Filtering, Principle of Orthogonality, Minimum Mean Square Error, Winer-Hopf Equation, Error Performance Surface. [Read Haykin: Chapter 2.1-2.5]

Linear Prediction

Forward Linear Prediction, Backward Linear Prediction, Properties of Prediction Error Filters. [Read Haykin: Chapter 3.1, 3.2, 3.4]

MODULE – II (11 hours)

Method of Steepest Descent

Basic Idea of Steepest-Descent Algorithm, Steepest-Descent Algorithm Applied to Winer Filter, Stability of Steepest-Descent Algorithm, Limitations of Steepest-Descent Algorithm. [Read Haykin: Chapter 4.1 – 4.3, 4.6]

Least-Mean Square Adaptive Filter

Overview, LMS Adaptation Algorithm, Application, Comparison of LMS With Steepest-Descent Algorithm. [Read Haykin: Chapter 5.1 – 5.3, 5.5]

Normalized Least-Mean Square Adaptive Filter

Normalized LMS Filter as the Solution to Constrained Optimization Problem, Stability of the NLMS. [Read Haykin: Chapter 6.1, 6.2]

MODULE – III (11 hours)

Frequency-Domain and Subband Adaptive Filters

Block Adaptive Filters [Read Haykin: Chapter 7.1]

RLS Adaptive Filters

Statement of Linear Least-Square Estimation Problem, Matrix Inversion Lemma, The Exponentially Weighted RLS Algorithm. [Read Haykin: Chapter 8.1, **9.1 – 9.3]**

Kalman Filter

Recursive Minimum Mean-Square Estimation For Scalar Random Variable, Kalman Filtering Problem, Initial Conditions, Summary of Kalman Filter. [Read Haykin: Chapter 10.1, 10.2, 10.6, 10.7]

Text Books

1. *Bernard Widrow and Samuel D. Stearns, Adaptive Signal Processing, Pearson Education*
2. *Simon Haykin, Adaptive Filter Theory (Fourth Edition), Pearson Education.*

Statistical Signal Processing

(3-0-0) Credits: 3

Module – 1 **(9 hrs)**

Discrete Random Process

Random Process- Ensemble Average, Gaussian Process, Stationary Process, The Autocorrelation and Autocovariance Matrix, Ergodicity, White Noise, The Power Spectrom, Filtering Random Process, Special Types of Random Process-ARMV Process, AR Process, MA Process, Harmonic Process. [Read Hayes Chapter 3.3.1 – 3.3.8, 3.4, 3.6.1 – 3.6.4]

Signal Modeling

Introduction, Stochastic Models- ARMA Models, AR Models, MA Models, Application: Power Spectrum Estimation. [Read Hayes Chapter 4.1, 4.7.1 – 4.7.4]

Module – 2 **(14 hrs)**

WINER FILTERING

Introduction, The FIR Wiener Filter- Filtering, Linear Prediction, Noise Cancellation, IIR Wiener Filter- Noncausal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution, Discrete Kalman Filter. [Read Hayes Chapter 7.1, 7.2.1 – 7.2.3, 7.3.1 – 7.3.5, 7.4)

SPECTRUM ESTIMATION

Introduction, Nonparametric Method- The Periodogram, Performance of Periodogram. Parametric Methods- AR Spectrum Estimation, MA Spectrum Estimation, ARMA Spectrum Estimation. Frequency Estimation- Eigendecomposition of the Autocorrelation Matrix, MUSIC. [Read Hayes Chapter 8.1, 8.2.1, 8.2.2, 8.5.1 – 8.5.3, 8.6.1, 8.6.3]

Module – 3 **(11 hrs)**

ADAPTIVE FILTERING

Introduction, FIR Adaptive Filters- The Steepest Descent Adaptive Filter, The LMS Algorithm, Convergence of LMS Algorithm, NLMS, Noise Cancellation, LMS Based Adaptive Filter, Channel Equalization, Adaptive Recursive Filter, RLS- Exponentially Weighted RLS, Sliding Window RLS. [Read Hayes Chapter 9.1, 9.2.1 – 9.2.6, 9.2.9, 9.3, 9.4]

Text Book

1. *Monson H. Hayes, Statistical Digital Signal Processing & Modeling, John Wiley & Sons*

Reference Books

1. *Steven M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall.*

Digital and Adaptive Control

(3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Review of Spectrum Analysis and Sampling Process. Reconstructing Original Signals from sampled signals: Sampling theorm, Ideal lowpass filter, frequency responce characteristics of the zero-order Hold, folding, aliasing. Pulse Transfermation: Pulse ternsfer function of closed loop systems, Pulse transfer function of Digital PID controllers.

MODULE – II **(11 hours)**

Transient and steady state response analysis of Digital control system: Deadbeat response, Digital control system with state feedback. State regular, State observer, combined state feedback control and state Estimation, Deedbeat control by state feedback and Dead beat observer. Optimal Digital Control System: Discrete Algebraic Riccati Equation.

MODULE – III **(12 hours)**

Adaptive Control: Introduction to adaptive control. Model Reference Adaptive Control (MARC) system. Application to a first order control system. System Identification, Parametric Estimation. Self-Tuning Regulator (STR), Generalized predictive control, Application to a first order control system. Relation between MRAC and STR. Introduction to sliding Mode Control (Variable Structure Control).

Textbooks:

1. K. Ogata, ***Discrete-Time Control System*****,** 2nd edn., Pearson Education, Printed by Thomson Press (India).
2. M. Gopal, ***Digital Control and State Variable Methods*****,** 3rd edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi.
3. Eronini Umez-Eronini, ***System Dynamics and Control***, Thomson Books/Cole Publication.

Fiber Optics and Laser Instrumentation (3 – 0 – 0) Credits: 3

MODULE – I **(11 hours)**

Optical Fibers and their Properties

Principles of light propagation through a fiber, Different types of fibers and their properties, Transmission characteristics of optical fiber, Absorption losses, Scattering losses, Dispersion, Optical fiber measurement, Optical sources, Optical detectors, LED-LD-PIN and APD.

Industrial Application of Optical Fibers

Fiber optic sensors, Fiber optic instrumentation system, Different types of modulators, Detectors, Application in instrumentation, Interferometric method of measurement of length, Moiré fringes, Measurement of pressure, temperature, current, voltage, liquid level and strain, Fiber optic gyroscope, Polarization maintaining fibers.

MODULE – II **(11 hours)**

Laser Fundamentals

Fundamental characteristics of Lasers, Three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Q-switching and mode locking, Cavity dumping, Types of lasers: gas lasers, solid lasers, liquid lasers, semi conductor lasers.

Industrial Application of Lasers

Laser for measurement of distance, length velocity, acceleration, current, voltage and atmospheric effect, Material processing, Laser heating, welding, melting and trimming of materials, Removal and vaporization.

MODULE – III **(12 hours)**

Hologram and Medical Application

Holography, Basic principle, methods, Holographic interferometry and applications, Holography for non-destructive testing, Holographic components, Medical applications of lasers, Laser and tissue interaction, Laser instruments for surgery, Application of Laser for removal of tumours, brain surgery, plastic surgery, gynaecology and oncology.

Textbooks:

1. *John and Harry,* ***Industrial Lasers and their Applications****, McGraw Hill, 1974.*
2. *Senior J.M.,* ***Optical Fiber Communication Principles and Practice****, Prentice Hall, 1985.*

Recommended Reading:

1. *John F Read,* ***Industrial Applications of Lasers****, Academic Press, 1978*
2. *MonteRoss,* ***Laser Applications****, McGraw Hill, 1968*
3. *Keiser G.,* ***Optical Fiber Communication****, McGraw Hill, 1991*
4. *Jasprit Singh,* ***Semiconductor Optoelectronics****, McGraw Hill, 1995*
5. *Ghatak A.K and Thiagarajar K, Optical Electronics Foundation Book, TMH, New Delhi, 1991.*

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