ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ
"ವಿಟಿಯು ಅಧಿನಿಯಮ ೧೯೯೪"ರ ಅಡಿಯಲ್ಲಿ ಕರ್ನಾಟಕ ಸರ್ಕಾರದಿಂದ ಸ್ಥಾಪಿತವಾದ ರಾಜ್ಯ ವಿಶ್ವವಿದ್ಯಾಲಯ
"ಜ್ಞಾನ ಸಂಗಮ", ಬೆಳಗಾವಿ-೫೯೦೦೧೮, ಕರ್ನಾಟಕ, ಭಾರತ

Visvesvaraya Technological University
(State University of Government of Karnataka Established as per the VTU Act, 1994)
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Registrar

Phone: (0831) 2498100
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Ref: VTU/BGM/BOS/A9/2020-21 / 398

Date: 22 APR 2021

CIRCULAR

Subject: Updated Open Elective Subjects syllabus EI/BM/ML 2018 scheme regarding.
Reference:

1. Chairperson BOS in EI/BM/ML email dated 12.04.2021
2. Hon'ble Vice-Chancellor's approval dated 20.04.2021

Concerning the subject cited above, the OPEN Elective subjects' syllabi of following UG programs (2018 scheme) are updated.

1. Electronics & Instrumentation Engineering
2. Biomedical Engineering and
3. Medical Electronics Engineering

The complete list of subjects along with the syllabus is enclosed with this circular for kind reference to the concerned. And also updated scheme and syllabus is uploaded on the VTU web portal **@ https://vtu.ac.in/en/b-e-scheme-syllabus/#menu0**

All the Principals of Engineering Colleges are hereby requested to inform the concerned faculty to counsel the students regarding the OPEN elective subjects
Encl: As mentioned above

Sd/-
REGISTRAR

To,

- All the Principals of the Engineering Colleges under the ambit of VTU Belagavi.

Copy to:

1. The Registrar(Evaluation) for information and needful
2. The Registrar's Office, VTU, Belagavi, for information.
3. The Special Officer, Academic Section, VTU Belagavi, for information.
4. The Special Officer CNC section to upload the circular on the VTU web portal.

22/4/2021.
REGISTRAR

B.E. – ELECTRONICS AND INSTRUMENTATION ENGINEERING (EI)
OPEN ELECTIVES (REVISED)

Semester - VI			
OPEN ELECTIVE - A			
Course Code	**18EI65X**	CIE Marks	40
TeachingHours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electivesoffered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl.NO.	**Board and the Department offering the Electives**		**Course**		**Course Title**
			Sl. No.	**code under 18EI65X**	
01	**EI/ BM/ ML**	Electronics and Instrumentation Engineering	1	18EI651	Transducers and Process Instrumentation
			2	18EI652	Analytical Instrumentation
			3	18EI653	Optical Instrumentation

Semester –VI: Open Elective-A				
Transducers and Process Instrumentation				
Subject Code	: **18EI651**		CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (8 Hours per module)

Course Objectives:

- To provide the fundamental knowledge of transducers, instrumentation and measurement systems.
- To understand the functional elements of instrumentation/measurement systems.
- To impart the knowledge of static and dynamic characteristics of instruments, and understand the factors in selection of instruments for measurement.
- To discuss the principle, design and working of transducers for the measurement of displacement, level, strain, force, torque, pressure, sound and speed.

Modules

Module -1

Measurement, Instruments and Generalized Measurement/ Instrumentation system:

Measurement, significance of measurement, Methods of Measurements, instruments and measurement systems, Mechanical, electrical and electronic instruments, Deflection & Null type instruments and their comparison, Analog and digital modes of operation, functions of instruments and measurement systems, applications of measurement systems, Elements of generalized measurement system, Input-output configuration of measuring instruments and measurement systems, methods of correction for interfering and modifying inputs.

Module -2

Characteristics of Instruments & Measurement Systems: Measurement system performance,Static calibration and error calibration curve, accuracy and precision, indications of precision, static error, relative error, static correction, scale range and scale span, reproducibility and drift, repeatability, signal to noise ratio, static sensitivity, linearity, hysteresis, threshold, dead time and dead zone, resolution.

Transducers: Definition of Transducers, Classifications of transducers-based on principle, primary & secondary transducers, active & passive transducers, analog and digital transducers, transducers & inverse transducers, summary of factors influencing the choice of transducers/instruments.

Module -3

Transducers/Instruments for Measurement of Displacement: Introduction, Principles of Transduction, Variable resistance devices, Variable Inductance Transducer-LVDT, variable reluctance, Synchros and Resolvers, Variable Capacitance Transducer, Hall Effect Devices, Digital Transducer.

Transducers/Instruments for Measurement of Level: Capacitance probes – bare and coated capacitance probes, Conductivity probes, Float level devices – atmospheric tanks, mercury float switch, pneumatic float switch, Optical level switches-Noncontact level sensor, contacting level sensor, laser based level detector, Ultrasonic level detector-On-ff and continuous, Thermal level sensors

Module -4

Transducers/Instruments for Measurement of Strain: Introduction, Types of Strain Gauges, Theory of operation of resistance strain gauges, Types of Electrical Strain Gauges – Wire gauges, unbounded strain gauges, foil gauges, Semiconductor strain gauges (principle, types & list of main characteristics only), Strain gauge Circuits – Wheatstone bride circuit (quarter bridge, half bridge and full bridge), Applications.

Transducers/Instruments for Measurement of Force & Torque: Introduction, Force measuring sensor – Load cells – column types devices, proving rings, cantilever beam, pressductor. Hydraulic load cell, Electronic weighing system. Torque measurement: Absorption type, transmission type, stress type & deflection type.

Module -5

Transducers/Instruments for Measurement of Pressure: Introduction, Diaphragms, Other elastic elements, Transduction methods – potentiometric device, strain gauge transducer, variable reluctance, LVDT type, variable capacitance device (principle & working, no derivation), force balance transducer with analysis, Thin film pressure transducers, Digital pressure transducer, Piezoelectric pressure transducer, Pressure multiplexer, Pressure calibration.

Course Outcomes: After studying this course, students will able to:

- Define the transducer, instrument, measurement and classify different types of transducers
- Explain the functional elements of instrumentation / measurement systems
- Discuss the input-output configuration of measurement systems
- Define, interpret and analyze the static and dynamic characteristics of instruments

- Explain the principle, design and analyze the transducers for the measurement of displacement, level, strain, force, torque, and pressure.

Graduate Attributes (as per NBA)

- Engineering knowledge
- Problem analysis
- Design & Development of Solutions
- Engineer and society
- Environment & sustainability
- Lifelong learning

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question fromeachmodule.

Text Books:

1. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), DhanpatRai& Co. Pvt. Ltd., 2004. (Module 1 & 2)
2. Instrumentation: Devices and Systems- C. S. Rangan, G. R. Sarma, V. S. V. Mani, 2nd Edition (32nd Reprint), McGraw Hill Education (India), 2014. (Module 3-Displacement measurement, Module 4, and Module 5)
3. Process Measurement Instrument Engineers Handbook- BelaG.Liptak, Revised Edition, Chilton Book Company, 1982. (Module 3 – Level measurement**)**

Reference Books:

1. Transducers and Instrumentation – D.V.S.Murty, 2nd Edition, PHI, 2009.
2. Introduction to Measurements and Instrumentation - A. K. Ghosh, 2nd Edition, PHI, 2007.
3. Instrumentation Measurement and Analysis- B.C.Nakra and K.K.Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt.Ltd. 2009.
4. Measurement Systems Application and Design- Ernest O.Doeblin and Dhanesh N Manik, 5th Edition, McGraw Hill, 2007

B.E. Electronics and Instrumentation Engineering (EI)
Choice Based Credit System (CBCS)
Semester – VI: Open Elective-A

Analytical Instrumentation

Subject Code	: **18EI652**		CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (8 Hours per module)

Course Objectives:

- To introduce the basic concept of qualitative and quantitative analysis of a given sample.
- To impart various spectroscopic techniques and its instrumentation.
- To impart the concept of separation science and its application.
- To impart methods of Industrial analyzers and its application.

Modules
Module -1 **An Introduction to Instrumental Methods:** Terms associated with Chemical analysis, Classification of instrumental techniques, A review of important consideration in analytical methods, Basic functions of instrumentation (Text book 1). **IR Spectroscopy:** Basic Components of IR Spectrophotometers, monochromators- Littrow mounting, Fourier Transform IR Spectroscopy (Text book 2).
Module -2 **Colorimeters and Spectrophotometers(Visible - Ultraviolet)**: Electromagnetic radiation, The Beer Lambert Law, Absorption instruments ,Colorimeters, Spectrophotometers-Single beam Null-Type Spectrophotometer , Microprocessor based Spectrophotometer, Sources of error in Spectrophotometric measurements.(Text book 2)
Module -3 **Flame Photometers**: Principle of Flame Photometry, Constructional details of Flame photometers, clinical flame photometers, Interferences in flame photometry, procedure for determinations. **Thermo-Analytical Methods**: Thermogravimetric analysis(TGA), Differential thermal analysis(DTA) (Text book 2).
Module -4 **Gas Chromatography:** Chromatograph, Basics parts of a chromatograph: carrier gas supply, sample injection system, chromatographic columns: packed column & capillary column, Detectors: katharometer cell, differential flame ionization detector, electron capture detector.(Text book 2). **HPLC Instrumentation**: Mobile –phase delivery system sample introduction, separation of columns, Detectors–Ultraviolet Photometers & Spectrophotometers, electrochemical detector (amperometric detector), Differential refractometer. (Text book 1).
Module -5 **Industrial gas analysers :** Typesof gas analysersMagnetic wind instruments. Infrared gas analyser, Thermal conductivity analysers, analysers based on gas density, method based on Ionization of gases. **Air pollution monitoring instruments:** Carbon monoxide (CO) -Non-dispersive infrared analyzer, Sulphur dioxide (SO_2)-Conductivitimetry, UV fluorescence method, Nitrogen oxides-Using CO laser, laser opto-acoustic spectroscopy, Hydrocarbons-Flame ionization detector, Ozone-Chemiluminescence, Automated wet chemical air analysis, **Water pollution monitoring instruments**. (Text book 2)
Course Outcomes: 1. The students get well versed with the principle, construction and working of various analytical instrumentation. 2. Students get detailed information about the application of analytical techniques in pollution monitor, Industry, etc.
Graduate Attributes (as per NBA) • Engineering Knowledge • Problem Analysis • Life-long Learning

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Instrumental Methods of Analysis, 7th edition. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS Publishing & Distribution (Module 1 and Module 4-HPLC)
2. Handbook of Analytical Instruments – R.S. Khandpur, Tata McGraw Hill (Module 1-IR Spectroscopy, Module2,Module 3, Module 4-GasChromatography, Module 5)

Reference Books:

1. Braun R.D., Introduction to Instrumental Analysis, McGraw –Hill Singapore,2006.
2. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and Francis group, 2007.
3. Principles of Instrumental Analysis 5th Edition – Douglas A. Skoog, F. James Holler, Timothy A. Niemen, Thomason Brooks/ Cole

Semester – VI: Open Elective-A

Optical Instrumentation

Subject Code	: **18EI653**		CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (8 Hours per module)

Module -1

Introduction to Laser (Lasers -I): Introduction, Emission and absorption of radiation, Einstein relation, population inversion, optical feedback, threshold conditions, Line shape function, population inversion and pumping threshold conditions**.**

Classes of Laser: Doped insulator Lasers, semiconductor Lasers, Gas Lasers, Liquid dye Lasers.

(Textbook-1)

Module -2

Lasers-II: Single mode operation, frequency stabilization, Mode locking and Q-switching.

Applications of Laser: Measurement of distance: Interferometric methods, Beam modulation telemetry; Holography &Holography interferometry.

(Textbook-1)

Module -3

Optical Fiber Communications: Motivations for light wave communications, optical spectral bands, Network information rates, WDM concepts, Key elements of optical fiber systems, standards for optical fiber communications, Modeling and simulation tools.

Optical Fibers: Structures, Wave guiding, and Fabrication: The nature of light, basic optical laws and definitions, optical fiber modes and configurations.

(Textbook-2)

Module -4

Types of Fibers, Material and Fabrication: Single mode fibers, Graded index fiber structure, Fiber materials, Photonic crystal fibers, Fiber fabrication,Fiber optic cables.
Optical Amplifiers: Types of optical amplifiers and its applications, Semiconductor optical amplifiers, Erbium-doped fiber amplifiers, Amplifier noise, Optical SNR, System, Raman amplifiers.
(Textbook-2)

Module -5
Applications of Lasers in Medicine: Fiberoptic laser systems in cardiovascular disease-Endoscopic laser systems in cardiology, Fiber-optic laser therapy-angioplasty, Endoscopic Nd:YAG Laser therapy in gastroenterology, Laproscopic laser surgery, ophthalmological applications of laser-fiber systems, arthroscopic surgery in orthopedics, laser lithotripsy.
(Textbook-3)

Course Outcomes: After studying this course, students will be able to:

1. Explain theprinciple and working of Laser system.
2. Discuss the engineering applications of laser systems.
3. Discuss the fundamentals of optical fiber communications.
4. Evaluate the design of optical fibers.
5. Apply fiber optic laser systems in medical field.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Optoelectronics- An Introduction-Wilson & Hawkes, Prentice Hall of India.
2. Optical fiber communications-GeirdKeser, McGraw Hill education (India) private limited, Fifth edition.
3. Lasers and Optical Fibers in Medicine - by Abraham Katzir, Academic Press, 1998.

Reference Books:

1. LASER Fundamentals- William T. Silfvast, Cambridge University Press.
2. Essentials of Opto Electronics with Applications - A.J. Rogers, CRC press 1997.

B.E. Electronics and Instrumentation Engineering (EI) Choice Based Credit System (CBCS) Semester - VII			
OPEN ELECTIVE - B			
Course Code	**18EI75X**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl. NO.	**Board and the Department offering the Electives**		**Course**		**Course Title**
			Sl. No.	**code under 18EI75X**	
01	**EI/ BM/ ML**	Electronics and Instrumentation Engineering	1	18EI751	Medical Instrumentation
			2	18EI752	Robotics and Industrial Automation
			3	18EI753	Smart Sensors

Semester – VII: Open Elective-B				
Medical Instrumentation				
Subject Code	: **18EI751**		CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	:40		Exam Hours	: 03

Credits – 3 (8 Hours per module)

Module -1

Fundamentals of Biomedical Instrumentation: Sources of biomedical signals, Basic Medical Instrumentation system, Interfacing analog signals to microprocessors. PC based medical instruments, General constraints in design of biomedical instrumentation systems.

Bioelectric Signals and Electrodes: Origin of Bioelectric signals, Types of bioelectric signals-ECG, EEG, EMG, Recording electrodes: Electrode – Tissue interface, polarization, skin contact-impedance, Silver-silver chloride electrodes, Electrodes for ECG (limb electrodes, floating electrodes, pregelled disposable electrodes), EEG, EMG, Microelectrodes.

Module -2

Electrocardiograph: Physiology of the heart, Electrical activity of the heart and Electrocardiogram (ECG), Normal & Abnormal cardiac Rhythms, Block diagram-description of an Electrocardiograph, ECG leads, Effects of artifacts on ECG Recordings, Multichannel ECG Machine.

Electroencephalograph: Block diagram description of an Electroencephalograph, 10-20 electrode systems, computerized analysis of EEG.

Module -3

Patient Monitoring System: Bedside patient monitoring systems, Central monitors, Measurement of heart rate – Average heart rate meter, Instantaneous heart rate meter, Measurement of pulse rate.

Blood Pressure Measurement: Introduction, Indirect methods of blood pressure measurement: Korotkoff's method, Rheographic method, differential auscultatory technique.

Measurement of Respiration Rate: Impedance pneumography, CO_2 method of respiration rate measurement, Apnoea detectors.

Module -4

Blood Flow Measurement: Electromagnetic blood flow meter- Principle and Square wave electromagnetic flowmeter. Doppler shift blood flow velocity meter, Blood flow measurement by Doppler imaging, NMR blood flowmeter.

Cardiac Pacemakers: Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Types of Implantable pacemakers, Programmable pacemakers.

Cardiac Defibrillator: Need for a Defibrillator, DC defibrillator, Pacer-Cardioverter-Defibrillator.

Module -5

Therapeutic Instruments:

Cardiac-assist devices, Pump oxygenators, Total artificial heart, Haemodialysis, Ventilators, Infant incubators, Drug infusion pumps.

Patient Safety: Electric shock hazards, Leakage currents, Electrical safety analyzer, Testing of Biomedical equipment.

Course Outcome: After studying this course, students will able to:

1. Acquire knowledge about origin of bio-potential, bio-signals and their measurement
2. Describe the problem, identify and formulate solution in the field of Bio-Medical Engineering for current and future issues
3. Describe the cardiac, brain and muscular physiological systems with the related diagnostic measurement methods.
4. Recognize the therapeutic methods of treatment and the associated instrumentation.
5. Identify and judge patient safety issues related to biomedical instrumentation.
6. Describe the principle and working of cardiac pacemakers, defibrillators, BP measurement, blood flow meters, CO_2 measurement, respiration measurements and their implementation.

Question Paper Pattern:

- The question paper will have TEN questions
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Handbook of Biomedical Instrumentation - R.S.Khandpur, 2nd Edition, Tata McGraw- Hill, 2003 (Module 1, 2, 3, 4 & Module 5- Patient Safety)
2. Medical Instrumentation: Application and Design – John G Webster, 3rd Edition, John Wiley & Sons, 2006. (Module 5- Therapeutic Instruments)

Reference Book:

1. Biomedical Instrumentation & Measurement - Leslie Cromwell, Fred J Weibell& Erich A Pfeiffer, 2nd Edition, Prentice Hall of India, 2001.

Semester – VII: Open Elective-B

Robotics and Industrial Automation

Subject Code	: **18EI752**		CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (8 Hours per module)

Module -1

Fundamentals of Robotics & SCADA: Automation and robotics, robots in science fiction, history of robotics, robotics market and future prospects, robot anatomy, work volume, robot drive systems, control systems and dynamic performance, precision of movement and robot applications.[Textbook-1] SCADA: Introduction and brief history of SCADA, SCADA systems software, considerations and benefits of SCADA system. [Textbook-2]

Module -2

Control Systems and Components: Basic control systems concepts and models, controllers, robot actuation and feedback components.

Robot end effectors: Types of end effecters, mechanical grippers, other types of grippers, tools as end effectors, robot/end effector interface, consideration in gripper selection and design, problems.

Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors [Textbook-1]

Module -3

Machine Vision & Artificial Intelligence: Introduction to machine vision, The sensing and digitizing function in machine vision, image processing and analysis: image data reduction, segmentation, feature extraction, object recognition, training the vision system, robotic applications.

Artificial Intelligence (AI): Goals of AI in research, AI techniques: knowledge representation, problem representation and problem solving and search techniques in problem solving. [Textbook-1]

Module -4

Robot cell design and control, Material Transfer, Machine Loading/Unloading:

Robot cell layouts, multiple robots and machine interference, other considerations in work -cell design, work-cell control, interlocks, error detection and recovery, work -cell controller, robot cycle time analysis.

Material Transfer, Machine Loading/Unloading: General considerations in robot material

handling, material transfer applications, machine loading and unloading. [Textbook-1]

Module -5

Processing Operations, Assembly & Inspection: Spot welding, continuous arc welding, spray coating, other processing operations using robots. Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote center compliance (RCC) device, assembly system configurations, designing for robotic assembly, inspection automation. [Textbook-1]

Autonomous Mobile Robots: Introduction, Planning &Navigation: Introduction, basic control scheme for mobile robots (only basic understanding of perception, localization, path planning & motion control). [Textbook-3]

Course Outcomes: After studying this course, students will able to:

1. Identify basic components of robot system and its functionality
2. Identify DH representation of robot and homogenous transformation for various arm configurations.
3. Analyze the functions of sensors in the robot.
4. Solve forward and inverse kinematic problems.
5. Evaluate and compare the use Robots in different applications.
6. Recognize material-handling applications, processing operations, assembly and inspection operations to increase product quality and uniformity in minimize cycle times and effort.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carry 20 marks.
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and AshishDutta, "Industrial Robotics: Technology, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2012.
2. SrinivasMedida, Pocket Guide on Industrial Automation: For Engineers and Technicians, 1st Edition, IDC Technologies, 2007. (http://www.pacontrol.com/download/Industri al-Automation-Pocket-Guide.pdf)
3. Roland Siegwart, Illah R. Nourbakhsh, and DavideScaramuzza, "Introduction to Autonomous Mobile Robots", 2ndEdition, PHI, 2011.

Reference Books:

1. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.

Semester – VII: Open Elective-B				
Smart Sensors				
Subject Code	: **18EI753**		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 2+2		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (8 Hours per module)

Module -1

Basics of smart sensors and micromachining: Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining.

Module -2

MCUs and DSPs for sensor: Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

Module -3

Sensor Communication and MEMS: Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro-mirrors. **Communications for smart sensors** - sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

Module -4

Packaging, Testing and Reliability of Smart Sensors: Introduction, Semiconductor packaging applied to sensors, hybrid packaging, packaging for monolithic sensors, reliability implications, testing smart sensors.

Standards for Smart Sensors: Introduction, setting the standards for smart sensors and systems, IEEE 1451.1, IEEE 1451.2, IEEE P1451.3, IEEE 1451.4, extending the systems to network.

Module -5

Implications of Smart Sensor Standards and Recent Trends: Introduction, sensor plug-and-play, communicating sensor data via existing wiring, automated/remote sensing and web, process control over the internet, alternative standards, HVAC sensor chip, MCU with integrated pressure sensors, alternative views of smart sensing, smart loop.

Course Outcomes: After studying this course, students will be able to:

1. Describe the principle of smart sensors and process of micromachining in development of smart sensors.
2. Develop intelligent systems by interfacing the smart sensors to MCUs and DSPs.
3. Analyze the use of smart sensors in communication, MEMS and automation.
4. Evaluate the standards of smart sensors by the assessment of reliability testing and packaging.
5. Discuss the applications of smart sensors in different fields and recent development.
6. Develop/sketch the simple models of intelligent instrumentation.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Understanding Smart Sensors- Randy Frank, 2nd Edition. Artech House Publications, 2013.

Reference Books:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, V. K. Aatre, Micro and Smart Systems: Technology and modeling, Willey Publications,2012.

B.E. - BIOMEDICAL ENGINEERING (BM)
OPEN ELECTIVES (REVISED)

Semester - VI			
OPEN ELECTIVE - A			
Course Code	**18BM65X**	CIE Marks	40
TeachingHours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electivesoffered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl.No.	**Board and the Department offering the Electives**		**Course**		**Course Title**
			Sl. No.	**code under 18BM65X**	
	EI/ BM/ ML	Biomedical Engineering	1	18BM651	Biomedical Transducers and Medical Instrumentation
			2	18BM652	Fundamentals of Medical Imaging Techniques
			3	18BM653	Rehabilitation Engineering and Assistive Technology

Biomedical Transducers and Medical Instrumentation

(Common to BM & ML)

Subject Code	: **18BM651/18ML651**		CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hrs)

Course Objectives: This course will enable the students to

- Gain the knowledge of working principle and construction details of Biomedical Transducers.
- Acquire the knowledge of transducer applications to access the biological signals.
- Access the performance of various Biomedical Transducers.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules

Module -1

Fundamental Concepts and Basic Transducers: Introduction, Classification of Transducers**,** Classification of transducers, Perfomance characteristics of Transducers, Displacement, Position and Motion Transducers, Pressure Transducers, Photoelectric Transducers, Optical fibre sensors and Smart sensors.

Module -2

Bioelectric Signals and Electrodes:

Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes–Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.

Module -3

Recording Systems: Basic recording system, General considerations for signal conditioners, Preamplifiers, Biomedical signal analysis techniques, Signal processing techniques, Writing systems, Direct writing recorders, Ink Jet recorders, Potentiometric Recorders, Tape Recorders and Digital Recorders.

Module -4

Clinical Laboratory Instruments: Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers: photovoltaic cells and photoemissive cells. Spectrophotometer, Colorimeter, Automated Biochemical Analysis Systems, Clinical Flame Photometers and Selective-ion Electrodes Based Electrode Analysers. Blood Cell Counters.

Module -5

Flow Measurement: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic Doppler flowmeters, blood flow measurement through Doppler imaging. Cardiac Output Measurement - Indicator dilution method, Dye Dilution method, Thermal Dilution Method, impedance cardiography.

Course Outcomes: After studying this course, students will able to:

1. Understand the working principle and construction details of Transducers.
2. Improve the measurement techniques through different approach.
3. Practically can implement the technology in measurement field.

Graduate Attributes (as per NBA)

- Engineering knowledge
- Modern tool usage
- Engineer and society
- Environment& sustainability
- Lifelong learning

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. **Biomedical Transducers and Instruments –** Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. **Handbook of Biomedical Instrumentation**- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.

Reference Books:

1. **Biomedical Instrumentation and Measurement** – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
2. **Transducers and Instrumentation** -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition

Semester – VI: Open Elective-A

Fundamentals of Medical Imaging Techniques

(Common to BM & ML)

Subject Code	**: 18BM652/18ML652**		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

X-Ray Machines and Radiography: Fundamentals of X-ray – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, Biological effects of ionizing radiation.

X-Ray Diagnostic Methods: Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography.

Module -2

Computed Tomography: Principle of CT, System components, Gantry geometry, Patient dose in CT scanners. Algorithms for image reconstruction, CT number, Spiral CT. Recent developments .Digital Radiography- Digital subtraction angiography (DSA), Dynamic spatial reconstructor (DSR), Image artifacts and Image characteristics.

Module -3

Ultrasound Imaging: Fundamentals of acoustic propagation - Characteristic impedance, Intensity, Reflection and refraction, Attenuation, Doppler effect. Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution, Focusing, Arrays. Ultrasonic Diagnostic Methods:Pulse echo systems- Amplitude mode (A-mode), Brightness mode (Bmode), Motion mode (M-mode), Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging, Image characteristics – Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound.

Module -4

Radionuclide Imaging: Introduction, Fundamentals of Radioactivity – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Diagnostic methods using radiation detector probes – Thyroid function test, Renal

function test, Blood volume measurement, Radionuclide imaging systems- Rectilinear scanner, Scintillation camera, SPECT, PET.

Module - 5

Basics of Magnetic Resonance Imaging: Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

MRI System & Imaging Methods: Introduction, Magnet, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Gradient echo imaging, Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields.

Course Outcomes: After studying this course, students will be able to:

1. Describe the fundamentals of x-ray radiography and analyze the system requirements.
2. Explain principles and applications of Computed Tomography system requirements.
3. Discuss the fundamentals of Ultrasonic imaging and analyze the system requirements.
4. Describe the fundamental concepts of Radionuclide Imaging and analysis of the system.
5. Understand physics and Instrumentation of MR imaging system.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carries 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Principles of Medical Imaging – by Kirk Shung, Michael B. Smith and BanjaminTsui, Academic Press, 1992.
2. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003.
3. Fundamentals of Medical Imaging – by Paul Suetens, Cambridge University Press, 2002.

Reference Books:

1. The Physics of Medical Imaging – by Steve Webb (Editor), Adam Hilger, Bristol and Philadelphia Publications, 1988.

Semester – VI: Open Elective-A

Rehabilitation Engineering and Assistive Technology

(Common to BM & ML)				
Subject Code	: 18BM653/18ML 653		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module 1

Introduction to Rehabilitation: Introduction Types of physical impairments, Principles of Rehabilitation, Motor, Sensor and Communication disorders. Intelligent prosthetic knee & arm. Advanced automatic prosthetics and orthotics. Prevention and cure of visual impairment, Electronics travel appliances, path sounder, laser cane, ultrasonic torch and guide, light probes, obstacle sensors, electro cortical prosthesis, classification.

Module 2

Therapeutic Exercise Technique: Coordination Exercises, Balance Training, Gait, Pathological Gaits, Gait Training – Crutch Walking: Patterns of Gait, Relaxation exercises, Methods for training Relaxation, Strengthening exercises, Mobilization exercises.

Principles in Management of Communication: Communication, Speech, Language, Aphasia, Dysarthria, Speech therapy, Dysphagia, Communication for Visually impaired, Types of visual aids, Writing aids.

Module 3

Orthotic Devices in Rehabilitation Engineering: Definition, General Principles of Orthosis, Biomechanics of Orthosis, Classification, Material and fabrication for lower limb Orthosis, Calipers – Foot Orthoses, Ankle-Foot Orthosis, Knee-Ankle-Foot Orthosis, Hip-Knee-Ankle-Foot Orthoses, Functional Electrical Stimulation, Spinal Orthosis- Cervical, Head cervical Orthosis, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacro-orthosis, Splints-its functions & types.

Module 4

Subjective and objective measurement methods. Characterizing human systems, and assertive devices. Biomaterials outlook for organ transplant, design considerations evaluation process. Engineering design of artificial heart and circulatory assist devices, Implementation and implantation aspects.

Module 5

Computer application in rehabilitation engineering; Interfaces in compensation for visual perception and improvement of orientation and mobility, rehabilitation aids for mentally impaired. Physical therapist, Occupational therapist, Prosthetist-Orthotist, Rehabilitation nurse, Speech pathologist, Psychologist and child development Specialist, Horticultural Therapist, Music therapist, Creative Movement. Therapist, Dance and play Therapist, Recreational therapist, Biomedical engineer.

Course Outcomes: After studying this course, students will be able to:

1. Define rehabilitation and explain the composition of rehabilitation team.
2. Discuss the engineering principles of rehabilitation engineering.
3. Apply engineering skills in the development of prosthetic and orthotic devices.
4. Evaluate the orthopedic design and applications.
5. Apply the principles of engineering in the development of mobility aids for physically handicap.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Rehabilitation Medicine - By Dr. S. Sunder, 3rd Edition, Jaypee Medical Publications, Reprint 2004.
2. Biomedical Engg., Handbook, Bronzino J. D., CRC press (New York),1995

Semester – VII			
OPEN ELECTIVE - B			
Course Code	**18BM75X**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl. NO.	**Board and the Department offering the Electives**		**Course**		**Course Title**
			Sl. No.	**code under 18BM75X**	
	EI/ BM/ ML	Biomedical Engineering	1	18BM751	Biomedical Signal Processing
			2	18BM752	Biomedical Image Processing
			3	18BM753	Medical Informatics

Semester – VII: Open Elective-B				
Biomedical Signal Processing (Common to BM & ML)				
Subject Code	**: 18BM751/18ML751**		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

Signal processing: Review of Discrete time signals and systems - LTI systems - Response of LTI systems – Convolution - Difference equation representation of discrete systems Z transform - Transform analysis of LTI system – DFT. STFT - Introduction to wavelets - CWT and DWT with Haar wavelet. Introduction to biosignals: Computers in medicine. Human anatomy and physiology - Cell structure - Origin of bioelectric potentials - Biomedical signals - The Brain and its potentials. Electrophysiological origin of brain waves. EEG signal and its characteristic- ECG signal origin and characteristics.

Module -2

Neurological signal processing: EEG analysis - Parametric modelling - Linear prediction theory; Autoregressive (AR) method; Recursive estimation of AR parameters. Cardiological signal processing: ECG parameters and their estimation - Arrhythmia analysis monitoring - ECG data reduction techniques

Module-3

Adaptive interference / Noise cancellation: Types of noise in biosignals; Digital filters - IIR and FIR - Notch filters - Optimal and adaptive filters. Weiner filters - steepest descent algorithm - LMS adaptive algorithm - Adaptive noise canceller - cancellation of 50 Hz signal in ECG - Cancellation of maternal ECG in foetal electrocardiography.

Module -4

Basics of signal averaging, Signal averaging as a digital filter, A typical average, Software for signal averaging, Limitations of signal averaging. Data Acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of Sleep-wave Transitions, Hypnogram Model Parameters.

Module -5

Direct data compression techniques, Direct ECG data compression techniques, Transformation compression techniques, Other data compression techniques, Data compression techniques comparison.

Note: Assignments can be given on analysis other important biomedical signals like EMG, ERG, EOG, Evoked potentials.

Course Outcomes: After studying this course, students will be able to:

1. Analyze the nature of Biomedical signals and related concepts
2. Apply filters to remove noise from biomedical signals.
3. Apply averaging technique on biomedical signals and extract the features of EEG signals.
4. Analyze event detection techniques for EEG and ECG signals.
5. Apply signal compression techniques on biomedical signals.

Question Paper Pattern

The question paper will have TEN questions.

- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Biomedical signal analysis- A case study approach, RangayyanRangaraj, Wiley (IEEE Press)-2005
2. Biomedical Signal Processing- Principles and Techniques - D.C.Reddy, Tata McGraw-Hill, 2005.
3. Biomedical Digital Signal Processing-Willis J.Tompkins, PHI, 2000.

Reference Books:

1. Biomedical Signal Processing -Akay M, , Academic: Press 1994
2. Biomedical Signal Processing (Vol. I Time & Frequency Analysis) - Cohen.A,, CRC Press, 1986.

Semester – VII: Open Elective-B				
Biomedical Image Processing **(Common to BM & ML)**				
Subject Code	**: 18BM/ML752**		CIE Marks	: 40
Number of Lecture Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

Fundamentals of Digital image, Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2D convolution, Color models.

Module -2

Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Intensity level slicing, Bit plane slicing, Histogram processing – Histogram equalization, Histogram matching (specification), Arithmetic/Logic operations – Image subtraction, Image averaging. Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters.

Module -3

Image Enhancement In Frequency Domain: Background, 2D-Discrete Fourier Transform and its Inverse, Basic properties of the 2D-Discrete Fourier Transform, Basics of filtering in the frequency domain. Image smoothing using frequency domain filters – Ideal low pass filters, Butterworth low pass filters, Gaussian low pass filters; Image sharpening using frequency domain filters – Ideal high pass filters, Butterworth high pass filters, Gaussian high pass filters, Homo-morphic filtering.

Module -4

Image Segmentation Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering.

Module -5

Image Restoration: Model of the Image degradation/restoration process, Noise models, Restoration using spatial filtering: Mean filters, Order statistic filters - Median filter, Min and Max filters, Midpoint filter.

Image Compression: Fundamentals, Image compression models, Basic compression methods – Huffman coding, Arithmetic coding, LZW coding, Run-length coding.

Course Outcomes: After studying this course, students will be able to,

1. Define the general terminology of digital image processing.
2. Identify the need for image transforms and their types both in spatial and frequency domain.
3. Identify different types of image enhancement techniques.
4. Describe image segmentation models and learn image segmentation techniques.

5. Explain and apply various methodologies for image compression.

Note: It is suggested to give assignments / hands-on-experience on the above image processing concepts using Matlab / C programming on medical images like x-ray / CT / MRI.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carry20 marks.
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Digital Image Processing - Rafael. C. Gonzalez and Richard. E. Woods, Third Edition, Pearson Education, 2008.

Reference Books:

1. Fundamentals of Digital Image Processing - Anil K. Jain, 5th Indian Print, PHI, 2002.
2. Digital Image Processing and Computer Vision - Milan Sonka, India Edition, Cengage Learning.

Semester – VII: Open Elective-B

Medical Informatics

(Common to BM & ML)

Subject Code	**: 18BM753/18ML753**	CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02	SEE Marks	: 60
Total Number of Lecture Hours	: 40	Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module- 1

Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics. Impact of Systems on Health Care, Care Providers and Organizations, mobile health care technologies.

Module-2

Hospital Management Need for HMIS, Capabilities & Development of HMIS, functional area, modules forming HMIS, (like Pathology Lab, Blood bank, Pharmacy, Diet planning). Maintenance and development of HMIS-Ideal Features and functionality of CPR, Development tools for CPR.

Module–3

Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring.

Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS.

Module–4

Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications. Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications. Real-time Telemedicine. Data Exchange: Network Configuration, circuit and packet switching, H.320 series (Video phone based ISBN) T.120, H.324. Video Conferencing.

Module–5

Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES.

Course Outcomes: After studying this course, students will be able to:

1. Explain the basics and importance of medical informatics in hospital management.
2. Describe the different modalities functions exists in the hospital for effective management.
3. Discuss the role of telecommunication, tele-surgery, robotics in healthcare.
4. Explain the decision making concepts used in healthcare and their applications.
5. Apply information and communication technology in healthcare.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill, Publications, 2003.
2. A.S. Tanenbaum, “Computer Networks”, 2012, 5th Edition, Pearson Education, London.
3. Kenneth R. Ong, “Medical Informatics: An Executive primer”, 2015, 1st Edition, HIMSS Publishing, Chicago

Reference Books:

1. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2nd Edition, Springer Verlag, 2000.
2. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.

B.E. - MEDICAL ELECTRONICS (ML)
OPEN ELECTIVES (REVISED)

Semester - VI			
OPEN ELECTIVE - A			
Course Code	**18ML65X**	CIE Marks	40
TeachingHours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electivesoffered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl.No.	Board and the Department offering the Electives		Course Sl. No.	Course code under 18BM65X	Course Title
01	EI/ BM/ ML	Medical Electronics	1	18ML651	Biomedical Transducers and Medical Instrumentation
			2	18ML652	Fundamentals of Medical Imaging Techniques
			3	18ML653	Rehabilitation Engineering and Assistive Technology

Semester –VI: Open Elective-A

Biomedical Transducers and Medical Instrumentation

(Common to BM & ML)

Subject Code	: **18BM651/18ML651**	CIE Marks	: 40
Number of Lecture + Tutorial Hours/Week	: 02+02	SEE Marks	: 60
Total Number of Lecture Hours	: 40	Exam Hours	: 03

Credits – 3 (Each module – 8 Hrs)

Course Objectives: This course will enable the students to

- Gain the knowledge of working principle and construction details of Biomedical Transducers.
- Acquire the knowledge of transducer applications to access the biological signals.
- Access the performance of various Biomedical Transducers.

Revised Bloom's Taxonomy Levels: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules

Module -1

Fundamental Concepts and Basic Transducers: Introduction, Classification of Transducers,

Classification of transducers, Perfomance characteristics of Transducers, Displacement, Position and Motion Transducers, Pressure Transducers, Photoelectric Transducers, Optical fibre sensors and Smart sensors.

Module -2

Bioelectric Signals and Electrodes:

Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes–Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.

Module -3

Recording Systems: Basic recording system, General considerations for signal conditioners, Preamplifiers, Biomedical signal analysis techniques, Signal processing techniques, Writing systems, Direct writing recorders, Ink Jet recorders, Potentiometric Recorders, Tape Recorders and Digital Recorders.

Module -4

Clinical Laboratory Instruments: Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers: photovoltaic cells and photoemissive cells. Spectrophotometer, Colorimeter, Automated Biochemical Analysis Systems, Clinical Flame Photometers and Selective-ion Electrodes Based Electrode Analysers. Blood Cell Counters.

Module -5

Flow Measurement: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic Doppler flowmeters, blood flow measurement through Doppler imaging. Cardiac Output Measurement - Indicator dilution method, Dye Dilution method, Thermal Dilution Method, impedance cardiography.

Course Outcomes: After studying this course, students will able to:

1. Understand the working principle and construction details of Transducers.
2. Improve the measurement techniques through different approach.
3. Practically can implement the technology in measurement field.

Graduate Attributes (as per NBA)

- Engineering knowledge
- Modern tool usage
- Engineer and society
- Environment& sustainability
- Lifelong learning

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. **Biomedical Transducers and Instruments –** Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. **Handbook of Biomedical Instrumentation**- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.

Reference Books:

1. **Biomedical Instrumentation and Measurement** – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
2. **Transducers and Instrumentation** -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition

Semester – VI: Open Elective-A

Fundamentals of Medical Imaging Techniques

(Common to BM & ML)

Subject Code	**: 18BM652/18ML652**	CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02	SEE Marks	: 60
Total Number of Lecture Hours	: 40	Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

X-Ray Machines and Radiography: Fundamentals of X-ray – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, Biological effects of ionizing radiation.

X-Ray Diagnostic Methods: Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography.

Module -2

Computed Tomography: Principle of CT, System components, Gantry geometry, Patient dose in CT scanners. Algorithms for image reconstruction, CT number, Spiral CT. Recent developments .Digital Radiography- Digital subtraction angiography (DSA), Dynamic spatial reconstructor (DSR), Image artifacts and Image characteristics.

Module -3

Ultrasound Imaging: Fundamentals of acoustic propagation - Characteristic impedance, Intensity, Reflection and refraction, Attenuation, Doppler effect. Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution, Focusing, Arrays. Ultrasonic Diagnostic Methods:Pulse echo systems- Amplitude mode (A-mode), Brightness mode (Bmode), Motion mode (M-mode), Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging, Image characteristics – Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound.

Module -4

Radionuclide Imaging: Introduction, Fundamentals of Radioactivity – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Diagnostic methods using radiation detector probes – Thyroid function test, Renal

function test, Blood volume measurement, Radionuclide imaging systems- Rectilinear scanner, Scintillation camera, SPECT, PET.

Module - 5

Basics of Magnetic Resonance Imaging: Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

MRI System & Imaging Methods: Introduction, Magnet, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Gradient echo imaging, Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields.

Course Outcomes: After studying this course, students will be able to:

1. Describe the fundamentals of x-ray radiography and analyze the system requirements.
2. Explain principles and applications of Computed Tomography system requirements.
3. Discuss the fundamentals of Ultrasonic imaging and analyze the system requirements.
4. Describe the fundamental concepts of Radionuclide Imaging and analysis of the system.
5. Understand physics and Instrumentation of MR imaging system.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carries 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Principles of Medical Imaging – by Kirk Shung, Michael B. Smith and BanjaminTsui, Academic Press, 1992.
2. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003.
3. Fundamentals of Medical Imaging – by Paul Suetens, Cambridge University Press, 2002.

Reference Books:

1. The Physics of Medical Imaging – by Steve Webb (Editor), Adam Hilger, Bristol and Philadelphia Publications, 1988.

Semester – VI: Open Elective-A

Rehabilitation Engineering and Assistive Technology

(Common to BM & ML)

Subject Code	: 18BM/ML 653		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module 1

Introduction to Rehabilitation: Introduction Types of physical impairments, Principles of Rehabilitation, Motor, Sensor and Communication disorders. Intelligent prosthetic knee & arm. Advanced automatic prosthetics and orthotics. Prevention and cure of visual impairment, Electronics travel appliances, path sounder, laser cane, ultrasonic torch and guide, light probes, obstacle sensors, electro cortical prosthesis, classification.

Module 2

Therapeutic Exercise Technique: Coordination Exercises, Balance Training, Gait, Pathological Gaits, Gait Training – Crutch Walking: Patterns of Gait, Relaxation exercises, Methods for training Relaxation, Strengthening exercises, Mobilization exercises.

Principles in Management of Communication: Communication, Speech, Language, Aphasia, Dysarthria, Speech therapy, Dysphagia, Communication for Visually impaired, Types of visual aids, Writing aids.

Module 3

Orthotic Devices in Rehabilitation Engineering: Definition, General Principles of Orthosis, Biomechanics of Orthosis, Classification, Material and fabrication for lower limb Orthosis, Calipers – Foot Orthoses, Ankle-Foot Orthosis, Knee-Ankle-Foot Orthosis, Hip-Knee-Ankle-Foot Orthoses, Functional Electrical Stimulation, Spinal Orthosis- Cervical, Head cervical Orthosis, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacro-orthosis, Splints-its functions & types.

Module 4

Subjective and objective measurement methods. Characterizing human systems, and assertive devices. Biomaterials outlook for organ transplant, design considerations evaluation process. Engineering design of artificial heart and circulatory assist devices, Implementation and implantation aspects.

Module 5

Computer application in rehabilitation engineering; Interfaces in compensation for visual perception and improvement of orientation and mobility, rehabilitation aids for mentally impaired. Physical therapist, Occupational therapist, Prosthetist-Orthotist, Rehabilitation nurse, Speech pathologist, Psychologist and child development Specialist, Horticultural Therapist, Music therapist, Creative Movement. Therapist, Dance and play Therapist, Recreational therapist, Biomedical engineer.

Course Outcomes: After studying this course, students will be able to:

1. Define rehabilitation and explain the composition of rehabilitation team.
2. Discuss the engineering principles of rehabilitation engineering.
3. Apply engineering skills in the development of prosthetic and orthotic devices.
4. Evaluate the orthopedic design and applications.
5. Apply the principles of engineering in the development of mobility aids for physically

handicap.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Rehabilitation Medicine - By Dr. S. Sunder, 3rd Edition, Jaypee Medical Publications, Reprint 2004.
2. Biomedical Engg., Handbook, Bronzino J. D., CRC press (New York),1995

B.E. Medical Electronics (ML) Choice Based Credit System (CBCS) Semester - VII			
OPEN ELECTIVE - B			
Course Code	**18ML75X**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (For syllabus, please refer to the concerned Programme syllabus book or VTU website vtu.ac.in may be visited.).
Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Sl. NO.	**Board and the Department offering the Electives**		**Course**		**Course Title**
			Sl. No.	**code under 18BM75X**	
	EI/ BM/ ML	Medical Electronics	1	18ML751	Biomedical Signal Processing
			2	18ML752	Biomedical Image Processing
			3	18ML753	Medical Informatics

B.E. Medical Electronics (ML) Choice Based Credit System (CBCS) Semester – VII: Open Elective-B				
Biomedical Signal Processing (Common to BM & ML)				
Subject Code	**: 18BM751/18ML751**		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03
Credits – 3 (Each module – 08 Hours)				

Module -1

Signal processing: Review of Discrete time signals and systems - LTI systems - Response of LTI systems – Convolution - Difference equation representation of discrete systems Z transform - Transform analysis of LTI system – DFT. STFT - Introduction to wavelets - CWT and DWT with Haar wavelet. Introduction to biosignals: Computers in medicine. Human anatomy and physiology - Cell structure - Origin of bioelectric potentials - Biomedical signals - The Brain and its potentials. Electrophysiological origin of brain waves. EEG signal and its characteristic- ECG signal origin and characteristics.

Module -2

Neurological signal processing: EEG analysis - Parametric modelling - Linear prediction theory; Autoregressive (AR) method; Recursive estimation of AR parameters. Cardiological signal processing: ECG parameters and their estimation - Arrhythmia analysis monitoring - ECG data reduction techniques

Module-3

Adaptive interference / Noise cancellation: Types of noise in biosignals; Digital filters - IIR and FIR - Notch filters - Optimal and adaptive filters. Weiner filters - steepest descent algorithm - LMS adaptive algorithm - Adaptive noise canceller - cancellation of 50 Hz signal in ECG - Cancellation of maternal ECG in foetal electrocardiography.

Module -4

Basics of signal averaging, Signal averaging as a digital filter, A typical average, Software for signal averaging, Limitations of signal averaging. Data Acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of Sleep-wave Transitions, Hypnogram Model Parameters.

Module -5

Direct data compression techniques, Direct ECG data compression techniques, Transformation compression techniques, Other data compression techniques, Data compression techniques comparison.

Note: Assignments can be given on analysis other important biomedical signals like EMG, ERG, EOG, Evoked potentials.

Course Outcomes: After studying this course, students will be able to:

1. Analyze the nature of Biomedical signals and related concepts
2. Apply filters to remove noise from biomedical signals.
3. Apply averaging technique on biomedical signals and extract the features of EEG signals.
4. Analyze event detection techniques for EEG and ECG signals.
5. Apply signal compression techniques on biomedical signals.

Question Paper Pattern

The question paper will have TEN questions.

- Each full question carry 20 marks
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Biomedical signal analysis- A case study approach, RangayyanRangaraj, Wiley (IEEE Press)-2005
2. Biomedical Signal Processing- Principles and Techniques - D.C.Reddy, Tata McGraw-Hill, 2005.
3. Biomedical Digital Signal Processing-Willis J.Tompkins, PHI, 2000.

Reference Books:

1. Biomedical Signal Processing -Akay M, , Academic: Press 1994
2. Biomedical Signal Processing (Vol. I Time & Frequency Analysis) - Cohen.A,, CRC Press, 1986.

Semester – VII: Open Elective-B

Biomedical Image Processing

(Common to BM & ML)

Subject Code	**: 18BM752/18ML752**	CIE Marks	: 40
Number of Lecture Hours /Week	: 02+02	SEE Marks	: 60
Total Number of Lecture Hours	: 40	Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

Fundamentals of Digital image, Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighborhoods, adjacency, connectivity, boundaries, regions, 2D convolution, Color models.

Module -2

Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Intensity level slicing, Bit plane slicing, Histogram processing – Histogram equalization, Histogram matching (specification), Arithmetic/Logic operations – Image subtraction, Image averaging. Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters.

Module -3

Image Enhancement In Frequency Domain: Background, 2D-Discrete Fourier Transform and its Inverse, Basic properties of the 2D-Discrete Fourier Transform, Basics of filtering in the frequency domain. Image smoothing using frequency domain filters – Ideal low pass filters, Butterworth low pass filters, Gaussian low pass filters; Image sharpening using frequency domain filters – Ideal high pass filters, Butterworth high pass filters, Gaussian high pass filters, Homo-morphic filtering.

Module -4

Image Segmentation Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering.

Module -5

Image Restoration: Model of the Image degradation/restoration process, Noise models, Restoration using spatial filtering: Mean filters, Order statistic filters - Median filter, Min and Max filters, Midpoint filter.

Image Compression: Fundamentals, Image compression models, Basic compression methods – Huffman coding, Arithmetic coding, LZW coding, Run-length coding.

Course Outcomes: After studying this course, students will be able to,

1. Define the general terminology of digital image processing.
2. Identify the need for image transforms and their types both in spatial and frequency

domain.
3. Identify different types of image enhancement techniques.
4. Describe image segmentation models and learn image segmentation techniques.
5. Explain and apply various methodologies for image compression.

Note: It is suggested to give assignments / hands-on-experience on the above image processing concepts using Matlab / C programming on medical images like x-ray / CT / MRI.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carry20 marks.
- There will be TWO full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Digital Image Processing - Rafael. C. Gonzalez and Richard. E. Woods, Third Edition, Pearson Education, 2008.

Reference Books:

1. Fundamentals of Digital Image Processing - Anil K. Jain, 5th Indian Print, PHI, 2002.
2. Digital Image Processing and Computer Vision - Milan Sonka, India Edition, Cengage Learning.

Semester – VII: Open Elective-B

Medical Informatics

(Common to BM & ML)

Subject Code	**: 18BM753/18ML753**		CIE Marks	: 40
Number of Lecture + Tutorial Hours /Week	: 02+02		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module- 1

Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics. Impact of Systems on Health Care, Care Providers and Organizations, mobile health care technologies.

Module-2

Hospital Management Need for HMIS, Capabilities & Development of HMIS, functional area, modules forming HMIS, (like Pathology Lab, Blood bank, Pharmacy, Diet planning). Maintenance and development of HMIS-Ideal Features and functionality of CPR, Development tools for CPR.

Module–3

Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring.
Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS.

Module–4
Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications. Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications. Real-time Telemedicine. Data Exchange: Network Configuration, circuit and packet switching, H.320 series (Video phone based ISBN) T.120, H.324. Video Conferencing.

Module–5
Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES.

Course Outcomes: After studying this course, students will be able to:

1. Explain the basics and importance of medical informatics in hospital management.
2. Describe the different modalities functions exists in the hospital for effective management.
3. Discuss the role of telecommunication, tele-surgery, robotics in healthcare.
4. Explain the decision making concepts used in healthcare and their applications.
5. Apply information and communication technology in healthcare.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question consists of 20 marks.
- There will be 2 full questions (with maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill, Publications, 2003.
2. A.S. Tanenbaum, “Computer Networks”, 2012, 5th Edition, Pearson Education, London.
3. Kenneth R. Ong, “Medical Informatics: An Executive primer”, 2015, 1st Edition, HIMSS Publishing, Chicago

Reference Books:

1. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2nd Edition, Springer Verlag, 2000.
2. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.