Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Biomedical Engineering

(Applicable from the academic session 2018-2019)

SEMESTER-VIII

Name of the Course	**HOME MEDICARE TECHNOLOGY**
Course Code: PE-BME801	**Semester: Eighth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	Toprovidebasicknowledge of homemedicare system and various clinical application.
2	Tounderstandthevariousaspectsthat influencesafety, qualityandeffectivehomemedicare.
3	Togainin-depthknowledgeabout theadvancesinhealthcaretechnologiesandwirelesstechnologyrelatedtohealthcaresystem.
Pre-Requisite: Engineering Physiology & Anatomy (PCBME302), Biomedical Instrumentation (PCBME402), Telehealth Technology (PEBME501)/Communication Engineering & Bio-Telemetry (PEBME502).	

M #	**Content**	**Hrs**
1	**Introduction to Home Medicare:** Homehealthcare,purpose, legalandethicalaspects, organizationof homecare system, historicaldevelopmentofhomecare, environmentalinfluencesonhome care, homecareorganization, homecarenursingpractice, roleof homecarenurse andorientationstrategies, infectioncontrol inhome, patienteducation inhome.	8
2	**Working with Clients:** Basic human needs, communication and interpersonal skills, caregiver observation,recordingand reporting,confidentiality, working with elderly-agingand bodysystems, working with children-need forhomecare, mobility-transfersand ambulation, rangeof motionexercises,skincareandcomfort measures.	8
3	**Home Medical Devices:** Medicaldevicesathome, usercentereddesignandimplementation, co-design witholdusers, device types, user issues, ethicaland legalissues, infant monitors, medical alertservices,activitymonitors.	7
4	**Advancement in Medical Technologies:** Advances and trendsin health caretechnologies, driverimpacting the growthof medical technologies, impact of Moore'slaw of medical imaging, e-health and personalhealthcare, definingthefutureofhealthtechnology, inventingthefuture, tools for self-health, futureofnano-fabrication molecular scale devices, futureof telemedicine, futureof medical computing.	10
5	**Wireless Technology:** Wireless communicationbasics, types of wireless network, body area network, emergencyrescue, remote recovery, generalhealthassessmentstechnologyin medical informationprocessing, futuretrendsinhealthcaretechnology.	7

COURSE OUTCOMES

At the end of the course, students should able to:

1. Demonstrate the understanding about basics of home medicare system.
2. Identify the critical elements for providing effective integrated health care at home.
3. Evaluate home medicare devices and their clinical applications.

4. Illustrate the various aspects that influence safety, quality and effective home medicare.
5. Anticipate advances in healthcare technologies and wireless technology related to healthcare system.
6. Plan and design cost effective quality home care devices with proper patent safety.

Text/Reference Books:

1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th edition, Elsevier, 2006.
2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph D. Bronzino,"Clinical Engineering", CRC Press, 2010.
4. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011.

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Name of the Course	**BIOMEDICAL HAZARDS & SAFETY**
Course Code: PE-BME802	**Semester: Eighth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To understandthehazardous materialsusedin hospital and its impactonhealth.
2	To know various wastedisposal proceduresand management.
3	Toimpartsufficientinformationonthevarioushazards, medical wastesandrelevantprecautionarycontrol measuresfor patient safety in healthcaresystem.
Pre-Requisite: BiomedicalInstrumentation (PCBME402), HospitalEngineering & Management (PEBME701)/Hospital Safety & Management (PEBME702).	

M #	**Content**	**Hrs**
1	**HazardousMaterials:**HazardousSubstances,OSHAhazardcommunicationstandard, DOThazardousmaterial regulations,healthcarehazardousmaterials,medical gassystems, hazardouswasteoperationsand emergency response standard, respiratory protection.	6
2	**HealthcareHazard Control:**Introduction,hazardcontrol,hazardcontrolmanagement,hazard control responsibilities,addressingbehaviors,hazardcontrol practice, hazardanalysis,hazardcontrol andcorrection, personal protectiveequipment,hazardcontrol committees,hazardcontrol evaluation,systemsafety,ergonomics, understanding accidents:accidentcausation theories,human factors,accidentdeviationmodels,accident reporting,accidentinvestigations,accidentanalysis,accidentprevention,workers' compensation, orientation, educationandtraining.	10
3	**BiomedicalWasteManagemen**t: Typesof wastes,majorandminorsourcesofbiomedicalwaste, categoriesandclassificationofbiomedicalwaste,hazardofbiomedicalwaste,needfordisposal ofbiomedicalwaste,waste minimization,waste segregation and labeling,wastehandling, collection,storageandtransportation, treatment anddisposal.	8
4	**Infection Control, Prevention & Patient Safety:**Healthcareimmunizations,centers fordisease controlandprevention,disinfectants,sterilants, andantiseptics,OSHAbloodbornepathogensstandard, tuberculosis,healthcareopportunistic infections,patientsafety:organizationalfunction,errorsand adverseevents, safety cultures,quality improvementtoolsandstrategies.	8
5	**FacilitySafety:**Introduction,administrativeareasafety,slip,trip, andfall prevention,safety signs, colorsandmarkingrequirements,scaffolding,fall protection, machineguarding,compressedairsafety,electrical safety,control ofhazardous energy,OSHA hearingconservation standard, ventilating and air-conditioning systems, assessing IAQ, landscape and grounds maintenance, fleet and vehicle safety.	8

COURSE OUTCOMES

At the end of the course, students should able to:

1. Demonstratethetypesofhazards,planning,organizationandtrainingneededtoworksafely with hazardousmaterials.
2. Explain the different types of hazardous exposure and its biological effects, exposure guidelinesand basic workplacemonitoring.
3. Analyze various hazards, infection,accidentsanditscontrol.
4. Categorize biowastesand design efficient wastedisposal procedures.
5. Design different safetyfacility and control measures in hospitals.
6. Proposeand adopt mandatory regulations and safetynorms for improving healthcare delivery.

Text/Reference Books:

1. Tweedy,JamesT.,"HealthcareHazardControlandSafetyManagement", CRCPress_Taylorand Francis (2014).
2. AnantpreetSingh, SukhjitKaur, "Biomedical Waste Disposal", JaypeeBrothers MedicalPublishers (P) Ltd(2012).
3. R.C.Goyal, "HospitalAdministrationand HumanResourceManagement",PHI,FourthEdition,2006
4. V.J. Landrum, "MedicalWasteManagementanddisposal", Elsevier,1991

Name of the Course	**BIOINFORMATICS & EXPERT SYSTEM**
Course Code: PE-BME803	**Semester: Eighth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To get introduced to the basic concepts of bioinformatics and its significance in biological data analysis.
2	To acquaint with bioinformatics tools, biological database and recent advances in genomics technology.
3	To trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein function.
4	To impart concepts of expert systems and its application in medical field.
Pre-Requisite: Knowledge of Biochemistry,Mathematics,Statistics,Computational theory, Analysis and AlgorithmDesign.	

M #	**Content**	**Hrs**
1	**Introduction to Bioinformatics:** Definition and history, applications of bioinformatics, internet resources, various databases and bioinformatics tools, organization of databases.	2
2	**Sequence Alignment:**Sequence analysis: protein and nucleic acids, analysis tools for sequences,data bank, pairwise and multiple sequence alignment, secondary structure predictions, fold recognition, FASTA-BLAST-aminoacid substitution matrices.	8
3	**Projects & Databases:**Structural comparisons, genome projects, biologicalinformation, database location andorganization, access to database, software, database searching, locating specific entries, identity searches, similaritysearches.	8
4	**Information Theory & Biology:**Entropy, Shannon's formula, divergences fromequiprobability and independence,Markov chains, ergodic processes, redundancy,application to DNA and protein sequences.	8
5	**DNA Mapping & Sequencing:**Map alignment, large scale sequencing and alignment, shotgun-DNAsequencing, sequence assembly, gene predictions and molecular predictions withDNA strings.	8
6	**Experts Systems:** Overview of an expert system, structure of an expert systems, different types of expert systems-rule based, model based, case based and hybrid expert systems, knowledge acquisition and validation techniques, a case study: MYCIN.	6

COURSE OUTCOMES

At the end of the course, students should able to:

1. Demonstrate the most important bioinformatics databases, perform text and sequence-based searches, and analyze the results.
2. Carry out gene and protein expression patterns and modeling cellular interactions and processes.
3. Apply bioinformatics and biological databases to solve in real research problems.

4. Choose biological data, submission and retrieval it from databases and design databases to store the information.
5. Illustrate the impact of bioinformatics in a global, economic, environmental, and societal context.
6. Design and develop expert system for real world problems.

Text/Reference Books:

1. Sillince JA, Sillince M,"Molecular databases for protein sequence and structure studies", springer Verlag, 1991.
2. M. Gribskov, J. Devereux, "Sequence Analysis primer "Stockton Press, 1989.
3. S.L.Seizberg, DB Searls,S.Kasif, "Computational Methods in Mol.Biol./.Now Comprehensive Biochemistry", Vol.32. Elsevier 1998.
4. R.F.Doolittle, "Computer methods for macromolecular analysis-Methods in Enzymology", Vol.266, Academic Press 1996.
5. L.I. Garfield, "Information theory&living systems" Columbia UniversityPress,1992.
6. Dan Gusfield, "Algorthms on Strings Trees and Sequences", CambridgeUniversity Press, 1997.
7. P.Baldi,SBrunak, Bioinformatics; "A Machine Learning Approach", MIT Press, 1998.

Name of the Course	**QUALITY CONTROL & REGULATORY ASPECTS OF MEDICAL DEVICES**
Course Code: OE-BME801	**Semester: Eighth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	Toknowthevariousqualitystandards and regulatory guidance used inhealthcare.
2	To impart the fundamental knowledge on the medical devices and in vitrodiagnostics, basis of classification and product life cycle of medical devices.
3	To make them understand the regulations of Food and Drug Administration.
4	To give sufficient knowledge about the legal and regulatory requirements for medical devices.
5	To know the regulatory requirementsfor approval of medical devices in regulated countries.
Pre-Requisite: Biomedical Instrumentation, Analytical & Diagnostic Equipment, Therapeutic Equipment & Implants**,** Imaging Instruments,Principles of management.	

M #	**Content**	**Hrs**
1	**Quality Management & Assurance System:**Needfor ISO9000andotherqualitysystems, ISO9000:2000 qualitysystem-elements, implementation of quality system, quality auditing, need for accreditationofhospitals, NABH, NABL.	6
2	**Classification of Medical Devices:** Introduction, definition, risk based classification and essential principles of medical devices and IVDs, differentiating medical devices IVDs and combination products from that of pharmaceuticals, product lifecycle of medical devices and classification of medical devices.	7
3	**Regulation of Medical Devices:**FDAregulations, history of medical device regulation, regulatory approval process for medical devices (Medical Device Directive, Active Implantable Medical Device Directive) and in-vitro diagnostics (In Vitro Diagnostics Directive), CE certification process, basics of in-vitro diagnostics, classification and approval process.	8
4	**Quality System Regulation &Ethics:** Quality system regulations of medical devices: ISO 13485, quality risk management of medical devices: ISO 14971, validation and verification of medical device, adverse event reporting of medical device, clinical investigation of medical devices, clinical investigation plan for medical devices, good clinical practice for clinical investigation of medical devices (ISO 14155:2011).	9
5	**Regulation in Emerging Market & Regulated Market:** Applicable regulations, regulatory registration procedure, guidelines and standards for regulatory filing of medical devices, data requirement for market authorization, advertising, labeling and packaging.	4
6	**IMDRF/GHTF:** Introduction, organizational structure, purpose and functions, regulatory guidelines, working groups, summary technical document (STED),	6

	global medical device nomenclature (GMDN).	

COURSE OUTCOMES

At the end of the course, students should able to:

1. Examine the broad scope of the medical device industry and its quality assurance practices.
2. Explain the basics of medical devices and process of development.
3. Demonstrate the regulatory requirements for approval of medical devices.
4. Harmonize the initiatives forquality and ethical considerationsfor medical devices.
5. Conduct clinical evaluation and investigation for medical devices.
6. Proposeprocedures for approval and marketing of medical devices.

Text/Reference Books:

1. Douglas J. Pisano, David Mantus, "FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics".
2. Jonathan S. Kahan, "Medical Device Development: A Regulatory Overview".
3. John J. Tobin, Gary Walsh, "Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, and Medical Devices".
4. Carmen Medina, "Compliance Handbook for Pharmaceuticals, Medical Devices and Biologics".
5. Webster J.G, Albert M. Cook, "Clinical Engineering, Principles & Practices",PrenticeHall Inc., Englewoodcliffs, NewJersey,1979.
6. S. Amato, B. Ezzell, "Regulatory Affairs for Biomaterials and Medical Devices", Woodhead Publishing
7. Shayne C. Gad, "Safety Evaluation of Pharmaceuticals and Medical Devices: International Regulatory Guidelines", Springer.
8. Country Specific Guidelines from official websites.

Name of the Course	**DESIGN CONCEPT & MAINTENANCE OF BIOMEDICAL INSTRUMENTS**
Course Code: OE-BME802	**Semester: Eighth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To understand about basic design processes of medical device.
2	To introduce with basics of design, construction and development devices.
3	To familiarize with the application and troubleshooting, maintenance and repairing of medical instruments.
Pre-Requisite: BiomedicalInstrumentation, Medical Equipment & Imaging Instruments, Knowledge of biomaterials and Management.	

M #	**Content**	**Hrs**
1	**Introduction to Design Process:** Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modeling, machine elements, ergonomics and prototyping.	4
2	**Design of Medical Devices & System:** Medical device classification, bioethics and privacy, biocompatibility and sterilization techniques, design of clinical trials, design control and regulatory requirements, introduction to specific medical technologies: biopotentials measurement (EMG, EOG, ECG, EEG), medical diagnostics (In-vitro diagnostics), medical diagnostics (Imaging), minimally invasive devices, surgical tools and implants.	10
3	**Medical Instruments Troubleshooting& Testing:**AC, DC power supply, grounding, shielding, guarding, insulation testing, insulation resistance measurement, testing of electronic components, troubleshooting of PCB boards, calibration of analog and digital sensor probe, display interface, safe electrical practice, cables and standard, fuse, transformer testing, CT and PT, Panel wiring, troubleshooting of X-ray machines, troubleshooting of ECG recorders.,	10
4	**Maintenanceof MedicalInstruments:**BPapparatus, suctionmachine,microscope, ECG machines,pulse oximeter, patient monitor, X-ray machine, ultrasound machine, ventilator, dialyser, heart lung machine, surgical lights, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards.	10
5	**Maintenance ofPC Based MedicalInstruments:**Introduction to PC based medical instruments, system configuration and BIOS, identification and troubleshooting of PC components: motherboard, HDD, FDD, CD-ROM, monitor, printers, modems, ports etc.	6

COURSE OUTCOMES

At the end of the course, students should able to:

1. Perform needs finding and generate design requirements for medical instruments.
2. Utilize fundamental design principles, machine elements, manufacturing and assembly techniques.
3. Perform risk assessment for prototyping and countermeasure development.
4. Appreciate the need for grounding aspects, maintenance and troubleshooting.

5. Identify the reasons for equipment failure and formulate solution.
6. Conductinvestigationandanalyzethedatasheetsforperformancemeasurementof biomedicalinstruments.

Text/Reference Books:

1. Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems", Third Edition, ISBN 9781466569133.
2. John G. Webster (ed), "Medical Instrumentation: Application and Design", 2007.
3. Peter J. Ogrodnik, "Medical Device Design: Innovation from Concept to Market", Academic Press Inc; 1 edition (2012), ISBN-10: 0123919428.
4. StefanosZenios , Josh Makower , Paul Yock , Todd J. Brinton , Uday N. Kumar , Lyn Denend, Thomas M. Krummel, "Biodesign: The Process of Innovating Medical Technologies", Cambridge University Press; 1 edition (2009), ISBN-10: 0521517427.
5. Medical Equipment Maintenance Manuel, Ministry of Health and Family Welfare, New Delhi, 2010.
6. Shakti Chatterjee,Aubert Miller, "Biomedical Equipment Repair", Cengage Learning Technology& Engineering, 2010.
7. David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGrawHill,Professional edition, 2013.
8. L.Nokes.B.Turton, D.Jennings, T. Flint, "Introduction to Medical Electronics Applications", A Butterworth Heinemann Title. 1995.
9. Joseph F. Dyro, "Clinical engineering handbook, Elsevier Academic Press, 2004.

Name of the Course	**VIRTUAL INSTRUMENTATION DESIGN FOR MEDICAL SYSTEM**
Course Code: OE-BME803	**Semester: Eighth**
L-T-P-C: 3-0-0-3	**Contact: 3 hrs/week**
Objectives:	
1	To impart knowledge on the concepts of virtual instrumentation (VI).
2	To understand the programming concepts of VI and insight to various Common Instrument Interface.
3	To familiarize with the data acquisition system and analyzing tools for medical applications.
Pre-Requisite: Engineering Physiology& Anatomy (PC-BME302), Mathematics-III (BS-M301), Biomedical Instrumentation (PC-BME402)	

M #	**Content**	**Hrs**
1	**Introduction to Virtual Instrumentation (VI):** Historical perspective of VI, architecture and block diagram, comparisonofVIwithtraditionalinstruments, needof VI,advantages,data flow techniques,graphicalprogramming in data flow,comparisonbetween graphical programmingandconventionalprogramming.	6
2	**Programming Techniques:** VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, strings, tables, file I/O functions, 2D and 3D plots, instrument drivers, publishing measurement data in the web.	9
3	**Data Acquisition Basics:** Introduction to data acquisition on PC, sampling fundamentals, I/O techniques and buses. ADC, DAC, digital I/O, counters and timers, DMA, software and hardware installation, calibration, resolution, data acquisition interface requirements.	9
4	**Common Instrument Interface:** Common instrument interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.	9
5	**Analysis Tools and Designing for Medical Applications:** Fourier transform,power spectrum,correlation, windowing,filtering,oscilloscope, waveformgenerator,Multi-channeldataacquisitionusing LABVIEW,Medical applications: ECG, EMG, Air Flow and Lung Volume, HR variability analysis, noninvasive BP measurement.	7

COURSE OUTCOMES

At the end of the course, students should able to:

1. Explain applications of mathematical modelling for designing virtual instrument.
2. Relate fundamental physiological properties with virtual biomedical instruments.
3. Demonstrate advanced analysis capabilities that explore potential research topics.
4. Demonstrate clinical utilization of virtual biomedical instrumentation.
5. Categorise functions related to medical device development and tests.
6. Design and implement data acquisition system with PC interfacing.

Text/Reference Books:

1. Stephan Bennett, Emagic Logic Virtual Instruments, PC Publishing 2003.
2. Anand M M S, Elecronic Instruments and Instrumentation Technology, PHI Publishers, 2007.
3. Gary Jonson, "Labview Graphical Programming", McGraw Hill, New York, Fourth edition 2006.
4. Lisa K. Wells, Jeffrey Travis, "Labview for everyone", Prentice Hall Inc., New Jersey;First edition 1997.
5. Gupta S, Gupta J P, "PC interfacing for Data Acquisition & Process Control", Instrument Society of America, Second Edition, 1994
6. K.James, PC Interfacing and Data Acquisition: Techniques for Measurement Instrumentation and Control, Newness, 2000.
7. Sokoloff, Basic Concepts of Labview, Prentice Hall, New Jersey.
8. Technical Manuals for DAS Modulesof AdvantechandNational Instruments

Name of the Course	**DESIGN LAB / INDUSTRIAL PROBLEM RELATED PRACTICAL TRAINING**
Course Code: PROJ-BME891	**Semester: Eighth**
L-T-P-C: 0-0-4-2	**Contact: 4 hrs/week**
Objectives:	
1	Tounderstandrequirementof engineeringfor new product development and convert them in to designspecification.
2	Tounderstandsystemmodelingforsystem,sub-systemandtheir interfacesand arrive at theoptimum systemspecificationand characteristics.
3	Toconceptualize,prototypeanddevelopproductmanagementplanforanewproduct anddevelopmentmethodologyintegratingthehardware,software, controls,electronicsandmechanical systems.
4	Tounderstandtheglobaltrendsanddevelopmentmethodologiesofvarioustypesof productsandservices.

GUIDELINES:

- Carry out a comprehensive work on the chosen topic which will stand them in good stead as they face real life situation.
- Convert innovative ideas into working models /systems using all the concepts learnt anduse suitable modern tools.
- Take up any challenging practical problems and find solution by formulating proper methodology.
- Expected to exert on design, development and testing of the proposed work.
- Industryrelatedproblems are highly encouraged andassesitsimpact.

COURSE OUTCOMES

At the end of the course, students should able to:

1. Develop a model or simulation or prototype using industry best practices and tools.
2. Design a medical electronic circuits starting with a given specifications.
3. Solve aspecificproblemright fromits identification till thesuccessfulsolution of thesame.
4. Formulate a real world problem, identify the requirement and develop the design solutions.

Name of the Course	**PROJECT-II**
Course Code: PROJ-BME881	**Semester: Eighth**
L-T-P-C: 0-0-12-6	**Contact: 12 hrs/week**

Objectives:	
1	Toestimatetheabilityofthestudentintransformingthetheoreticalknowledgestudiedsofar intoa workingmodel
2	Toteachuseofnewtools,algorithmsandtechniques requiredtocarryoutthe projects.
3	Togive guidanceonthevarious proceduresforvalidationoftheproduct andanalyze thecost effectiveness.
4	Totrain the students in preparingproject reportsand tofacereviewsand viva voceexamination.

GUIDELINES:

- The project topics are decided in Phase-1 and the project work is to be carried out in group of 3 or 4.
- Industry projects are encouraged and promoted.
- Submit a report showing the design and implementation along with the literature survey.
- projectworkisevaluatedbasedonoral presentationand theproject report jointly by externaland internalexaminers

COURSE OUTCOMES

At the end of the course, students should able to:

1. Prepareacomprehensivetechnicalprojectreportandcommunicate with engineers and the community at large.
2. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
3. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
4. Work independently as well as in teams and manage a project from start to finish.

Name of the Course	**GRAND VIVA-VOCE**
Course Code: BME882	**Semester: Eighth**
L-T-P-C: 0-0-0-1	**Contact: NIL**

Objectives:	
1	To assess comprehensive knowledge on all courses in under graduate program in Biomedical Engineering.
2	To judge the basic concepts of core courses and techniques applicable to their own area of professional practice.
3	To evaluate knowledge and ideas gained in real worldproblems and issues relevant to the field.
4	To prepare the students to face interview both at the academic and the industrial sector.

GUIDELINES:

- Viva voce will be conducted at the end of the programme.
- Involvement of external experts is highly appreciated.
- Assessment should be in cognitive, affective and psychomotor domain of learning.

COURSE OUTCOMES

At the end of the course, students should able to:

1. Explore their field of knowledge, which includes a critical awareness of current problems and/or new insights at the forefront of that field.
2. Demonstrate confidence and versatility in answering the varieties of questions posed by a group of faculty members in a moderately short duration.
3. Demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level.
4. Demonstrate originality in the application of knowledge, together with a practical understanding of how established techniques professional enquiries are used to create and interpret knowledge in their discipline.

Special Remarks:

The above mentioned outcomes are not limited. Institute may redefine course outcomes based on their Program Educational Objectives (PEOs).