Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus

Final Year

in

Biomedical Engineering

(Semester VII and VIII)

Revision: (2021)
With effect from the Academic Year: 2022-2023

Scheme for Final Year Undergraduate Program in Biomedical Engineering : Semester VII (Autonomous)
(Academic Year 2022-2023)

Semester VII

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)					Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Term Work Total	CA Total (B)			
1	DJ19BMC701	Nuclear Medicine	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**3**
2	DJ19BMC702	Medical Imaging	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19BML702	Medical Imaging Lab	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
3	DJ19BML703	Product Design Lab	--	2	--	1	--	--	--	--	25	25	--	--	--	25	25	50	1	**1**
4@	DJ19BMEC7011	Deep Learning	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19BMEL7011	Deep Learning Lab	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19BMEC7012	Bioinformatics	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19BMEL7012	Bioinformatics Lab	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19BMEC7013	VLSI	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19BMEL7013	VLSI Lab	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
5#	DJ19ILO7011	Product Lifecycle Management (PLM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**3**
	DJ19ILO7012	Management Information System (MIS)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7013	Operations Research (OR)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7014	Cyber Security and Laws (CSL)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7015	Personal Finance Management (PFM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7016	Energy Audit and Management (EAM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7017	Disaster Management and Mitigation Measures (DMM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7018	Science of Wellbeing (SW)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7019	Research Methodology (RM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO7020	Public Systems and Policies (PSP)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
7	DJ19BMP704	Project Stage - I	--	4	--	2	--	--	--	--	50	50	--	--	--	50	50	100	**2**	**2**
		Total	**12**	**10**	**--**	**17**	**--**	**300**	**25**	**--**	**75**	**400**	**100**	**100**	**100**	**125**	**225**	**625**	**17**	

@ Any 1 Elective Course

Any 1 Institute Professional Elective

Prepared by Checked by **Head of the Department** **Vice Principal** **Principal**

Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

Scheme for Final Year Undergraduate Program in Biomedical Engineering : Semester VIII (Autonomous)
(Academic Year 2022-2023)

Semester VIII

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)					Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Term Work Total	CA Total (B)			
1	DJ19BMC801	Biomedical Microsystems	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	4
	DJ19BML801	Biomedical Microsystems Lab	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
2	DJ19BMC802	Hospital Management	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	4
	DJ19BML802	Hospital Management Lab	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
3@	DJ19BMEC8011	Big Data and Could computing	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	4
	DJ19BMEL8011	Big Data and Could computing Lab	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19BMEC8012	Medical Device Regulatory Affairs	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19BMEL8012	Medical Device Regulatory Affairs Lab	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
	DJ19BMEC8013	Robotics in Medicine	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19BMEL8013	Robotics in Medicine Lab	--	2	--	1	--	--	--	--	--	--	--	--	--	25	25	25	1	
4#	DJ19ILO8021	Project Management (PM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	3
	DJ19ILO8022	Entrepreneurship Development and Management (EDM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8023	Corporate Social Responsibility (CSR)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8024	Human Resource Management (HRM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8025	Corporate Finance Management (CFM)	**3**	--	--	**3**	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8026	Logistics and Supply Chain Management (LSCM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8027	IPR and Patenting (IPR)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8028	Digital Marketing Management (DMM)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8029	Environmental Management (EM)	**3**	--	--	**3**	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19ILO8030	Labour and Corporate Law (LCL)	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
5	DJ19BMP803	Project Stage - II	--	10	--	5	--	--	--	--	100	100	--	--	--	100	100	200	**5**	5
		Total	**12**	**16**	**--**	**20**	**--**	**300**	**50**	**--**	**100**	**450**	**100**	**100**	**100**	**175**	**300**	**725**	**20**	

@ Any 1 Elective Course

Any 1 Institute Professional Elective

Prepared by Checked by **Head of the Department** **Vice Principal** **Principal**

Syllabus for Forth Year Biomedical Engineering - Semester VII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Fourth Year Biomedical Engineering</td><td colspan="3">Semester : VII</td></tr>
<tr><td colspan="8">Course : Nuclear Medicine</td><td colspan="3">Course Code: DJ19BMC701</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">--</td><td rowspan="2">--</td><td rowspan="2">3</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
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</table>

Objectives:

1. To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment.
2. To keep the students abreast with the technological developments in the field of nuclear medicine.

Outcomes: On completion of the course, learner will be able to:

1. Describe essential physics of nuclear medicine such as basic concepts of radioactivity, its measurement, interaction with matter and radionuclide production.
2. Explain concepts of radiopharmaceuticals and various aspects of radiation safety.
3. Compare various detectors and counting systems.
4. Describe in-vivo and in-vitro techniques and its applications.
5. Compare various Emission Tomography Techniques along with their Clinical Applications.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Basics of Nuclear Physics**: Radioactivity, Radioactive Decay Law, Radioactive Decay Processes, Decay scheme of Mo-99. Units of Radioactivity Measurement, Successive Decay Equations. Statistics of Counting, Interaction of Radiation with Matter **Production of Radionuclide:** Methods of radionuclide production: Nuclear Reactor, Medical Cyclotron & Radionuclide Generators Spectra of commonly used radio nuclides e.g Tc-99m, Cs-137. Problems in radiation measurements.	**12**

2	**Radiopharmaceuticals:** Ideal Radiopharmaceutical, Methods of Radiolabeling **Internal Radiation Dosimetry:** Absorbed Dose Calculations to Target & Non-Target Tissues, MIRD Methodology **Radiation Safety:** Natural & Artificial Radiation Exposure, External & Internal Radiation Hazard, Methods of Minimizing External Exposure, Methods of Preventing Internal Exposure, Evaluation of External & Internal Hazard, Biological Effects of Radiation, Radioactive Waste Management.	**07**
3	**Detectors in Nuclear Medicine & Counting and Measuring System:** Gas filled Detectors, Scintillation Detectors and Solid State Detectors, Scintillation Counting System, Gamma Ray Spectrometry, Radionuclide Dose Calibrator, Properties of Detectors.	**06**
4	**Applications of Nuclear Medicine:** **In Vitro techniques:** Single and Double Isotope method, RIA Counting System and Liquid Scintillation Counting system. **In Vivo Techniques:** Uptake Monitoring System, Rectilinear Scanner and Gamma Camera. **Radionuclide Therapy** Choice of a Radionuclide in Therapeutic Nuclear Medicine Radiotherapy Equipment: Gamma knife	**10**
5	**Emission Tomography Techniques and Clinical Applications**: Single Photon Emission Computed Tomography (SPECT) Positron Emission Tomography (PET)	**07**

Books Recommended:

Text books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea& Febiger.
2. B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, *Handbook of Nuclear medicine Instruments*, Tata McGraw – Hill.
3. Gopal B. Saha, *Fundamentals of Nuclear Pharmacy*, Springer Science+Business Media
4. Ramesh Chandra, *Introductory Physics of Nuclear Medicine*, Lea& Febiger.

Reference Books:

1. William R. Hendee, *Medical Radiation Physics*, Year Book Medical Publishers
2. G. Hine, *Instrumentation of Nuclear medicine*, Academic Press
3. Glenn F. Knoll, *Radiation Detection & Measurement*, John Wiley & Sons.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VII (Autonomous)
(Academic Year 2022-23)

<table>
<tr><td colspan="8">Program: Fourth Year Biomedical Engineering</td><td colspan="3">Semester : VII</td></tr>
<tr><td colspan="8">Course : Medical Imaging</td><td colspan="3">Course Code: DJ19BMC702</td></tr>
<tr><td colspan="8">Course : Medical Imaging Laboratory</td><td colspan="3">Course Code: DJ19BML702</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td rowspan="3">03</td><td rowspan="3">02</td><td rowspan="3">--</td><td rowspan="3">04</td><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Basic concepts of physics- sound as done in applied physics.
2. Basic concepts of chemistry- nucleus, nuclear spin and chemical metabolites as done in applied chemistry.

Objectives:

1. To familiarize the learners with the various medical imaging modalities, their operating principles, instrumentation and clinical applications.
2. To keep the learners abreast with the technological developments as well as challenges in the field of medical imaging.

Outcomes: On completion of the course, learner will be able to:

1. Describe use of ultrasound in medicine, distinguish various ultrasonic display systems with appropriate applications and explain the clinical applications.
2. Apply the NMR principles in understanding the MRI working, describe the MRI components, safety considerations and explain clinical applications.
3. Describe basic principle of magnetic resonance spectroscopy and its applications.
4. Explain working of Hybrid imaging and its clinical applications.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Ultrasound in Medicine:** Introduction to ultrasound, characteristics, ultrasound transducer and production of ultrasound waves, ultrasound display modes and applications, real time ultrasound, continuous wave and pulsed Doppler	**12**
2	**Physics of MRI**: Magnetic dipole moments, relaxation parameters, spin echo, magnetic field gradients, slice selection, phase and frequency encoding	**06**
3	**Magnetic Resonance Imaging** Hardware: magnets, gradient coils, RF coils, spin echo imaging, inversion recovery pulse sequence, gradient imaging, image reconstruction, resolution and factors affecting signal-to-noise, MRI patient and instrument handling safety considerations and biological effects of MRI, clinical applications	**12**
4	**Magnetic Resonance Spectroscopy (MRS)** Basic principle of MRS and localization techniques, chemical shift imaging, single-voxel and Multi-voxel MRS, water suppression techniques	**06**
5	**Hybrid Imaging** Introduction, principles and applications of PET and SPECT, introduction to hybrid imaging modalities: PET/CT, SPECT/CT, clinical applications	**06**

List of Laboratory Experiments: (Any Eight)

1. Study experiment on ultrasound transducer.
2. Image segmentation on ultrasound image.
3. Distance and velocity calculation using ultrasound and continuous flow imaging techniques.
4. Study experiment on MRI installation.
5. MRI safety considerations.
6. Calculation of T2 from T2* given ΔB and plot the equations.
7. MRI reconstruction using Fourier Transform.
8. Image fusion for Hybrid Imaging.
9. Study experiment on MRS.
10. Group presentation.
11. Review of recent literature.
12. Hospital Visit may be conducted to Radiology Department.
13. Demonstrations/Experts talk.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text books:

1. Christensen's Physics of Diagnostic Radiology- Thomas S. Curry, James E. Dowdey, Robert C. Murry, Lippincott Williams & Wilkins Publications
2. Medical Imaging Physics- William R. Hendee, E. Russell Ritenour- Wiley Publications
3. The essential physics of Medical Imaging- Jerrold T. Bushberg, J. Anthony Seibert, Edwin L, John Boone

Reference Books:

1. Biomedical Technology and Devices- James Moore- CRC Press Books
2. Biomedical Engineering Handbook – Bronzino- CRC Press Books
3. Physics of Diagnostic images –Dowsett- CRC Press Books

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="3">Semester : VII</td></tr>
<tr><td colspan="8">Course : Product Design Laboratory</td><td colspan="3">Course Code: DJ19BML703</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td>-</td><td>-</td><td>25</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1) Analog and Digital circuits and Simulation,
2) Microcontrollers and programming
3) Structured and OOPM concepts
4) CAD modeling

Objectives: To familiarize students with end-to-end steps/process in product design.

Outcomes: On completion of the course, learner will be able to:

1. Understand Embedded systems and their design necessary for biomedical applications
2. Understand hardware design/architecture for product design
3. Understand software design/architecture for product design
4. Understand testing and debugging approaches
5. Understand Intellectual Property (IP), product standards and product certification process

Detailed Syllabus: (unit wise)

Unit	Description	Duration
1	Embedded Systems, RTOS, HMI, Boot loaders	**06**
2	Hardware architecture and Design	**10**
3	Software architecture and Design	**10**
4	Product debugging and testing, Product housing Design, EMI/EMC, Various product standards and certifications	**10**
5	Documentation process and IP handling	**06**

List of Laboratory Experiments : (Any eight)

1) Embedded system resource planning, design and fabrication
2) Visual state diagram based application design
3) Bootloader and security planning - Embedded
4) PCB design standards. EMI/EMC compatibility.
5) Software architecture and design standards.
6) Product housing design and fabrication. Discussing all possible methods of fabrication but adopting additive manufacturing (3d printing) for fabrication.
7) Optimizing product for Product Housing standards.
8) Product optimizing for product certification.
9) Industry standards/certifications approaches around products.
10) IP identification and protection/handling approaches.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text books:

1. Dr. K.V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition 2014
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd
3. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
4. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws

Reference Books:

1. DavidSimon,"An Embedded Software Primer", Pearson, 2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 Edition 3rd
3. FrankVahid, Tony Givargis,"Embedded System Design – A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002
4. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International

Evaluation Scheme:

Semester End Examination (A):

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practical's performed during laboratory sessions.

Continuous Assessment (B):

Laboratory: (Term work)

Term work shall consist of minimum 8 experiments, 1 Power Point Presentation and 2 assignments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by	Checked by	Head of the Department	Principal

Syllabus for Final Year Biomedical Engineering - Semester VIII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="4">Semester : VII</td></tr>
<tr><td colspan="8">Course: Deep Learning</td><td colspan="4">Course Code: DJ19BMEC7011</td></tr>
<tr><td colspan="8">Course: Deep Learning Laboratory</td><td colspan="4">Course Code: DJ19BMEL7011</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

- Linear algebra, Probability
- Data mining and Machine Learning

Objective:

1. To familiarize students with significant technological trends of deep learning thereby enabling them to build, train, and apply it in healthcare applications.

Outcomes: On completion of the course, learner will be able to:

1. Design and implement neural network
2. Apply and compare various optimization techniques for training deep model
3. Design and implement convolution neural network
4. Design and implement recurrent neural network
5. Apply GAN in healthcare applications

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction** History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron and Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, proof of convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs, sigmoid neuron, feed forward neural network, Error back propagation algorithm	**10**
2	**Parameter tuning and Optimization** Difference between learning and optimization, challenges, parameter tuning, stochastic gradient descent, momentum based gradient descent, nesterov accelerated gradient descent, adaprive gradient algorithm	**08**
3	**Convolutional Neural Network** Convolution, pooling, dropout, visualizing convolutional neural networks CNN architectures: AlexNet, VGGNet, GoogLeNet, ResNet, YOLO Deep dream, deep art, fooling convolutional neural networks	**08**
4	**Recurrent Neural Networks** Sequence learning, RNN architecture, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units, Long Short Term Memory architecture	**08**
5	**Generative modeling with Deep Learning** Autoencoders, Variational Autoencoder, Generative Adversarial Network, Applications of GANs in medical image analysis	**08**

List of Laboratory Experiments: (any eight)

1. Implement XOR using shallow network
2. Implement perceptron learning algorithm
3. Implement back propagation algorithm
4. Analyze heart beats using ANN
5. Study of Tensorflow and Keras
6. Image classification using CNN
7. Object detection using YOLO
8. Detection of pneumonia from chest X-ray using CNN
9. Brain tumor detection from MRI using CNN
10. Medical image analysis using Generative adversarial network

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text books:

1. Deep Learning, Ian Goodfellow, YoshuaBengio, Aaron Courville, MIT Press, 2016
2. Deep Learning with Python, Francois Cholle, Manning Publication, 2018

Reference Books:

1. Neural network for pattern recognition, Christopher m. Bishop, Clarendon press - oxford, 2014
2. Neural Network and Deep Learning, Chary C. Aggarwal, Springer, 2018

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal documentation (Write-up and/or Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="3">Semester : VII</td></tr>
<tr><td colspan="8">Course: Bioinformatics and Biostatistics</td><td colspan="3">Course Code: DJ19BMEC7012</td></tr>
<tr><td colspan="8">Course: Bioinformatics and Biostatistics Laboratory</td><td colspan="3">Course Code: DJ19BMEL7012</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Basics of biology and mathematics
2. Basic concepts of computer science

Objective:

1. The course is aimed at introducing the students to the field of Bioinformatics.
2. To enable students to understand the concepts of statistics in biology.

Outcomes: On completion of the course, learner will be able to :

1. Apply knowledge and awareness of the basic principles and concepts of biology and computer science
2. Apply knowledge of basic principles of mathematics and statistics.
3. Apply existing software effectively to extract information from large databases and to use this information in computer modelling
4. Apply problem-solving skills to multivariate methods in bioinformatics
5. Apply knowledge of bioinformatics to various tools.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Cells, DNA and Chromosome, Genes and the Genome, DNA Sequencing, Proteomics. Basic Principles of Genetics. **Foundation Statistics:** Point Estimation, Hypothesis Testing, Analysis of Variance, Regression Models.	**09**
2	**Statistical Methods in Bioinformatics:** Basic Statistical Modelling and Bayesian Inference, Gene Expression and Microarray Analysis, Sequence Alignment, Sequence Pattern Discovery, Combining Sequence and Expression Information.	**10**
3	**Algorithms in Computational Biology:** Introduction, Dynamic Programming and Sequence Alignment, Greedy Algorithms for Genome Rearrangement, Breakpoint Graph, Approximation Algorithm.	**08**
4	**Multivariate Methods in Bioinformatics:** Multivariate Normal Distribution, Multivariate Hypothesis Tests, Principle Component Analysis, Orthogonal Factor Model.	**07**
5	**Applied Bioinformatics Tools:** DNA Sequence Analysis, Protein Sequence Analysis, Bioinformatics Databases, Phylogenetic Analysis, Tools for the detection of Covid variants.	**08**

List of Tutorials: (any seven Tutorials based on following topics)

1. Steps in Hypothesis Testing
2. Types of regression
3. Types of statistical models
4. Steps in DNA sequencing
5. Different methods of DNA sequencing
6. Types of Proteomics
7. Mendel's postulates and laws of inheritance
8. Steps of dynamic programming
9. Types of biological databases

Any other tutorial based on syllabus may be included, which would help the learner to understand topic/concept.

A power point presentation on any of the topics in syllabus should be carried out.

Books Recommended:

Text books:

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

Reference Books:

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments / tutorials
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments / Tutorials): 15 Marks
Presentation : 10 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 7 tutorials and a presentation.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="3">Semester : VII</td></tr>
<tr><td colspan="8">Course: VLSI</td><td colspan="3">Course Code: DJ19BMEC7013</td></tr>
<tr><td colspan="8">Course: VLSI Laboratory</td><td colspan="3">Course Code: DJ19BMEL7013</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Engineering Physics studied in First year of Engineering.
2. Basic coding.

Objective:

1. To familiarize students with FPGA technology and associated coding approaches.
2. To familiarize students with logic design and MOS fabrication process/approaches.

Outcomes: On completion of the course, learner will be able to:

1. Understand hardware description language as a design tool for various digital circuits.
2. Understand the physics of MOS devices
3. Understand the implementation of inverter circuits using MOS devices
4. Understand the fabrication technology used in IC fabrication and need for system clocking technologies
5. Understand the stick diagrams and design rules for layouts to design combinational circuits

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction:** Introduction to VHDL as hardware description language, core features of VHDL, data types, concurrent and sequential statements, architecture body modelling : data flow, behavioural, structural. **Implementations in vhdl:** Combinational and Sequential Logic design using VHDL. Adders, multipliers, multiplexers and demultiplexers, decoders and encoders, cascading comparator. VHDL sequential circuit design features: flipflops, counters.	**10**
2	**Physics of MOS** NMOS, PMOS, enhancement and depletion mode transistor, mosfet operation with linear and saturated modes , V-I characteristics, transfer characteristics, Physics of unbiased and biased mos with energy band diagrams, threshold voltage, flatband condition, FET capacitance, short channel effects.	**08**
3	**CMOS Inverters** MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active load nMOS inverter, MOSFET Inverter with E-nMOS as pull up, MOSFET Inverter with D- nMOS as pull up, MOSFET Inverter with pMOS as pull up, CMOS inverter, voltage transfer characteristics, noise immunity and noise margins, power and area considerations, Parameter measurement in MOS circuits	**06**
4	**Fabrication** Silicon Semiconductor Technology Wafer processing, mask generation, oxidation, epitaxy growth diffusion, ion implantation, lithography, etching, metallization, basic NMOS and PMOS processes. Latch up in CMOS, CMOS using twin tub process. Scaling of MOS circuits, types of scaling and limitations of scaling. **Clocks** Introduction to VLSI Clocking and System Design: Clocking: CMOS clocking styles, Clock generation, stabilization and distribution. Low Power CMOS Circuits: Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling.	**08**
5	**Digital Design process** Design rules and Layout for MOS, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits like multiplexer, decoder, Flip flops using MOS.	**10**

List of practical's: (minimum eight and may include following)

1. Study of NMOS CW modulation of NMOS channel (Using EDA tool/s)
2. Study of CMOS Inverter characteristics (Using ORCAD or similar software)
3. Basic Logic gates (using VHDL)
4. Binary to gray and Gray to Binary code conversion (using VHDL)
5. Binary to Excess-3 code conversion (using VHDL)
6. Implementation of 4:1/8:1 Mux (using VHDL)
7. Implementation of 3:8 Decoder (using VHDL)
8. Implementation of Half Adder and Full adder (using VHDL)
9. Implementation of 4 bit full adder using half adder as component (using VHDL)
10. Implementation of JK flip flop (using VHDL)

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text books:

1. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, first edition, 1990
2. Basic VLSI Design D.A. Pucknell and Eshraghian,
3. Digital Design Principles and Practises John F Wakerly
4. CMOS Digital Integrated Circuits, Kang , Tata McGraw Hill Publications

Reference Books:

1. VHDL Programming by Examples Douglas Perry, , Tata McGraw Hill Publications, 2002
2. Principles of CMOS VLSI Design : ASystems Perspective Neil H.E. Weste, Kamran Eshraghian second edition, Addison Wesley Publications, 1993
3. Digital Integrated Circuits: A Desiqn Perspective, Rabaey Jan M., Chandrakasan Anantha, Nikolic Borivoje, second edition, Prentice Hall of India

Assessment:

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

1) Term work shall consist of minimum 8 experiments / tutorials
2) The distribution of marks for term work shall be as follows:
   Laboratory work (Experiments / Tutorials) : 15 Marks
   Presentation : 10 Marks
3) The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Forth Year Biomedical Engineering - Semester VII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Fourth Year Biomedical Engineering</td><td colspan="3">Semester: VII</td></tr>
<tr><td colspan="8">Course: Project Stage I</td><td colspan="3">Course Code: DJ19BMP704</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td>--</td><td>--</td><td>50</td><td>50</td><td>--</td><td>50</td></tr>
</table>

Pre-requisite: Knowledge of

1. Programming, software for circuit design.
2. Microcontroller programming and hardware design.
3. Curriculum gained during lower semesters of engineering.

Objectives:

1. To apply the knowledge gained during Curriculum to develop and design problem statement.
2. Conduct literature survey.
3. Design Circuit/ Flow chart of the statement.
4. Documentation and project report writing.

Outcomes: On completion of the course, learner will be able to:

1. Review literature to define problem statement
2. Apply knowledge of the engineering fundamentals acquired during the curriculum and beyond
3. Develop and create design using appropriate design methodologies considering the various health, society and environmental needs.
4. Write problem statement, Design concept in prescribed format.
5. Learn the behavioral science by working in a group.

Project Guidelines:

1. Learner is allotted 6 hrs per week for the project work
2. Learners should carry out literature survey /visit industry / analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor.
3. Group of maximum four students will be completing a comprehensive project work.
4. Learners should use multiple literatures and understand the problem.
5. Learners should attempt solution to the problem by experimental/simulation methods.
6. The solution to be validated with proper justification and compile the report in standard format

Faculty Load:

1. In semester VII – 1/2 (half) period of 1/2 hour per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups

Evaluation Scheme:

Laboratory (B):

1. Project I should be assessed through a presentation jointly by Internal and External Examiners approved by the Board of Studies
2. Project stage I should be assessed based on following points
   - Quality of problem selected
   - Literature Survey
   - Clarity of Problem definition and Feasibility of problem solution
   - Relevance to the specialization / Industrial trends
   - Clarity of objective and scope
   - Quality of Project Design
   - Compilation of Project Report
   - Quality of Written and Oral Presentation

Laboratory: (Term work)

Term Work should be examined by approved internal faculty appointed by the head of the institute based on the following:

1. Scope and objective of the project work.
2. Extensive Literature survey.
3. Progress of the work (Continuous assessment)
4. Report in prescribed University format.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VIII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="3">Semester : VIII</td></tr>
<tr><td colspan="8">Course: Biomedical Microsystems</td><td colspan="3">Course Code: DJ19BMC801</td></tr>
<tr><td colspan="8">Course: Biomedical Microsystems Laboratory</td><td colspan="3">Course Code: DJ19BML801</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Working of transducers used in medical applications
2. Basic fundamentals of Electrical and Electronics.

Objectives:

1. To understand various fabrication techniques for MEMS devices.
2. To apply the knowledge of MEMS in Biomedical field.

Outcomes: On completion of the course, learner will be able to:

1. Understand basic properties of MEMS materials and select appropriate material for MEMS application
2. Develop or modify the MEMS processes for a simple MEMS device in order to reduce the fabrication time.
3. Understand different microfabrication techniques and choose appropriate technique
4. Analyze Micro total analysis system with designing of its components
5. Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to miniaturization and materials** Block diagram of MEMS and BIOMEMS, comparison, examples Clean room: definition, classification, air flow system Scaling Laws in Miniaturization Substrates and Wafers: CZ process, wafer types Materials:Properties and applications of single crystal silicon, Polysilicon, Porous silicon, SiO2, PSG, Quartz, Spin on glass, Silicon Nitride, Silicon Carbide, Germanium, Polymers (PMMA, PDMS, SU8)	**08**
2	**MEMS FABRICATION PROCESSES** Wafer cleaning processes: RCA PVD: Evaporation (Thermal and E-beam) and Sputtering (DC and RF), applicable materials, advantages, disadvantages CVD: Reaction steps, APCVD, LPCVD, PECVD, applicable materials, advantages, disadvantages Oxidation, Doping: Ion implantation, Diffusion, advantages, disadvantages Etching: Dry etching (RIE, DRIE) and wet etching (isotropic and anisotropic), advantages, disadvantages, specific etchants Photolithography: Definition, steps, light sources, positive and negative photoresist, mask, different projection systems X-ray lithography: Synchrotron radiation, X-ray mask, Nanolithography: EBL	**12**
3	**Microfabrication Techniques** Bulk micromachining: definition, advantages and disadvantages, Examples: pressure sensor, dissolved wafer process, CO_2 sensor Surface micromachining: definition, advantages and disadvantages, Examples: pressure sensor, cantilever, Non polysilicon surface micromachining: SOI fabrication LIGA: definition, process steps, examples, advantages and disadvantages, molding techniques: injection, compression, hot embossing Soft lithography: Definition, SAMs, types	**06**
4	**MICRO TOTAL ANALYSIS SYSTEMS (μTAS)** Basic block diagram, Flow techniques in μ-fluidics: pressure driven force, electro-osmosis, electrophoresis Micropump, microvalves: types and fabrication, Microchannels: Types and fabrication (SU8, glass, silicon) Separation techniques: Capillary electropherosis, Electrochromatography Detection techniques: Electrochemical detection, Fluorescence, Chemiluminiscence	**08**
5	**MICRO/ NANO BIOSENSORS AND DRUG DELIVERY DEVICES** Biosensor: definition, block diagram Classification based on the basis of detection techniques: Electric, Magnetic, Optical, Thermal, Mechanical, and Chemical Basic steps involved in the development of biosensors: surface modification,	**08**

	immobilization, integration with transducer Design, fabrication of cantilever for antibody detection Drug delivery techniques, profiles, Micro needles: solid, hollow, polymer, silicon (fabrication), Vehicles for drug delivery	

List of Experiments (Any Four)

1. Simulate scaling laws
2. Study crystal structure using simulation
3. Simulate thermal actuator
4. Simulate pressure sensor
5. Simulate cantilever
6. Simulate Microchannel
7. Simulate Microvalve
8. Simulate Micropump

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

List of Tutorials (Any Six)

1. Scaling Laws
2. Materials for MEMS
3. MEMS deposition techniques
4. MEMS etching techniques
5. Lithography
6. Surface characterization techniques
7. Micromachining
8. Softlithography
9. Micro Total Analysis systems
10. Drug delivery devices

Books Recommended:

Text books:

1. Mems and microsystems - design and manufacture,Tai-Ran Hsu, TATA Mcgraw-Hill
2. Fundamentals of Microfabrication, Marc Madou, CRC Press.

Reference Books:

1. MEMS design and fabrication, Mohamed Gad-el-Hak, Taylor and Francis
2. Bio-MEMS Technologies and Applications, Wanjun Wang and Steven A. Soper, CRC press
3. Microsensors MEMS and smart devices, Julian Gardner, Vijay Varadan and Osama Awadelkarim, John wiley& sons

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practical's performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal documentation (Write-up and/or Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VIII (Autonomous)
(Academic Year 2019-2020)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="3">Semester : VIII</td></tr>
<tr><td colspan="8">Course : Hospital Management and Regulatory Affairs</td><td colspan="3">Course Code: DJ19BMC802</td></tr>
<tr><td colspan="8">Course : Hospital Management and Regulatory Affairs Laboratory</td><td colspan="3">Course Code: DJ19BML802</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Specifications, working and application of Diagnostic, Therapy and Lifesaving equipment.
2. Basic fundamentals of Electrical and Electronics.
3. Basic operations in Microsoft Excel.

Objectives:

1. Apply modern engineering and management principles to provide high quality of hospital care to the community.
2. To understand the design considerations in a hospital for designing of various departments in the hospital.
3. To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve Hospitals.
4. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies.

Outcomes: On completion of the course, learner will be able to:

1. Apply the concepts of management (personnel, finance, and material resources) and the processes and strategies needed in specific hospital sectors.
2. Apply the knowledge of the management structure and functions in hospital. Communicate effectively and develop their leadership and team building abilities.
3. Apply the principles of designing, implementing and commissioning of clinical services and supportive departments in the hospital.
4. Apply the knowledge and execute the role and take up the responsibilities of Biomedical Engineer in hospital.
5. Apply the knowledge of functions of Engineering services and axillary services and co-ordinate with them.
6. Apply the knowledge of materials management in hospitals and industry.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Medical Device Regulatory Affairs:** Need of regulatory affairs, role & responsibility of regulatory professional. Medical device and in vitro diagnostics: Introduction and types of devices. Quality Management System. Introduction to ISO certification such as ISO 13485 & ISO 14971.	**08**
2	**Process of Management:** Principles of management, Finance Management, Materials Management, Human Resource Management, **Qualities of a Manager:** Leadership, Motivation, Time management, effective communication, etc.	**06**
3	**Organization of the hospital & Hospital Planning:** Management structure, Types of hospitals, Governing body, Duties and responsibilities of various positions such as Chief Executive Officer. Guiding principles in planning hospital facilities and services and planning the hospital building	**06**
4	**Clinical and Supportive Services: (Location, Layout, equipment and functions):** **Clinical Services:** IN patient, OUT patient, Intensive care unit, Operation Theatre, Pathology Laboratory and Blood Bank, Radiology, Physiotherapy and Emergency, **Other Services:** Hospital Ventilation and Air Conditioning, Medical Gas systems Central Sterile Service Department, Waste management, Hospital Infection control, Disaster management	**14**
5	**Biomedical Engineering Department: (Location, Layout, equipment and functions):** Roles and responsibilities of Biomedical Engineer in hospitals, Maintenance types: Routine(preventive) and breakdown, Contracts (CMC and AMC) **Biomedical Equipment Purchase Procedure:** Purchase system (Centralized, Decentralized, Local purchase), Purchase Procedures.	**08**

List of Laboratory Experiments / Assignments / Tutorials: (Any four Experiments, 1 Power Point Presentation and four Tutorials)

1. Medical Device QMS Requirements for Regulatory Compliance
2. Study of ISO 13485 and ISO 14971
3. Prepare budget using EXCEL sheet for purchase of hospital equipment.
4. Preparation of Comparative Statement of Equipment for purchase
5. Negotiations of the equipment in the comparative statement.
6. Design the layout of Out Patient Department in hospital.
7. Design the layout of In-Patient Department in hospital.
8. Design the layout of Surgical Operation Theatre Complex in hospital.
9. Design the layout of Radiology Department in hospital.
10. Design the layout of Pathology Laboratory and Blood Bank Department in hospital.
11. Design the layout of Physiotherapy Department in hospital.
12. Design the layout of Central Sterile Supply Department in hospital.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text books:

1. Hospital Management by Dr. Pradyna Pai
2. Hospitals - Planning, Designing and Management: Kunders G D, Gopinath, A Katakam (Tata McGraw Hill Education Private Limited)
3. Hospitals - Facilities Planning and Management: G D Kunders (Tata McGraw Hill Education Private Limited)
4. Modern Trends in Planning and Designing of Hospitals - Principles and Practice: Shakti Kumar Gupta, Lt Col Sunil Kant, R Chandrashekhar, Sidharth Satpathy (Jaypee Brothers, Medical Publishers (P) Ltd, New Delhi)

Reference Books:

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore)

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 4 Experiments, 1 Power Point Presentation and eight Tutorials.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments and Power Point Presentation): 15 Marks

ii. Journal Documentation (Tutorials / Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Fourth Year Biomedical Engineering - Semester VIII
(Autonomous) (Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Fourth Year Biomedical Engineering</td><td colspan="3">Semester: VIII</td></tr>
<tr><td colspan="8">Course: Big Data and Cloud Computing</td><td colspan="3">Course Code: DJ19BMEC8011</td></tr>
<tr><td colspan="8">Course: Big Data and Cloud Computing Laboratory</td><td colspan="3">Course Code: DJ19BMEL8011</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">25</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">3+1=4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Data Base Management System laboratory

Objectives:

2. To Provide an Overview of an exciting growing field of Big Data Analytics.
3. To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
4. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability.
5. To introduce Different Cloud Computing services

Outcomes: On completion of the course, learner will be able to:

1. Understand the key issues in big data management and its associated applications for business decisions and strategy.
2. Understand and Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop and NoSQL in big data analytics.
3. Evaluate Big Data processing by using MapReduce
4. Solve complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Syllabus for Fourth Year Biomedical Engineering - Semester VIII
(Autonomous) (Academic Year 2022-2023)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Big Data Analytics & Hadoop** **1.1** Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach. **1.2** Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions. **1.3** Introduction to Hadoop, Core Hadoop Components, Hadoop Ecosystem, Physical Architecture, Hadoop limitations.	**06**
2	**NoSQL** **2.1** Introduction to NoSQL, NoSQL business drivers, NoSQL case studies. **2.2** NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns, analysing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer **2.3** Introduction to MongoDB, MongoDB commands.	**08**
3	**MapReduce** **3.1** MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization. **3.2** MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures **3.3** Matrix vector multiplication using MapReduce, Case studies on MapReduce using Java/Python	**08**
4	**Big Data Analytics Applications** **4.1** Recommendation Systems: Introduction, Collaborative-Filtering System, Content based recommendation system **4.2** Mining Social-network Graphs: Social Networks as graphs, Types of Social-network, relevance of community detection, Clique Percolation Method.	**10**
5.	**Cloud Computing Services:** Exploring Cloud Computing Services: SPI Model: Software as a Service, Platform as a service, and Infrastructure as a service. Anything as a service or Everything as a service (XaaS): Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service, Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.	**10**

Syllabus for Fourth Year Biomedical Engineering - Semester VIII (Autonomous)
(Academic Year 2022-2023)

List of Laboratory Experiments: (Minimum Eight)

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks.
3. Installation of MongoDB, and execution of CREATE, INSERT, DELETE and UPDATE operations.
4. Querying in MongoDB using FIND command, aggregate functions etc.
5. Execution of PIG SCRIPTING language.
6. Execution of HIVE SCRIPTING language.
7. Execution of Matrix Multiplication Using MapReduce.
8. Execution of Word Count using MapReduce.
9. Case Study on Recommendation Systems.
10. Configuration of AWS

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text Books:

1. Radha Shankarmani and M Vijayalakshmi ―Big Data Analytics‖, Wiley
2. Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly ―Making Sense of NoSQL‖ – A guide for managers and the rest of us, Manning Press.
4. Learn to Master Cloud Computing by Star EduSolutions
5. Kai Hwang, “Distributed and Cloud Computing”, MK Publication
6. Thomas Erl, Robert Cope, Amin naserpour, “Cloud Computing Design Patterns”, Pearson Publication.

Reference Books:

1. Bill Franks, ―Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, ―Hadoop in Action‖, Dreamtech Press

Web Resources:

1. http://fosshelp.blogspot.in
2. https://aws.amazon.com/
3. https://docs.openstack.org/
4. https://owncloud.org/

5. https://appengine.google.com

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 7 experiments, 1 Power Point Presentation and minimum 2 assignments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up and/or Power Point Presentation and/or Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VIII(Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="3">Semester: VIII</td></tr>
<tr><td colspan="8">Course: Medical Device Regulatory Affairs</td><td colspan="3">Course Code: DJ19BMEC8012</td></tr>
<tr><td colspan="8">Course: Medical Device Regulatory Affairs</td><td colspan="3">Course Code: DJ19BMEL8012</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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<tr><td rowspan="3">03</td><td rowspan="3">02</td><td rowspan="3">--</td><td rowspan="3">04</td><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">25</td></tr>
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</table>

Pre-requisite: Knowledge of Medical Devices

Objectives:

1. To build a strong base for medical device regulatory affairs in terms of classification of devices, its standards & manufacturing license etc.
2. To train and motivate students to work in Industry or to pursue higher education with base of regulatory affairs

Outcomes: On completion of the course, learner will be able to understand:

1. Medical device and in vitro diagnostic (IVD), classification and types of medical devices
2. Medical device and testing, personnel involved, quality assurance, quality management system.
3. Biocompatibility studies, clinical investigation, risk management, international practices.
4. Manufacturing license, inspection, fees, import, export, etc.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to regulatory affairs:** Introduction and types of devices including combination devices .Medical Device Rules, 2017: Implications on medical device. US FDA Medical Device Regulations and IVD regulations.EU Medical Device Regulations	**07**
2	**Classification & Labeling of medical devices:** Main classification i.e. Medical devices, active devices & IVD devices. Definition & basic elements of labeling. Risk management, clinical evaluation &labeling. New world of labeling i.e. e-labeling, websites, internet.	**10**
3	**Standards of medical device, quality assurance, and testing:** Regulatory requirements of biocompatibility of medical devices and ISO 10993**.**Clinical investigation of medical devices: regulation of investigational medical devices. AERB guidelines & ISO11137-1/2	**07**
4	**Quality assurance and quality management system:** Quality Management System, How to obtain a license to manufacture a medical device? ISO 13485 & ISO 14971 (Medical devices: Application of risk management to medical devices).	**10**
5	**Inspection of medical device and IVD establishments:** Import and export of medical devices and IVDs. Medical device international Regulatory affairs (China, Japan)	**08**

List of Assignments/Tutorials, Case Study or Presentation Topics:

1. Preparation of checklist of documents needed for distributor
2. Preparation of checklist of documents needed for Manufacturing License Class A & B,C &D Medical devices
3. Requirements for importers class A device
4. Requirements for importers class B ,C ,D device
5. Requirements of Site or Plant Master file
6. Checklist for device master file
7. Medical Device QMS Requirements for Regulatory Compliance
8. Preparation of checklist for registration of medical device
9. Guidance document on common submission format for import license of notified medical devices
10. Comparative study of marketing authorization procedure for medical devices in USA, EU and Japan
11. Preparation of regulatory submission using eCTD software
12. Preparation of Clinical Trial Application (CTA) in India
13. Regulatory requirements checklist for conducting clinical trials in India
14. Registering for different Intellectual Property Rights in India

Any other assignment/tutorial based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text books:

1. Handbook of Medical Device Regulatory Affairs in Asia, Jack, Raymond Tong Kaiyu. Jenny Stanford ,Second Edition
2. Medical Device Development: A Regulatory Overview, Jonathan S. Kahan, Hogan lovells US LLP
3. Medical Devices Rules, 2017, Related Guidance documents available at CDSCO websites

Reference Book:

1. FDA Regulatory Affairs, David Mantus & Douglas J. Pisano,CRC Press, Third Edition
2. Medical Product Regulatory Affairs :Pharmaceuticals, Diagnostics, Medical Devices, John J. Tobin, Gary Walsh , Wiley

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term-work shall consist of minimum (One presentation/Case Study, Five Assignments/Tutorials)
Term work shall carry total 25 marks based on the performance in the assignments/tutorials, presentation/case study

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Final Year Biomedical Engineering - Semester VIII (Autonomous)
(Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Final Year Biomedical Engineering</td><td colspan="2">Semester : VIII</td></tr>
<tr><td colspan="8">Course : Robotics in Medicine</td><td colspan="2">Course Code: DJ19BMEC8013</td></tr>
<tr><td colspan="8">Course : Robotics in Medicine Laboratory</td><td colspan="2">Course Code: DJ19BMEL8013</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
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<tr><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work&Power Point Presentation</td><td>Tutorial / Mini project / Journal</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

Basic electrical and electronics

Engineering mathematics

Objectives:

1) To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning.
2) To introduce to various applications of Robots in Medicine.

Outcomes: On completion of the course, learner will be able to:

1) Analyse and Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations.
2) Analyse and Design Robotic systems for Medical application.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	Introduction Automation and Robots, Classification, Application, Specification, Notations	**06**
2	Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, Four-axis robot, Six-axis robot)	**08**
3	Inverse Kinematics General properties of solutions tool configuration Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	**10**
4	Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).	**10**
5	Task and Trajectory Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation. Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery	**14**

List of Laboratory Experiments / Assignments / Tutorials: (Any seven Experiments, 1 Power Point Presentation)

1) Automation and Robots Classification
2) Specification, Notations
3) Direct Kinematics Dot and cross products
4) Five- axis robot, Four-axis robot, Six-axis robot(Direct Kinematics)
5) Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics)
6) Robot Vision Image representation
7) Segmentation
8) Applications in Biomedical Engineering ,Application in rehabilitation, Clinical and Surgery
9) Task Planning, Task level programming Any other experiment based on syllabus which will

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Group Presentation on the latest technology in hospitals based on the topics covered in the syllabus. Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

Books Recommended:

Text books:

1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu,Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J,Craig,Pearson Education

Reference Books:

1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semesterout of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 4 Experiments, 1 Power Point Presentation.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments and Power Point Presentation): 15 Marks
ii. Journal Documentation (Tutorials / Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal

Syllabus for Forth Year Biomedical Engineering - Semester VIII
(Autonomous) (Academic Year 2022-2023)

<table>
<tr><td colspan="8">Program: Fourth Year Biomedical Engineering</td><td colspan="2">Semester: VIII</td></tr>
<tr><td colspan="8">Course: Project Stage II</td><td colspan="2">Course Code: DJ19BMP803</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">200</td></tr>
<tr><td rowspan="2">--</td><td rowspan="2">12</td><td rowspan="2">--</td><td rowspan="2">06</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>100</td><td>100</td><td>--</td><td>100</td></tr>
</table>

Objectives:

1) Implement the concept of Project Stage-I
2) Use advanced tools for Implementation
3) Rectify/ Debug the design and Submit project report.

Outcomes: On completion of the course, learner will be able to:

1) Implement the concept of Project Stage-I
2) Use advanced tools for Implementation
3) Rectify/ Debug the design and Submit project report

Project Guidelines:

1. Learner is allotted 12 hrs per week for the project work
2. The students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I and should attempt solution to the problem.
3. Learners should attempt solution to the problem by experimental/simulation methods.
4. The solution to be validated with proper justification.
5. Report should be prepared as per the guidelines issued by the University of Mumbai
6. Learners should be motivated to publish a paper based on the work in Conferences/students competitions
7. Project Groups: Learners can form groups not more than 4 (Four)

Faculty Load:

1) In semester VIII - 1 (One) periods of 1 hour each per week per project group
2) Each faculty is permitted to take (guide) maximum 4 (Four) project groups

Evaluation Scheme:

Laboratory (B):

1. Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the Board of Studies
2. Project stage II should be assessed based on following points
   - Quality of problem selected
   - Clarity of Problem definition and Feasibility of problem solution
   - Relevance to the specialization / Industrial trends
   - Clarity of objective and scope
   - Quality of work attempted
   - Validation of results
   - Compilation of Project Report
   - Quality of Written and Oral Presentation

Laboratory: (Term work)

Term Work should be examined by approved internal faculty appointed by the head of the institute based on the following:

1. Scope and objective of the project work.
2. Extensive Literature survey.
3. Progress of the work (Continuous assessment)
4. Report in prescribed University format.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal