Maharashtra State Board Of Technical Education, Mumbai

Learning and Assessment Scheme for Post S.S.C Diploma Courses

Programme Name	: Diploma In Medical Electronics		
Programme Code	: MU	With Effect From Academic Year	: 2023-24
Duration Of Programme	: 6 Semester	Duration	: 16 WEEKS
Semester	: Fifth NCrF Entry Level : 4.0	Scheme	: K

Sr No	Course Title	Abbrevation	Course Type	Course Code	Total IKS Hrs for Sem.	Actual Contact Hrs./Week CL	Actual Contact Hrs./Week TL	Actual Contact Hrs./Week LL	Self Learning (Activity/ Assignment /Micro Project)	Notional Learning Hrs /Week	Credits	Paper Duration (hrs.)	Theory FA-TH Max	Theory SA-TH Max	Theory Total Max	Theory Total Min	Based on LL & TL Practical FA-PR Max	Based on LL & TL Practical FA-PR Min	Based on LL & TL Practical SA-PR Max	Based on LL & TL Practical SA-PR Min	Based on Self Learning SLA Max	Based on Self Learning SLA Min	Total Marks
(All Compulsory)																							
1	MANAGEMENT	MAN	AEC	315301	1	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125
2	MEDICAL IMAGING EQUIPMENT	MIE	DSC	315344	-	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175
3	PHYSICAL THERAPY DEVICES AND MACHINES	PTM	DSC	315345	1	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
4	ICU EQUIPMENT AND MAINTENANCE	ICU	DSC	315346	-	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175
5	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	EDS	AEC	314014	-	1	-	2	1	4	2	-	-	-	-	-	50	20	25@	10	25	10	100
6	BIOMEDICAL SIMULATION SOFTWARE	BSO	DSC	315005	-	1	-	2	1	4	2	-	-	-	-	-	25	10	25@	10	25	10	75
Elective (Any - One)																							
7	APPLICATIONS OF IoT	AOI	DSE	315347	-	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
7	MECHATRONICS	MEC	DSE	315348	-	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
7	REHABILITATION ENGINEERING	REN	DSE	315349	-	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150
Total					2	20		14	6		20		150	350	500		175		150		125		950

Abbreviations : CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends : @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.

2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.

3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.

4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks

5. 1 credit is equivalent to 30 Notional hrs.

6. * Self learning hours shall not be reflected in the Time Table.

7. * Self learning includes micro project / assignment / other activities.

Course Category : Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

MANAGEMENT	**Course Code : 315301**

Programme Name/s	: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg.
Programme Code	: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE
Semester	: Fifth / Sixth
Course Title	: MANAGEMENT
Course Code	: 315301

I. RATIONALE

Effective management is the cornerstone of success for both organizations and individuals. It empowers diploma engineers/ professionals to accomplish their tasks with finesse and efficiency through strategic planning and thoughtful execution, projects can optimize finances, enhance safety measures, facilitate sound decision-making, foster team collaboration and cultivate a harmonious work environment. The diploma engineers require leadership and management skills with technical knowledge of the core field to carry out various tasks smoothly. This course aims to instill fundamental management techniques, empowering diploma engineers/ professionals to enhance their effectiveness in the workplace.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Apply the relevant managerial skills for achieving optimal results at workplace.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use relevant management skills to handle work situation
- CO2 - Apply appropriate techniques of product, operations and project management
- CO3 - Use comprehensive tools of recent management practices
- CO4 - Plan suitable marketing strategy for a product / service
- CO5 - Utilize supply chain and human resource management techniques for effective management

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
																	Practical				
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315301	MANAGEMENT	MAN	AEC	3	-	-	1	4	2	1.5	30	70*#	100	40	-	-	-	-	25	10	125

Total IKS Hrs for Sem. : 1 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Justify the importance of management thoughts in Indian knowledge system. TLO 1.2 Describe the importance of management in day to day life. TLO 1.3 Explain Henry Fayol's principles of management. TLO 1.4 Describe the role of each level of management in its management hierarchy. TLO 1.5 Practice the self management skills for a given situation TLO 1.6 Apply the required managerial skills for a given situation	**Unit - I Introduction to Management** 1.1 Evolution of management thoughts from ancient/medieval to modern times in India (IKS) 1.2 Management: meaning, importance, characteristics, functions & challenges. 1.3 Introduction to scientific management- Taylor's & Fayol's principles of management 1.4 Levels & functions of management at supervisory level. 1.5 Self management skills: Self awareness, self discipline, self motivation, goal setting, time management, decision making, stress management, work life balance and multitasking 1.6 Overview of Managerial Skills: negotiation skills, team management, conflict resolution, feedback, leadership	Presentations Case Study Interactive session Quiz competition Mixed Picture Puzzle
2	TLO 2.1 Identify the appropriate creativity technique for new product development TLO 2.2 Describe the new product development process for a product / service TLO 2.3 Comprehend the importance of various strategic steps Product Management TLO 2.4 Elaborate Agile product management TLO 2.5 Explain the significance of the Project Management TLO 2.6 Describe the various tools of project management	**Unit - II Product, Operations and Project Management** 2.1 Creativity and innovation management: creativity techniques - brainstorming, checklist, reverse brainstorming, morphological analysis, six thinking hats. 2.2 New product development, change management 2.3 Product Management -meaning, strategic steps for sustainable design of a product 2.4 Agile product management- concept, benefits, principles and manifesto 2.5 Project Management: importance, areas within project management,4Ps and phases 2.6 Tools of Project Management: PERT and CPM, GANTT & Chart Overview of Estimate and Budget	Presentations Case Study Video Demonstrations Presentations Role Play

MANAGEMENT   Course Code : 315301

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Understand the importance of quality management tools TLO 3.2 Explain the importance of various techniques for optimization and waste minimization TLO 3.3 State the importance of ISO quality standards TLO 3.4 Describe ERP TLO 3.5 State the importance of ISO TLO 3.6 Recognize the importance of customer satisfaction as a competitive advantage	**Unit - III Management Practices** 3.1 Quality circle, kaizen, Six Sigma, TQM 3.2 5S, Kanban card system, TPM, Lean Manufacturing: Meaning, Steps and Importance 3.3 Quality Standards and ISO: Meaning, ISO 9001:2016, ISO 14000, OSHA 2020 3.4 The overview of ERP along with example 3.5 Service quality and customer/client satisfaction, servicescape	Presentation Case study Interactive session Quiz Video Demonstration Lecture Using Chalk-Board
4	TLO 4.1 Explain the importance of marketing techniques TLO 4.2 Explain the importance of needs, wants and desires in marketing TLO 4.3 Interpret the traditional and digital marketing techniques TLO 4.4 Plan different aspects of an event management	**Unit - IV Marketing Management** 4.1 Marketing management: meaning, significance, Seven P's of Marketing 4.2 Needs, wants and demands in marketing. Customer relationship management 4.3 Types of marketing: traditional and digital marketing 4.4 Event management: types, different aspects of event management, crisis management	Case Study Interactive session based video Role Play Flipped Classroom Presentations
5	TLO 5.1 State the importance of supply chain and logistics management TLO 5.2 Explain the components of supply chain and logistics Management TLO 5.3 Describe the role of information technology in supply chain & logistics management TLO 5.4 State the significance of Human Resource Management TLO 5.5 Analyze the various methods of recruitment, selection and training for an organization TLO 5.6 List the qualities of a successful supervisor	**Unit - V Supply Chain & Human Resource Management** 5.1 The overview of Supply Chain and logistics Management 5.2 Components of Supply Chain and logistics Management 5.3 Role of information technology in supply chain & logistics management 5.4 Overview of Human Resource Management-Meaning,significance,scope and principles 5.5 Recruitment, selection and training of human resources. Chalk Circle 5.6 Qualities of a successful supervisor /team leader and types of leadership	Presentations Video Demonstrations Case Study Collaborative learning Video Demonstrations Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment / Article

- Make a one page note based on a book of management you read.
- Write a short article on inventory management exploring online learning resources.
- Prepare a report on ISO standards applicable to your field. a. IATF 16949-2016 / SLA-TS 16949-2016, - Automotive Industry b. ISO 22000 — Food safety management c. ISO 50001 — Energy management d. ISO/IEC 27001 - Cyber Security e. ISO/DIS 4931-1 - Buildings and civil engineering works
- Prepare a 4 quadrant matrix of time management for managing the tasks.
- Prepare a report on any one software used for Supply Chain and Logistics Management.
- Prepare a GANTT Chart for project management related to your field.

Note Taking

- Watch a Tedx Talk Video on managerial skills and take notes in the form of keywords.

Case Study

- Prepare a case study and discuss the same on following topics a.Self Management Skills b.Six Thinking Hats c.Kaizen d.Quality Circle e.Safety Measures in different organizations related to your field
- Study the recruitment and selection process of any organization related to your field.
- Prepare a case study on management lessons based on life of Chhatrapati Shivaji Maharaj
- Conduct outbound training on managerial skills. Make a video and upload on social media.

Quizes

- Participate in online quizzes related to areas of management .

Assignment

- Workshops to be conducted for students on following topics a. creativity techniques b. time management c. stress management d. negotiation and conflict e. goal setting f. meditation new product development

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Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED : NOT APPLICABLE

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Management	CO1	13	8	6	4	18
2	II	Product, Operations and Project Management	CO2	8	2	4	6	12
3	III	Management Practices	CO3	8	4	4	6	14
4	IV	Marketing Management	CO4	8	2	4	6	12
5	V	Supply Chain & Human Resource Management	CO5	8	4	4	6	14
		Grand Total		**45**	**20**	**22**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- MCQ Based Class Test, Self Learning Activities / Assignment

Summative Assessment (Assessment of Learning)

- Summative Assessment (Assessment of Learning) MCQ based

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	1	1	1	-	-	2	3			
CO2	1	3	3	-	1	3	3			
CO3	1	3	1	-	1	1	3			

MANAGEMENT   **Course Code : 315301**

CO4	1	2	2	-	1	2	3		
CO5	1	1	2	-	1	2	3		

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	A. K. Gupta	Engineering Management	S. Chand, ISBN: 81-219-2812-5, 2007, 2nd Edition
2	O. P. Khanna	Industrial Engineering &management	Dhanpat Rai Publication, ISBN: 978-8189928353, 2018
3	Harold Koontz and Heinz Weinrich	Essentials of Management	Tata McGraw Hill Education ISBN: 9789353168148, 2020, 12th edition
4	E. H. McGrath	Basic Managerial Skills for All	PHI ISBN: 978-8120343146, 2011, 9th Edition
5	Andrew DuBrin	Management Concepts and Cases	Cengage Learning, ISBN: 978-8131510537, 2009, 9th edition
6	K. Dennis Chambers	How Toyota Changed the World	Jaico Books ISBN: 978-81-8495-052-6, 2009
7	Jason D. O'Grandy	How Apple changed the Wolrd	Jaico Publishing House ISBN: 978-81-8495-052-0, 2009
8	Subhash Sharma	Indian Management	New Age International Private Limited ; ISBN- 978-9389802412, 2020, 1st edition
9	Chitale, Dubey	Organizational Behaviour Text and Cases	PHI LEARNING PVT. LTD., ISBN: 978-9389347067, 2019, 2nd Edition

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.debonogroup.com/services/core-programs/six-thinking-hats/	Six Thinking Hats
2	https://hbr.org/1981/09/managing-human-resources	HR Management
3	https://theproductmanager.com/topics/agile-product-management/	Agile Product Management
4	https://www.cdlogistics.ca/freight-news/the-5-components-of-supply-chain-management	Supply Chain Management
5	https://www.infosectrain.com/blog/understanding-the-concepts-of-gantt-chart-and-critical-path-methodology-cpm	PERT, CPM, GANTT Chart
6	https://www.simplilearn.com/best-management-tools-article	Management Tools
7	https://www.psychometrica.in/free-online-psychometric-tests.html	Psychometric Tests
8	https://www.investopedia.com/terms/e/erp.asp	ERP
9	https://asq.org/quality-resources/quality-management-system	QMS
10	https://testlify.com/test-library/creative-thinking/	Psychometric Tests
11	https://www.mindtools.com/	Management Skills
12	https://www.investopedia.com/terms/d/digital-marketing.asp	Digital Marketing

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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Programme Name/s	**: Medical Electronics**
Programme Code	**: MU**
Semester	**: Fifth**
Course Title	**: MEDICAL IMAGING EQUIPMENT**
Course Code	**: 315344**

I. RATIONALE

Medical imaging equipment plays a crucial role in the diagnosis, treatment, and monitoring of various medical conditions. Thus for any healthcare professional whether radiologists, technicians or physicians understanding the operation and function of medical imaging equipment and techniques is essential. This course will enable the diploma graduate to develop skills related to operating procedures, troubleshooting and maintenance of medical imaging equipments along with their safety protocols

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

"Test operation of various types of medical imaging equipment to ensure their upkeep and maintenance."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Operate X-ray machine for specific image processing with safety aspects as per defined standards of industry.
- CO2 - Test the performance of radiography and fluoroscopy machine for imaging.
- CO3 - Test the operation of CT and MRI machine.
- CO4 - Troubleshoot the ultrasound image machine.
- CO5 - Describe steps of operating procedure, troubleshooting and maintenance of machines based on advanced nuclear imaging techniques with safe working.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											Total Marks
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		
				CL	TL	LL											Practical				
											FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315344	MEDICAL IMAGING EQUIPMENT	MIE	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

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2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

	MEDICAL IMAGING EQUIPMENT		Course Code : 315344
Sr.No	**Theory Learning Outcomes (TLO's)aligned to CO's.**	**Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.**	**Suggested Learning Pedagogies.**
1	TLO 1.1 Describe the physical properties of X-rays. TLO 1.2 Identify and describe the components of the X-ray machine. TLO 1.3 Explain the concept of mobile X-ray machines and dental X-ray machine. TLO 1.4 Describe the steps of installation and maintenance of X-ray machine. TLO 1.5 Describe the specified risk involved in handling X-ray machine. TLO 1.6 List the steps for quality assurance testing of X-ray machine.	**Unit - I X-ray Machine and Radiation Safety** 1.1 X-ray spectrum, X-ray properties, medical applications of X- rays 1.2 X-ray assembly and circuits, X-ray tubes (stationary and rotating) principle, construction, operation and specifications, function of filter ,collimator and bucky grids 1.3 Block diagram of X-ray machine, control circuit for high voltage (KV),current (mA), exposure timer circuit 1.4 Concept of mobile X-ray technology and dental X-ray machine, risk involved in X-ray machine 1.5 Installation and maintenance of X-ray machine 1.6 Protocol for extending tube life, quality assurance test of equipment 1.7 Biological effects of radiation on human health, prevention of radiation hazards	Lecture Using Chalk-Board Video Demonstrations Presentations Flipped Classroom
2	TLO 2.1 Describe the digital radiography. TLO 2.2 Explain the principles and processes involved in digital image formation. TLO 2.3 Identify the future trends in digital radiography. TLO 2.4 Describe the aspects of fluoroscopy machine. TLO 2.5 Describe with neat sketch of C arm fluoroscopy machine. TLO 2.6 Explain the concept of digital fluoroscopy and 3D imaging.	**Unit - II Digital Radiography and Fluoroscopy** 2.1 Concept of digital radiography 2.2 Digital image formation, X-ray generation and detection, direct vs indirect conversion, detector technologies (flat-panel detectors, CCDs) 2.3 Image acquisition and processing, analog to-digital conversion, image reconstruction algorithms 2.4 Future trends in digital radiography, artificial intelligence and machine learning in radiography 2.5 Fluoroscopy machine, principle and block diagram, image intensifier and flat panel detectors, image intensifier artifacts 2.6 Types of fluoroscopy, C arm fluoroscopy, safety tips for C arm fluoroscopy 2.7 Digital fluoroscopy and 3D imaging	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
3	TLO 3.1 Describe with sketches the function of CT machine. TLO 3.2 Explain the concept of photon counting CT machine. TLO 3.3 Calculate the CT number from the CT image. TLO 3.4 Describe with sketches the function of MRI machine. TLO 3.5 Explain the concept of high-field and ultra-high-field MRI. TLO 3.6 List the procedural steps for installation and maintenance of CT & MRI. TLO 3.7 Enlist benefits and risk involved in CT and MRI machine.	**Unit - III CT and MRI** 3.1 Computed tomography, basic principle of CT, block diagram of CT machine, parts of CT machine, clinical application 3.2 CT number, CT generations, CT detectors, photon-counting CT 3.3 Angiography technique and its block diagram 3.4 Basic definition- RF shielding, shimming 3.5 Magnetic resonance imaging: Principle, block diagram, types of magnets, biological effects of MRI imaging, advantages of MRI system 3.6 High-field and ultra-high-field MRI, 3 Tesla (3T) and 7 Tesla (7T) MRI scanners 3.7 Installation and maintenance of CT machine and MRI machine, benefits and risk involved in handling CT and MRI	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
4	TLO 4.1 Describe the physical properties of ultrasound transducer. TLO 4.2 Enlist and explain the techniques of ultrasound. TLO 4.3 Classify the different display modes of ultrasound. TLO 4.4 Explain ultrasound artifacts and transducer array. TLO 4.5 Describe the advanced technology in ultrasound as 3D and 4D. TLO 4.6 Identify the concept of image analysis using AI and ML. TLO 4.7 List the procedural steps for installation and maintenance of ultrasound machine.	**Unit - IV Ultrasound Imaging** 4.1 Ultrasound properties, ultrasound transducer, ultrasound wave zones, diagram, working and clinical applications of piezoelectric transducer 4.2 Pulse echo techniques, principle of doppler ultrasound 4.3 Displays of ultrasound: A scan, B scan,TM scan and real time B scan, ultrasound artifacts 4.4 Transducer arrays, linear switched array and linear phased array array 4.5 Advanced technology in ultrasound ,high frequency ultrasound, 3D and 4D ultrasound 4.6 Artificial intelligence (AI) and machine learning for automated image analysis 4.7 Installation and maintenance of ultrasound machine	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

MEDICAL IMAGING EQUIPMENT Course Code : 315344

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe the concept of nuclear medicine and nuclear imaging techniques. TLO 5.2 Explain the concept of radiation detection. TLO 5.3 Describe the principle of thermography machine and advanced technology in thermography machine. TLO 5.4 List the types of image tracers in nuclear medicine(PET and SPECT). TLO 5.5 Differentiate between PET and SPECT. TLO 5.6 Enlist the procedural steps for installation and maintenance of thermography machine. TLO 5.7 Enumerate the safety protocols and regulatory standards related to imaging machines.	**Unit - V Advanced Nuclear Imaging Technique** 5.1 Concept of nuclear medicine, radioactive Tracers 5.2 Nuclear imaging principle, radio isotope, gamma camera 5.3 Advanced technology in radiation detection, scintillation counter, Geiger Muller tube 5.4 Thermography machine, principle and block diagram, advanced technology in thermography machines, high-resolution thermal sensors, multi-spectral and hyper-spectral imaging 5.5 Positron emission tomography (PET) scan purpose, procedure and risk involved 5.6 Single photon emission computed tomography (SPECT) scan, purpose, procedure and risk involved, SPECT scan versus PET scan 5.7 Installation and maintenance of thermography machine 5.8 Safety protocols and regulatory standards related to imaging machines 5.9 Methods of radioactive waste disposal	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the components and controls of the X-ray machine.	1	*Functionality of the X-ray machine	2	CO1
LLO 2.1 Determine exposure factors (KVp, mAs) based on body part and patient size.	2	Determination of X-ray parameters	2	CO1
LLO 3.1 Identify the radiation dose and safety aspects of X-ray.	3	*Radiation safety considerations for X-ray machine	2	CO1
LLO 4.1 Check the performance of digital radiographic detectors.	4	Performance of digital radiographic detectors	2	CO2
LLO 5.1 Identify the fluoroscopy system components and controls. LLO 5.2 List the steps of operating procedure of fluoroscopy machine.	5	*Performance of fluoroscopy machine	2	CO2
LLO 6.1 Identify the CT scanner components and controls LLO 6.2 List the steps of operating procedure of CT scanner.	6	*Demonstration of CT scanner	2	CO3
LLO 7.1 Identify the step by step procedure of troubleshooting and maintenance of CT machine.	7	Fault finding in CT scanner	2	CO3
LLO 8.1 Identify the MRI machine components and controls. LLO 8.2 Follow the steps of operating procedure of machine.	8	*Demonstration of MRI	2	CO3
LLO 9.1 Identify the step-by-step procedure of troubleshooting and maintenance of MRI machine.	9	Fault finding in MRI machine	2	CO3
LLO 10.1 Identify the angiography techniques. LLO 10.2 List the parts of machine and the steps for maintenance and troubleshooting.	10	*Angiography techniques	2	CO3
LLO 11.1 Identify the parts of ultrasound machine. LLO 11.2 Set up the ultrasound image machine as per user and lab requirement.	11	* Demonstration of ultrasound machine	2	CO4
LLO 12.1 Identify the types of different ultrasonic probes. LLO 12.2 Observe how the various types of ultrasound probes are used to image different anatomy.	12	Demonstration of ultrasonic probes	2	CO4
LLO 13.1 Identify the step by step procedure of troubleshooting and maintenance of ultrasound machine.	13	Fault finding in ultrasound machine	2	CO4
LLO 14.1 Identify thermography machine components, controls, and safety features.	14	*Performance of thermography machine	2	CO5
LLO 15.1 Observe the functioning of PET imaging scan machine.	15	Demonstration of PET	2	CO5
LLO 16.1 Observe the functioning of SPECT imaging machine.	16	Demonstration of SPECT	2	CO5

MEDICAL IMAGING EQUIPMENT			Course Code : 315344	
Practical / Tutorial / Laboratory Learning Outcome (LLO)	**Sr No**	**Laboratory Experiment / Practical Titles / Tutorial Titles**	**Number of hrs.**	**Relevant COs**

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Design and build timer circuit for X-ray machine.
- Prepare the chart of fault finding of X ray machine.
- Detect the faults and troubleshooting of CT machine.
- Conduct an experiment comparing different types of ultrasound gels in terms of conductivity, viscosity, and imaging clarity.

Assignment

- Discuss the physiological principles and mechanism of X-ray machine.
- Identify the faults in digital radiography.
- Compare the radiography and fluoroscopy.
- Describe the different magnets in MRI machine.
- Prepare maintenance and troubleshooting chart of angiography machine.
- Standards (National / International) survey: Candidate should collect information of different standards with specifications related to medical imaging equipment.

Visit

- Student should visit the general hospital and diagnostic center.
- Explore internet and visit websites of manufacturers of medical imaging instruments to collect specifications and details of their products and prepare a comparative report of instruments of different makes.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Demo model of X-ray machine	1,2,3
2	Demo model of angiography machine	10
3	Demo model of ultrasound scanner	11,12,13
4	Demo model of thermography machine	14
5	Demo model of PET machine	15
6	Demo model of SPECT machine	16
7	Demo model of digital radiography machine	4
8	Demo model of fluoroscopy machine	5
9	Demo model of CT machine	6,7
10	Demo model of MRI machine	8,9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	X-ray Machine and Radiation Safety	CO1	12	2	6	6	14

MEDICAL IMAGING EQUIPMENT **Course Code : 315344**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
2	II	Digital Radiography and Fluoroscopy	CO2	12	2	6	6	14
3	III	CT and MRI	CO3	14	4	6	6	16
4	IV	Ultrasound Imaging	CO4	10	4	4	4	12
5	V	Advanced Nuclear Imaging Technique	CO5	12	4	4	6	14
		Grand Total		**60**	**16**	**26**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will considered for out of 30
- For formative assessment of laboratory learning 25 marks
- Each practical will be assessed considering 60%weightage to process,40% weightage for product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	2	1	1	2			
CO2	3	1	-	2	1	1	2			
CO3	3	1	1	2	1	1	2			
CO4	3	1	1	2	1	1	2			
CO5	3	1	-	2	1	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dance, D.R.; Christofides, S; Maidment A.D.A, McLean I.D,Ng K.H.	Diagnostic Radiology Physics Handbook for Teachers and Students	IAEA Publications, ISBN: 978-921310101
2	Khandpur, R.S.	Handbook of Biomedical Instrumentation	Tata McGraw Hill, New Delhi, ISBN: 978-9339205430
3	Hendee, William R.; Ritenour, Russell E	Medical Imaging Physics	Wiley-Liss Publication, ISBN: 978-0471382263
4	Anandanatarajan, R.	Biomedical Instrumentation and Measurement	Prentice Hall of India, ISBN: 978-8120352155
5	Chatterjee, Shakti; Miller, Aubert	Biomedical Instrumentation Systems	Cengage Learning, ISBN: 978-8131519530

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://atelearning.com/XRLab/presentation_4/index.htm	X-ray
2	https://mediso.com/hungary/en/product/pre-clinical-products/nanoscanr-spectct	SPECT-CT
3	https://www.webmd.com/cancer/what-is-a-ct-scan	CT Scan
4	https://www.radiologyinfo.org/en/ctscan	CT Scan

MEDICAL IMAGING EQUIPMENT   **Course Code : 315344**

Sr.No	Link / Portal	Description
5	https://www.siemens-healthineers.com/en-in/computed-tomography/technologies-and-innovations/photon-counting-ct	Photon Counting CT
6	https://www.aapm.org/meetings/03am/pdf/9834-13948.pdf	Digital Fluoroscopy
7	https://www.youtube.com/watch?v=UncQJH9u4qg	Virtual Reality X-ray Training Simulation
8	https://www.youtube.com/watch?v=i-DETRMOgak	3T MRI
9	https://www.youtube.com/watch?v=6gtywzzWJVY	7T MRI
10	https://www.news-medical.net/health/Ultrasound-scans-is-there-a-difference-between-3D-and-4D-scans.aspx	Advanced Ultrasound as 3D and 4D
11	https://www.logic-fruit.com/blog/al-ml/ai-and-ml-based-image-processing/	AI and ML for Automated Image Analysis
12	https://eos.com/blog/multispectral-vs-hyperspectral-imaging/	Multi Spectral and Hyper Spectral Imaging

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 24/02/2025   **Semester - 5, K Scheme**

PHYSICAL THERAPY DEVICES AND MACHINES	Course Code : 315345

Programme Name/s	: Medical Electronics
Programme Code	: MU
Semester	: Fifth
Course Title	: PHYSICAL THERAPY DEVICES AND MACHINES
Course Code	: 315345

I. RATIONALE

Physical therapy devices and machines in healthcare industry helps the patient to manage pain, improve mobility and accelerate recovery from injuries or surgeries. These devices and machines are based on high frequency stimulations, heat radiations, ultrasound therapy and laser. This course deals with enhancing the skills required for the operation, maintenance and safety measures of these machine.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/ empolyer expected outcome through various teaching learning experiences:

"Troubleshoot physical therapy devices and machines."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use IR lamp, UV lamp and laser for targeted application.
- CO2 - Perform troubleshooting of traction and CPM machine for safe working.
- CO3 - Troubleshoot electrotherapy and SWD equipment.
- CO4 - Test performance of ultrasound therapy and ESU equipment.
- CO5 - Apply safety protocols and regulatory standards related to the physical therapy machines used in hospital environment.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315345	PHYSICAL THERAPY DEVICES AND MACHINES	PTM	DSC	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 1 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

PHYSICAL THERAPY DEVICES AND MACHINES   Course Code : 315345

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain importance of physical therapy. TLO 1.2 Enlist physiological effects of IR and UV radiations on human body. TLO 1.3 Describe working principle and use of IR and UV lamp with sketch. TLO 1.4 Explain the working principle of different types of Lasers with the help of sketches. TLO 1.5 Suggest medical applications of Laser in a given situation. TLO 1.6 Explain the benefits and contra-indications of cold and hot therapy on human body. TLO 1.7 Explain the benefits of negative pressure wound therapy.	**Unit - I Basics of Physiotherapy** 1.1 Physical therapy- Introduction and importance of it in healthcare industry 1.2 Concept of Infrared (IR) and Ultraviolet (UV) radiation and its physiological effects on human body 1.3 Working principle and use of IR and UV lamp 1.4 Introduction of Light Amplification by Stimulated Emission of Radiation (Laser)- Working and types-Ruby, Nd:YAG (neodymium-doped yttrium aluminum garnet), He-Ne, CO2 lasers 1.5 Medical applications of Lasers 1.6 Concept of cold and hot therapy- Physiological effects of cold therapy and their uses, contra-indications of cold therapy on human body, paraffin wax bath unit 1.7 Negative pressure wound therapy- Introduction, features, advantages and applications 1.8 Traditional Indian physiotherapy methods (IKS)- Yoga in physiotherapy, aurvedic message and heated message stones therapy (IKS-1 hour, no question in theory paper)	Lecture Using Chalk-Board Hands-on Video Demonstrations
2	TLO 2.1 Explain the function of different blocks and working principle of traction machine. TLO 2.2 Describe the functions of different parts of CPM machine. TLO 2.3 Select the relevant type of CPM machine for given patient condition. TLO 2.4 Explain the setting procedure for tilt table traction and CPM machine for different patient conditions. TLO 2.5 Interpret troubleshooting chart of traction and CPM machine.	**Unit - II Traction and CPM Machine** 2.1 Traction therapy machine-Need of traction machine, cervical and lumbar traction 2.2 Block diagram and working principle of traction machine 2.3 Continuous passive motion (CPM) therapy- Need and working principle of CPM machine 2.4 Types of CPM- Knee, wrist, elbow and shoulder CPM 2.5 Tilt table- Working and applications 2.6 Troubleshooting and upkeep of traction and CPM machine	Lecture Using Chalk-Board Hands-on Video Demonstrations
3	TLO 3.1 Enlist types and applications of different frequency currents used in electrotherapy. TLO 3.2 Explain the physiological effects of electric current on human body. TLO 3.3 Describe the function of different blocks and working principle of nerve and muscle stimulator. TLO 3.4 Explain the steps used for application of nerve and muscle stimulator. TLO 3.5 Explain the function of different blocks and working principle of SWD machine. TLO 3.6 Explain capacitive and inductive techniques of SWD with neat sketch. TLO 3.7 Prepare a document of technical specifications of nerve muscle stimulator and SWD machine. TLO 3.8 Interpret troubleshooting chart of nerve muscle stimulator and SWD equipment.	**Unit - III Electrotherapy and Diathermy** 3.1 Electrotherapy- Introduction of low, medium and high frequency currents used in electrotherapy, effects of electric current on nerve and muscles of human body 3.2 Block diagram and working principle of nerve and muscle stimulator 3.3 Application techniques of nerve and muscle stimulator 3.4 Concept of Short Wave Diathermy (SWD) and its effects on human body 3.5 Block diagram and working principle of SWD 3.6 Application techniques of SWD as capacitive and inductive field 3.7 Technical specifications and troubleshooting of nerve and muscle stimulator and SWD equipment	Lecture Using Chalk-Board Hands-on Video Demonstrations

PHYSICAL THERAPY DEVICES AND MACHINES | **Course Code : 315345**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Suggest therapeutic uses of ultrasound. TLO 4.2 Explain the block diagram and working of ultrasound therapy equipment. TLO 4.3 Select the type of electrode for given patient condition. TLO 4.4 Explain the methods of cutting and coagulation using relevant electrodes. TLO 4.5 Explain the working principle and function of different blocks of electro surgical unit. TLO 4.6 Prepare a document of technical specifications of ultrasound therapy equipment and electro surgical equipment and electrodes. TLO 4.7 Interpret troubleshooting chart of ultrasound therapy equipment and ESU machine.	**Unit - IV Ultrasound Therapy and Electrosurgical Unit (ESU)** 4.1 Ultrasound Therapy - Introduction, block diagram and working principle of ultrasound therapy equipment, therapeutic uses of ultrasound 4.2 Electrosurgical unit (ESU) - Block diagram and working principle, uni-polar and bipolar modes 4.3 Different types of cutting and coagulation electrodes 4.4 Methods of cutting and coagulation 4.5 Technical specifications and troubleshooting of ultrasound therapy equipment and electrosurgical equipment	Lecture Using Chalk-Board Hands-on Video Demonstrations
5	TLO 5.1 Describe the effect of electric shock on human body. TLO 5.2 Explain the specified electric hazard in hospital environment. TLO 5.3 Describe the specified step for testing the grounding system. TLO 5.4 Explain electro static discharge. TLO 5.5 Describe the different methods for accident prevention in hospital environment. TLO 5.6 Suggest patient safety measures in hospitals. TLO 5.7 Enlist regulatory standards in biomedical equipment safety.	**Unit - V Safety Protocols and Regulatory Standards** 5.1 Physiological effects of electric shock as a micro and macro on human body 5.2 Electric hazard in hospital environment and leakage current through equipment 5.3 Testing of proper grounding system in patient care area in hospitals 5.4 Concept of electro static discharge (ESD) 5.5 Concept of accident prevention in hospital environment 5.6 Patient safety 5.7 Regulatory standards in biomedical equipment safety	Lecture Using Chalk-Board Hands-on Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Use IR lamp for muscle relaxation. LLO 1.2 Use UV lamp for muscle relaxation. LLO 1.3 Use laser therapy equipment for muscle relaxation.	1	*Use of muscle relaxation devices	2	CO1
LLO 2.1 Select relevant cold therapy techniques for reducing pain and swelling. LLO 2.2 Perform relevant cold therapy techniques for reducing pain and swelling.	2	Cold therapy techniques	2	CO1
LLO 3.1 Set up the negative pressure wound therapy machine around wound location. LLO 3.2 Operate negative pressure wound therapy machine.	3	Negative pressure wound therapy	2	CO1
LLO 4.1 Prepare set up for cervical traction. LLO 4.2 Operate traction unit for cervical traction.	4	*Operation of traction unit for cervical traction	2	CO2
LLO 5.1 Prepare set up for lumbar traction. LLO 5.2 Operate traction unit for lumbar traction.	5	Operation of traction unit for lumbar traction	2	CO2
LLO 6.1 Prepare set up for knee continuous passive motion (CPM) therapy machine. LLO 6.2 Operate the CPM therapy machine.	6	*Knee therapy using continuous passive motion (CPM)	2	CO2
LLO 7.1 Prepare set up for wrist continuous passive motion (CPM) therapy machine. LLO 7.2 Operate the CPM therapy machine.	7	Wrist therapy using continuous passive motion (CPM)	2	CO2
LLO 8.1 Determine the effect of electric current on nerves and muscle using of electrotherapy machine.	8	*Effect of electric current by use of electrotherapy machine	2	CO3
LLO 9.1 Draw the different types of waveforms of nerve muscle stimulator using CRO.	9	Types of waveforms of nerve muscle stimulator	2	CO3

PHYSICAL THERAPY DEVICES AND MACHINES | **Course Code : 315345**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Place electrodes of short wave diathermy machine at appropriate position on human body. LLO 10.2 Test the performance of short wave diathermy machine and various controls.	10	*Performance of short wave diathermy machine and various controls	2	CO3
LLO 11.1 Select relevant application technique of short wave diathermy as per given condition. LLO 11.2 Demonstrate the use the capacitive and inductive method as application techniques of short wave diathermy.	11	Application techniques of short wave diathermy	2	CO3
LLO 12.1 Operate ultrasound therapy machine and test its control.	12	*Operation of ultrasound therapy machine	2	CO4
LLO 13.1 Select relevant types of electrode used in electrosurgical unit as per given condition. LLO 13.2 Observe the performance of selected electrode using electrosurgical unit.	13	Performance of electrode using electrosurgical unit	2	CO4
LLO 14.1 Operate the ESU machine in different modes and observe its waveforms.	14	*Operation of ESU machine	2	CO4
LLO 15.1 Check grounding system of the laboratory.	15	*Measure the earthing resistance to verify grounding system of the laboratory	2	CO5
LLO 16.1 Identify regulatory standards in biomedical equipment safety.	16	Prepare report on regulatory standards in biomedical equipment safety	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Design a circuit for IR lamp and test it.
- Design the nerve muscle stimulator circuit and test it.
- Test for proper earthing /grounding in labs and prepare report of it.
- Design and create a simple, homemade physiotherapy tool.
- Develop a care and maintenance guide for a specific piece of physiotherapy equipment available in the laboratory.

Assignment

- Draw and explain block diagram of ultrasound therapy machine.
- Explain working principle of IR lamp.
- State need of traction unit.
- List technical specifications of short wave diathermy machine.

Hospital visit

- Visit a nearby hospital and prepare the report on name of the equipment, manufacturer, cost, technical specifications of equipment. Also students may observe available physical therapy equipment and troubleshooting chart of available machine.

Prepare a chart

- Prepare a troubleshooting chart of diathermy machine.
- Identify the various types of electrodes use in electrosurgical unit and develop a chart.

PHYSICAL THERAPY DEVICES AND MACHINES | **Course Code : 315345**

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	IR Lamp: Power 200W, Voltage 110 or 220-230V, Frequency 50/60Hz, Cord-length 200cm	1
2	UV Lamp: Curing Width 50-1700mm, Lamp Housing: 300-1998mm, UV pulsing power-Up to 240W/cm, power of 15 W, wavelength of UV A spectrum (365 nm), length of 436 mm	1
3	Laser therapy equipment: Laser type-Semiconductor laser-Ga Al As, Laser probe-810 nm-300 mW pointed (module), 650nm-40mW pointed (module), 650nm-200mW cluster (diode), Treatment time-0-60 mins	1
4	Short Wave Diathermy Machine: Main Supply-220-240v/50hz, Operating Frequency-27.12 MHz,Wavelength-11 Meters, Rf Power Source-Triode Valve, Timer-Digital 0-99 Minutes With Auto Alarm,Weight-40 Kg, Dimension (LxWxH)- 41cm x 47cm x 89cm	10,11
5	Ultrasound Therapy Machine: Frequency 1MHZ and 3MHZ, Therapy modes Continuous/Pulsed, Pulse Settings/Hz 9 settings/100 HZ. Output power-0-3W/cm^2,Timer-0-60mins	12
6	Electrosurgical Machine: Pure cut- 400W a 500 ohms Blend I-230W at 300 ohms Blend II-180W AT 300 ohms Blend III-120W at 300 ohms Two Modes of Monopolar Coagulation Contact coagulation-100W at 300 ohms Spray coagulation- 80W at 500 ohms	13,14
7	Cold therapy and Hot therapy devices: Cold therapy device-Skin temperature control sensor of different sizes upto-10OC, cooling cuff and heads. Hot therapy device-Paraffin wax bath unit- Voltage-230V, Power-2000W, Tank capacity-30 litre, Heat transfer liquid-water 10 litre, Temp. range-30 to 95 OC	2
8	Negative pressure wound therapy machine: Material-ABS Plastic, Model Name/Number-VSP VAC IROX, Weight-2.5 Kg, Battery Back up-14 hrs, Dimensions-15 x 12 x 12 cm, Display-LCD	3
9	Traction unit(Cervical and lumbar): Traction force-3 Kg to 90 Kg (1 Kg step), Base force-2 Kg to 85 Kg (1 Kg step), Traction mode - Cervical and Lumber, Treatment time - 01 to 99 min (1 min step), Hold time-01 to 99 sec (1 sec step), Rest time-01 to 99 min (1 sec step), Traction speed-5 speed, Progressive step-1 to 10 step (max)	4,5
10	CPM unit (Knee and wrist): Dimension (L*H*D)-1100 mm, 224 mm, 185mm, Weigh-16Kg. Approx., Operating Voltage-220V AC 50Hz, Absorption 60-Watts Max., Fuses- 1 Amp, Room Temperature-10°C to 40°C, Moisture-10% to 80%, Notation Range-10° to 120°, Digital Timer- 01 ~ 99 Minutes Adjustable	6,7
11	Nerve Muscle Stimulator: 4 Channel, 8 Electrodes; Modes- Continuous, Burst. Ramp. Wide Low Freq, Narrow Low Freq. Auto All; Pulse width- 50-350 µS. (10 µs/step); Pulse rate- 1-200 Hz; Contraction Time: 6 sec, 9 sec. Relaxation Time- 2 sec., 3 sec., 4 sec; Waveform: Symmetrical biphasic square pulse; Timer: 1-60 min. (1 min./step)	8,9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Basics of Physiotherapy	CO1	14	4	6	6	16
2	II	Traction and CPM Machine	CO2	12	4	6	6	16
3	III	Electrotherapy and Diathermy	CO3	12	4	4	6	14
4	IV	Ultrasound Therapy and Electrosurgical Unit (ESU)	CO4	12	4	6	6	16
5	V	Safety Protocols and Regulatory Standards	CO5	10	2	2	4	8
		Grand Total		**60**	**18**	**24**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

PHYSICAL THERAPY DEVICES AND MACHINES | **Course Code : 315345**

- Two offline unit tests of 30 marks and average of two-unit test marks will be consider for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	-	2	2	-	2			
CO2	3	2	2	2	2	1	2			
CO3	3	2	2	2	2	1	2			
CO4	3	2	2	2	2	1	2			
CO5	3	2	2	2	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Khandpur, R.S.	Handbook of Biomedical Instrumentation	McGraw Hill Education, Third Edition, ISBN: 9789339205430
2	Nigel, Angela Forster	Clayton's Electrotherapy	Bailliere Tindall, London, Ninth Edition, ISBN: 9780702011009
3	Anandnatrajan, R.	Biomedical Instrumentation and Measurement	Prentice Hall of India pvt. Ltd, Second Edition, ISBN: 9788120352155
4	Webster, John	Medical Instrumentation Application and Design	Wiley, Fourth Edition, ISBN: 9780471676003
5	Carr, Joseph, Brown, John M.	Introduction to Biomedical Equipment Technology	Pearson India, Fourth Edition, ISBN: 9788177588835
6	Chatterjee, Shakti	Biomedical Instrumentation Systems	Cengage Learning, ISBN: 9788131519530

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.healthline.com/health/diathermy#risks5	Basic Concept of Diathermy
2	https://www.sportsinjuryclinic.net/treatments-therapies/ultrasound-therapy	Ultrasound Therapy
3	https://www.physio-pedia.com/Infrared_Therapy	Infrared Therapy
4	https://www.physio-pedia.com/Ultraviolet_Therapy	Ultraviolet Therapy
5	https://www.physiotattva.com/therapies/laser-therapy	Laser Therapy
6	https://www.steris.com/healthcare/knowledge-center/therapeutic-endoscopy/electrosurgery-what-is-it-types-benefits	Electrosurgery

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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Programme Name/s	: Medical Electronics
Programme Code	: MU
Semester	: Fifth
Course Title	: ICU EQUIPMENT AND MAINTENANCE
Course Code	: 315346

I. RATIONALE

Intensive Care Units (ICUs) in hospitals are equipped with a wide range of critical equipment including life support systems and patient monitoring devices. In addition to these equipment, it is necessary that the bio medical waste generated from the ICU and other places should be handled and managed using appropriate devices and equipment. This course provides skills and knowledge of operational principles, modes and technical specifications of these equipment and checking their functionality for their proper upkeep and maintenance.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/ empolyer expected outcome through various teaching learning experiences:

"Check functionality of ICU equipment and bio-waste management equipment to ensure their upkeep and maintenance."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify relevant ICU equipment, maintenance policies, bio waste management and treatment technique.
- CO2 - Test the performance of pacemaker and defibrillator.
- CO3 - Test the performance of various types of respiratory support equipment and devices.
- CO4 - Check the performance of life support equipment.
- CO5 - Rectify faults of patient monitoring equipment.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315346	ICU EQUIPMENT AND MAINTENANCE	ICU	DSC	3	-	4	1	8	4	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the layout of specified intensive care unit with sketch. TLO 1.2 Describe the maintenance procedures and policies used for ICU equipment. TLO 1.3 Explain the biomedical waste management process with the help of flow chart. TLO 1.4 Classify the given biomedical waste. TLO 1.5 Explain the waste tratment/disposable technology for given biomedical waste considering the handling rules. TLO 1.6 Comment on safety and precautionary measures used for waste management.	**Unit - I Intensive Care Unit and Biomedical Waste Management** 1.1 Variety of instruments used in Intensive Care Unit (ICU) of the hospital, Concepts of NICU, ICU, ICCU and their layouts 1.2 Troubleshooting and maintenance procedures for ICU equipment – Schedule and corrective maintenance, Levels of maintenance, Identify types of maintenance, Mention steps involved in: daily maintenance, Weekly maintenance, monthly maintenance, quarterly maintenance, six monthly maintenance and yearly maintenance, Knowledge of codes and standards 1.3 Biomedical waste management Process- Waste collection,segregation, transportation and storage, treatment and disposal 1.4 Classification of biomedical waste- Pathological, microbiological, radiological and chemical waste 1.5 Biomedical waste treatment and disposal- Incineration technology, non-incineration technology, autoclaving, microwave irradiation, chemical methods, plasma pyrolysis 1.6 Biomedical waste Handling rules-1998 and its amendment thereafter	Video Demonstrations Lecture Using Chalk-Board Site/Industry/Hospital Visit
2	TLO 2.1 Explain the need and function of different types of pacemaker with the help of neat sketch. TLO 2.2 Describe the procedure to use leads in pacemaker. TLO 2.3 Explain types of pacing modes and different types of pacemakers. TLO 2.4 Prepare the technical specifications of the specified type of pacemaker. TLO 2.5 Mention maintenance steps for internal and external pacemaker. TLO 2.6 Describe the function of specified section of defibrillator with simplified circuit diagrams. TLO 2.7 Explain with sketches the use of given type of modes of DC defibrillator and defibrillator electrodes. TLO 2.8 Describe the advantages of DC defibrillator. TLO 2.9 Explain with sketches the working principle and waveform of defibrillator along with its merits and demerits. TLO 2.10 Prepare the technical specifications of DC defibrillator. TLO 2.11 Mention maintenance steps for given DC defibrillator.	**Unit - II Circulatory Support Equipment - Pacemaker and Defibrillator** 2.1 Cardiac arrhythmias- Heart block and need of cardiac pacemaker 2.2 Pacemaker leads- Endocardial and myocardial 2.3 Types of pacing modes in pacemaker and different types of pacemakers such as internal, external, fixed, asynchronous, demand, synchronous and programmable pacemaker 2.4 Technical specifications of internal and external pacemaker 2.5 Steps for maintenance of pacemaker 2.6 Fibrillation of heart, need of defibrillator, types of defibrillator 2.7 Modes of defibrillator: asynchronous and synchronous, Defibrillator electrodes 2.8 Charging and discharging of DC defibrillator 2.9 Automated External Defibrillator (AED), biphasic and monophasic defibrillator 2.10 Technical specifications of DC defibrillator 2.11 Steps for maintenance of DC defibrillator	Video Demonstrations Lecture Using Chalk-Board Industry/Hospital visit

ICU EQUIPMENT AND MAINTENANCE   Course Code : 315346

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Describe with sketches the function of specified type of ventilator. TLO 3.2 Explain the specified measurable parameter related with respiratory system. TLO 3.3 Explain with sketches the working principle of nebulizer /anesthesia equipment, significance and overview. TLO 3.4 Describe with sketches the given mode of ventilator. TLO 3.5 List the technical specifications of given respiratory support equipment. TLO 3.6 State the important steps for maintenance of the given respiratory support equipment.	**Unit - III Respiratory Support Equipment** 3.1 Respiration and apnea, artificial ventilation, types of ventilator 3.2 Measurable parameters related to lung- Mean airway pressure, inspiratory pause time, tidal volume, minute volume, conventional mechanical ventilation, positive end expiratory pressure (PEEP) 3.3 Working principle of nebulizer, anesthesia apparatus and suction apparatus 3.4 Different modes of ventilator- Assist-control mode, spontaneous and mandatory mode 3.5 Technical specifications of ventilator, nebulizer, suction apparatus, anesthesia equipment 3.6 Troubleshoot and maintenance of given equipment	Video Demonstrations Lecture Using Chalk-Board Site/Industry/hospital Visit
4	TLO 4.1 Explain with sketch the need of specified life support equipment. TLO 4.2 Explain with sketches the working of specified type of dialyzer. TLO 4.3 Describe the process of temperature control in baby incubator with neat circuit diagram. TLO 4.4 List technical specifications of the given life support equipment. TLO 4.5 Mention important steps for maintenance of the given type of life support equipment.	**Unit - IV Life Support Equipment in ICU** 4.1 Concept and application of life support equipment- Heart lung bypass machine, oxygenator, artificial heart pump, intra-aortic balloon pump 4.2 Hemodialysis machine- Artificial kidney, types of dialyzers, parallel plate dialyzers, hollow fiber dialyzers and coil dialyzers 4.3 Baby incubator- Need of baby incubator, temperature control in baby incubator 4.4 Technical specifications of heart lung bypass machine, hemodialysis machine, baby incubator 4.5 Maintenance and troubleshooting of heart lung bypass machine, hemodialysis machine, baby incubator	Video Demonstrations Lecture Using Chalk-Board Industry/Hospital visit
5	TLO 5.1 Describe working principle of bedside monitor and central monitor system along with block diagram. TLO 5.2 Explain with sketches the function of the Cardiac monitor. TLO 5.3 Describe the function of specified block of programmable microprocessor based infusion pump along with the block diagram. TLO 5.4 State the technical specifications of given type of patient monitoring equipment. TLO 5.5 Mention maintenance steps and rectify faults of the given type of monitor.	**Unit - V Patient Monitoring System** 5.1 Concepts of patient monitoring system, need of bedside and central monitors 5.2 Cardiac monitor 5.3 Infusion pump, evolution levels in the control of drug delivery system, block diagram of programmable microprocessor based infusion pump 5.4 Technical specifications of bedside monitor, central monitor, cardiac monitor and infusion pump 5.5 Troubleshooting and maintenance procedure of bedside monitor, central monitor, cardiac monitor and infusion pump	Video Demonstrations Lecture Using Chalk-Board Industry/Hospital visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify various equipment used in intensive care units of hospitals. LLO 1.2 Identify the type of maintenance specified in maintenance policy for different ICU equipment.	1	*Identification of ICU equipment and their maintenance type	2	CO1
LLO 2.1 Simulate the collection and handling of bio waste processes.	2	Process of collection and handling of bio waste	2	CO1

ICU EQUIPMENT AND MAINTENANCE   **Course Code : 315346**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Practice the color code for the bio waste management in hospitals.	3	*Color coding for bio waste management in hospitals	2	CO1
LLO 4.1 Identify radiological waste material. LLO 4.2 Identify techniques for disposing radiological waste material.	4	Identification of radiological waste material disposal techniques	2	CO1
LLO 5.1 Perform analysis of various biochemical waste hazards on human health.	5	Analysis of various biochemical waste hazards on human health	2	CO1
LLO 6.1 Identify various care and maintenance procedures for microwave incineration equipment. LLO 6.2 Identify various care and maintenance procedures for ultrasound cleaner equipment.	6	Identification of maintenance procedure for microwave incineration and ultrasound cleaner equipment	2	CO1
LLO 7.1 Perform Incineration process for biomedical waste disposal.	7	*Incineration process for biomedical waste disposal	2	CO1
LLO 8.1 Perform sterilization of biomedical waste before disposal.	8	Sterilization of biomedical waste	2	CO1
LLO 9.1 Treat various biomedical waste using integrated microwave with inbuilt shredder equipment.	9	Treatment of various biomedical waste using integrated microwave with inbuilt shredder equipment	2	CO1
LLO 10.1 Operate plasma pyrolysis for disposal of biomedical waste.	10	Bio waste disposal using plasma pyrolysis	2	CO1
LLO 11.1 Test the performance of pacemaker for bradycardia. LLO 11.2 Test the performance of pacemaker for tachycardia.	11	*Determination of the pacemaker performance	2	CO2
LLO 12.1 Identify the myocardium electrodes employed in pacemaker. LLO 12.2 Identify the endocardium electrodes employed in pacemaker.	12	*Identification of the various electrodes employed in pacemaker	2	CO2
LLO 13.1 Test charging circuit in DC defibrillators. LLO 13.2 Test discharging circuit and energy control in DC defibrillators with instant and synchronous mode.	13	*Operation of DC defibrillator	2	CO2
LLO 14.1 Determine the performance of DC defibrillator for square wave and truncated wave.	14	Performance of DC defibrillator	2	CO2
LLO 15.1 Identify the Internal and external electrodes employed in defibrillator. LLO 15.2 Identify positioning of electrodes employed in defibrillator.	15	*Identification and positioning of electrodes in defibrillator	2	CO2
LLO 16.1 Troubleshoot the given problem in DC defibrillator. LLO 16.2 Rectify the problem for optimal performance.	16	*Fault diagnosis and maintenance of defibrillator	4	CO2
LLO 17.1 Use automated (advisory) external defibrillator.	17	Automated (advisory) external defibrillator	2	CO2
LLO 18.1 Determination of pneumatic flow system in ventilator. LLO 18.2 Determination of electronic control system in ventilator.	18	*Operation of ventilator equipment	2	CO3
LLO 19.1 Use nebulizer for instant drug delivery.	19	*Performance of nebulizer	2	CO3
LLO 20.1 Operate suction equipment to remove fluid and obstruction in given cavity.	20	*Operation of suction equipment	2	CO3
LLO 21.1 Operate the anesthesia apparatus. LLO 21.2 Prepare list of anesthetic agents.	21	Operation of anesthesia apparatus	2	CO3
LLO 22.1 Identify primary conditions of application of intra-aortic balloon pump. LLO 22.2 Demonstrate application of different techniques of intra-aortic balloon pump.	22	Use of Intra-aortic balloon pump	2	CO4

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 23.1 Troubleshoot the given problem in hemodialysis machine. LLO 23.2 Rectify the problem for optimal performance.	23	*Fault diagnosis and maintenance of hemodialysis machine	4	CO4
LLO 24.1 Plot characteristics of temperature control in baby incubator.	24	Temperature control in baby incubator	2	CO4
LLO 25.1 Measure different parameters of patient using bed side monitor. LLO 25.2 Rectify the faults occur in bed-side monitor.	25	*Troubleshooting of bedside monitor	2	CO5
LLO 26.1 Record multiple physiological parameters of multiple patients using central monitor.	26	*Recording of physiological parameters of different patients using central monitor	2	CO5
LLO 27.1 Rectify the given problem in bed-side monitor. LLO 27.2 Rectify the given problem in central monitor.	27	*Fault diagnosis and maintenance steps for bed-side monitor and central monitor	2	CO5
LLO 28.1 Operate infusion pump to deliver medicine. LLO 28.2 Identify different faults occurs in infusion pump. LLO 28.3 Rectify the fault occurred in infusion pump.	28	*Troubleshooting of an infusion pump for smooth operation	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Perpare a report for instruments used in the Intensive Care Unit of the hospital by using resources such as digital library, internet and specification sheets.
- Make comparative statements for different intensive care equipment and suggest the appropriate equipment
- Prepare a flow chart for the biomedical waste management process.
- Visit a hospital and prepare a report on the following basis

i) Name of equipment, manufacturer, and cost of the equipment.
ii) Location of the equipment
iii) Problems frequently encountered in various intensive care equipment.
iv) Maintenance strategies of intensive care equipment.

Micro project

- Draw a diagrammatic design/ model of an ideal Intensive Care Unit.
- i) Identify the component from the given intensive care equipment. ii) Check and replace the components.
- Design signal conditioning circuit for temperature control in baby incubator. Prepare a plan for the establishment of an Intensive Care Unit/baby incubator.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Pacemaker: Basic Pacing Rates 30 – 200 ppm, output amplitude Atrial: 0.1 – 20 mA, ventricular: 0.1 – 25 mA, sensitivity atrial: 0.4 – 10 mV, ventricular: 0.8 – 20 mV.	1,11,12
2	DC defibrillator : DC defibrillator is microcontroller based demo type - Rechargeable lithium ion battery; AC power using a protectively grounded outlet, display resolution 800 x 480 pixels (VGA), with 32 brightness levels per color, waveform biphasic truncated exponential waveform, electrodes-paddle and skin surface type of electrodes with handles.	1,13,14,15,16,17
3	Ventilator: Total Volume Adult: 250 ml - 1.6 Liter, pediatric: 50 ml - 300 ml, 40 bpm, inspiratory time - 0.4 3 Sec, expiratory time - 0.8 6 Sec, supply pressure - 280 - 700 KPa (45 - 100 psi), battery life for alarms - 60 days of regular use.	1,18
4	Nebulizer : Sample intake min. 25ulit/m, gas flow range 0.6-1.2 lit/min, maximum compressor pressure: 2.5 – 3.0 bar, nebulization rate: 0.3 ml/min, nebulizer cup capacity: 6 ml, particle size 0.5µm to 5µm, operation cycles: operation for 20 min & off for 40 min.	1,19
5	Suction machine: Power coated M.S. chassis, noise level of suction apparatus from is 50 dB +/-03 dB, leakage current of suction units is least than 84 uA, electrical requirement – 220 ~ 230V, 50Hz, 1 phase, ideal for MTP / medical / surgical procedures, rotary vane type vacuum pump with – 740 +/-10mm Hg, free air displacement 40 ~ 60 liters / min, heavy duty HN – 65 antistatic castors.320 Watt, 1440 RPM, 0.50 H. P., electric Motor. 100mm, vacuum gauge, non-collapsible silicon tubing, polycarbonate jars with overflow safety, bacterial filter fitted on top.	1,20
6	Anesthesia machine: Machine should be 3 gas delivery (O2, N2O and air) systems with pipeline connections and reserve cylinder yokes, 5 tubes rotameter assembly for O2, N2O and air, ring indexed pipeline fittings and gauges, overhead monitor shelf, 3 liters reservoir for O2, alarm for oxygen failure.	1,21
7	Intra-aortic balloon pump: Material-CS100, voltage-120 VAC, frequency-60 Hz, internal battery-24 VDC (nominal), 17.2 Amp-hour, 3 hours, modem data rate-9,600 baud, operating temprature-40 degree C, humidity-95%, weight-29.1 Kg.	1,22
8	Hemodialysis machine: Microcontroller based demo type (no dialysate and actual blood, blood is red color water); Dialysis pump, parasitic pump, dialyzer heater, temperature control, Indication LCD display, blood leak and air bubble detector.	1,23
9	Baby incubator: Microprocessor based servo controlled temperature system controlled mode, air temperature control range- 25°C-38°C, facilities for LED display for set temperature, air temperature, heating power, audio and visual alarm function for power failure, temperature deviation, over temperature, temperature sensor failure and fan failure, adjustable inclination of infant bed, second thermal cut-off function, humidity in two grades.	1,24
10	Bedside monitor: Parameters measured- ECG, RESP, type of display-LCD, display Size-Standard, 5 - 12 lead ECG, respiration, NIBP, SpO2 (Nellcor / Masimo), temperature, EtCO2 Micro stream, mainstream Etco2, analog output for ECG and IBP, 2 BP, cardiac output gas analysis (Artema).	1,25,26,27
11	Infusion pump: Flow rate range- 1-600ml/h , volume limit- 1-9999 ml, accuracy- ± 5? , power supply- AC - 230V, 50/60 Hz, display information- flow rate, volume limit, accumulated volume, power indicator light, maximum power consummation- 25W, alarm function- Infusion completion, air bubble, low battery.	1,28
12	Incinerator machine: Temperature-Up to 1200°C or as required, capacity-10 to 500 Kg / hour, burning efficiency-98%, noise-<78db, power-electric, chamber-single / dual chamber, body construction-mild steel, painted w/ heat resistant aluminum paint, safety alarm-yes, emergency vent-yes, monitoring device-graphic or computer recording / monitoring device, air pollution control device-yes.	2,6,7
13	Bio medical waste microwave disinfection system: Microwave medical waste disinfection system. Single phase, zero emission & solar empaneled green technology. CPCB approved technology for medical waste disinfection, size-10L,30L,60L,80L,100L,150L,200L,250L,300L,350L, material-SS ,capacity-10L,30L,60L,80L,100L,150L,200L,250L,300L,350L.	8
14	Integrated microwave with inbuilt shredder: Shredding capacity 1-500 kg/hr, capacity 10-150 Kg/hr, shredding machine type-double shaft, material-stainless steel, shredding material-high carbon high chrome spl steel.	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Intensive Care Unit and Biomedical Waste Management	CO1	8	2	6	4	12
2	II	Circulatory Support Equipment - Pacemaker and Defibrillator	CO2	12	4	6	10	20
3	III	Respiratory Support Equipment	CO3	8	2	6	4	12
4	IV	Life Support Equipment in ICU	CO4	10	4	4	6	14

ICU EQUIPMENT AND MAINTENANCE   **Course Code : 315346**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
5	V	Patient Monitoring System	CO5	7	2	4	6	12
		Grand Total		**45**	**14**	**26**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two-unit test marks will be considered for out of 30 marks.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering - 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	-	-	2	2	1	2			
CO2	3	2	1	2	2	1	2			
CO3	3	2	1	2	2	1	2			
CO4	3	2	1	2	2	1	2			
CO5	3	2	1	2	2	1	2			

Legends :- High:03, Medium:02, Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Khandpur, R.S.	Handbook of Biomedical Instrumentation	McGraw-Hill Publishing Company New Delhi, 2014 Third Edition, ISBN: 978-9339205430
2	Webster, John. G.	Medical Instrumentation Application and Design	Wiley India Pvt. Ltd, New Delhi, 2014, Fourth Edition, ISBN: 978-0471676003
3	Cromwell, Lesli P. Fred J. Weibell , Erich A. Pfeiffer	Biomedical Instrumentation and Measurements	Prentice Hall of India, New Delhi, 2014, ISBN: 978-8120306530
4	Carr, Joseph J.; Brown, J. M	Introduction to Biomedical Equipment Technology	Pearson Education Delhi, New Delhi, Fourth Edition, 2014, ISBN: 978-0130104922
5	Anandnatarajan, R.	Biomedical Instrumentation and Measurements	Prentice Hall of India, New Delhi, 2014, ISBN: 978-8120342279
6	Singh, Mandeep	Introduction to Biomedical Instrumentation	Prentice Hall of India, New Delhi, Second Edition, 2014, ISBN: 978-8120350236
7	Armugam, M.	Biomedical Instrumentation	Anuradha Publications, New Delhi, 2014, ISBN: 978-8187721123
8	Sharma, Madhuri	Hospital Waste Management and its Monitoring	Jaypee Brothers Medical Publishers, Second Edition, 2017, ISBN: 978-9386056788

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Sr.No	Author	Title	Publisher with ISBN Number
9	Singh, Anantpreet; Kaur, Sukhjit	Biomedical Waste Disposal	Jaypee Brothers Medical Publishers (P) Ltd., First Edition, 2012, ISBN: 978-9350255544
10	Gupta, Joydeep Das	Hospital Administration and Management	Jaypee Brothers Medical Publishers, Second Edition, 2015, ISBN: 978-9352501328
11	Chatterjee Shakti	Biomedical Instrumentation Systems	Cengage Learning, 2013, ISBN: 978-8131519530

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://vikaspedia.in/energy/environment/waste-management/bio-medical-waste-management/bio-medical-waste-and-its-segregation	Bio-medical Waste and its Segregation
2	https://www.analog.com/en/resources/technical-articles/guide-to-how-does-a-dialysis-machine-works.html	Introduction to Dialysis Machines
3	https://vikaspedia.in/energy/environment/waste-management/bio-medical-waste-management/treatment-of-bio-medical-waste	Treatment of Bio-Medical Waste
4	https://bmsp-coep.vlabs.ac.in/exp/defibrillator/	To Simulate Defibrillator
5	https://www.webmd.com/covid/coronavirus-ventilators	Working of a Ventilator
6	https://bmsp-coep.vlabs.ac.in/exp/pacemaker/	Simulation of Pacemaker
7	https://thedoctorpreneuracademy.com/wp-content/uploads/2022/03/medical-equiipment-maintainence-manual.pdf	Medical Equipment Maintenance Manual
8	https://bmsp-coep.vlabs.ac.in/exp/haemodialysis-machine/	Simulation of Haemodialysis Machine
9	www.esic.nic.in/Publications/MEMP070812.pdf	Medical Equipment Maintenance Policy

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 24/02/2025   **Semester - 5, K Scheme**

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS

Course Code : 314014

Programme Name/s	: Architecture Assistantship/ Automobile Engineering./ Agricultural Engineering/ Architecture/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Food Technology/ Instrumentation & Control/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Surface Coating Technology/ Textile Technology/ Travel and Tourism/ Textile Manufactures
Programme Code	: AA/ AE/ AL/ AT/ DC/ DD/ FC/ IC/ IS/ IX/ IZ/ ME/ MK/ ML/ MU/ PG/ PN/ SC/ TC/ TR/ TX
Semester	: Fourth / Fifth / Sixth
Course Title	: ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS
Course Code	: 314014

I. RATIONALE

Entrepreneurship and Startup is introduced in this curriculum to develop the entrepreneurship traits among the students before they enter into the professional life. By exposing and interacting with entrepreneurship and startup eco-system, student will develop the entrepreneurial mind set. The innovative thinking with risk taking ability along with other traits are to be inculcated in the students through micro projects and training. This exposure will be instrumental in orienting the students in transforming them to be job generators after completion of Diploma in Engineering.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

• Develop project proposals for launching small scale enterprises and starts up.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify one's entrepreneurial traits.
- CO2 - Use information collected from stakeholder for establishing/setting up/founding starts up
- CO3 - Use support systems available for Starts up
- CO4 - Prepare project plans to manage the enterprise effectively

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory				Based on LL & TL				Based on SL		
				CL	TL	LL					FA-TH	SA-TH	Total		Practical				SLA		
															FA-PR		SA-PR				
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314014	ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	EDS	AEC	1	-	2	1	4	2	-	-	-	-	-	50	20	25@	10	25	10	100

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

			Course Code : 314014

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Compare advantages and disadvantages of Entrepreneurship TLO 1.2 Identify entrepreneurial traits through self-analysis TLO 1.3 Compare risk associated with different type of enterprise	**Unit - I Introduction to Entrepreneurship Development** 1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global 1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure 1.3 Types of enterprises and their features : manufacturing, service and trading	Presentations Lecture Using Chalk-Board
2	TLO 2.1 Explain Important factors essential for selection of product/service and selection of process TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification. TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification. TLO 2.4 Plan a market study /survey for the specified enterprise	**Unit - II Startup Selection Process** 2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development 2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling. 2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis 2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC]	Presentations Lecture Using Chalk-Board
3	TLO 3.1 Explain categorization of MSME on the basis of turnover and investment TLO 3.2 Describe support system provided by central and state government agencies TLO 3.3 State various schemes of government agencies for promotion of entrepreneurship TLO 3.4 Describe help provided by the non-governmental agencies for the specified product/service TLO 3.5 Compute breakeven point, ROI and ROS for the specified business enterprise, stating the assumptions made	**Unit - III Support System for Startup** 3.1 Categorization of MSME, ancillary industries 3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP,DI, KVIC 3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance. 3.4 Breakeven point, return on investment (ROI) and return on sales (ROS).	Presentations Lecture Using Chalk-Board
4	TLO 4.1 Explain key elements for the given business plan with respect to their purpose/size TLO 4.2 Justify USP of the given product/ service from marketing point of view. TLO 4.3 Formulate business policy for the given product/service. TLO 4.4 Choose relevant negotiation techniques for the given product/ service with justification TLO 4.5 Identify risks that you may encounter for the given type of business/enterprise with justification. TLO 4.6 Describe role of the incubation centre and accelerators for the given product/service.	**Unit - IV Managing Enterprise** 4.1 Techno commercial Feasibility study, feasibility report preparation and evaluation criteria 4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project 4.3 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan. 4.4 Preparing strategies of handling business: policy making, negotiation and bargaining techniques 4.5 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, definition of startup cycle, ecosystem , angel investors, venture capitalist 4.6 Incubation centers and accelerators : Role and procedure	Presentations Lecture Using Chalk-Board

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 314014**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Collect information of successful entrepreneurial traits	1	*Preparation of report on entrepreneurship as a career	2	CO1
LLO 2.1 Identify different traits as an entrepreneur from various field LLO 2.2 Suggest different traits from identified problem	2	Case study on 'Traits of Entrepreneur'	2	CO1
LLO 3.1 Explore probable risks for identified enterprise.	3	*Case study on 'Risks associated with enterprise	2	CO1
LLO 4.1 Identify new product for development LLO 4.2 Prepare a newly developed product	4	*Preparation of report on 'Development of new Product'	2	CO1 CO2
LLO 5.1 Identify Process for development of product for new startup	5	Preparation of Report on ' Process selection ' for new startup	2	CO1 CO2 CO3
LLO 6.1 Develop questioner for market survey	6	*Market survey for setting up new Start up	2	CO2 CO3
LLO 7.1 Interpret the use of Technology Life Cycle	7	A Case study on ' Technology life cycle' of any successful entrepreneur.	2	CO3
LLO 8.1 Use information related to support of startups from Government and non-government agencies' LLO 8.2 Prepare report for setting up startup	8	*Preparation of report on 'Information for setting up new startup' from MCED/MSME/KVIC etc	2	CO3 CO4
LLO 9.1 Compute ROI of successful enterprise.	9	Case study on 'Return on Investment (ROI)'of any successful startup	2	CO3
LLO 10.1 Calculate of ROS of any successful enterprise	10	Case study on 'Return on sales (ROS)'of any successful startup	2	CO3
LLO 11.1 Calculate Brake even point of any enterprise	11	Preparation of report on 'Brake even point calculation' of any enterprise.	2	CO3 CO4
LLO 12.1 Prepare feasibility report of given business	12	*Preparation of report on 'feasibility of any Techno-commercial business"	2	CO4
LLO 13.1 Plan a USP of any enterprise.	13	*A case study based on 'Unique selling Proposition (USP) of any successful enterprise	2	CO4
LLO 14.1 Prepare a project report using facilities of Atal Incubation center.	14	*Prepare project report for starting new startup using 'Atal incubation center (AIC)	2	CO1 CO2 CO3 CO4

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare a ' Women entrepreneurship business plan ' Choose relevant government scheme for the product/service
- Prepare a 'Pitch- desk' for your start up
- Prepare a business plan for a. Market research b. Advertisement agency c. Placement Agency d. Repair and Maintenance agency e. Tour and Travel agency
- Prepare a 'Social entrepreneurship business plan, plan for CSR funding.
- Prepare a business plan for identified projects by using entrepreneurial eco system for the same (Schemes, incentives, incubators etc.)

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS	**Course Code : 314014**

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Computers with internet and printer facility	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Entrepreneurship Development	CO1	5	0	0	0	0
2	II	Startup Selection Process	CO2	4	0	0	0	0
3	III	Support System for Startup	CO3	3	0	0	0	0
4	IV	Managing Enterprise	CO4	3	0	0	0	0
		Grand Total		**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

Summative Assessment (Assessment of Learning)

- End of Term Examination - Viva-voce

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	2	2	2	-	-	3	2			
CO2	2	2	2	2	-	3	2			
CO3	2	2	2	2	-	3	2			
CO4	2	2	2	2	-	3	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Dr. Nishith Dubey, Aditya Vyas , Annu Soman , Anupam Singh	Un- boxing Entrepreneurship your self help guide to setup a successful business	Indira Publishing House ISBN-2023,978-93-93577-70-2
2	Gujral, Raman	Reading Material of Entrepreneurship Awareness Camp	Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad
3	Chitale, A K	Product Design and Manufacturing	PHI Learning, New Delhi, 2014; ISBN: 9788120348738

ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS **Course Code : 314014**

Sr.No	Author	Title	Publisher with ISBN Number
4	Charantimath, Poornima	Entrepreneurship Development Small Business Entrepreneurship	Pearson Education India, New Delhi; ISBN: 9788131762264
5	Khanka, S.S.	Entrepreneurship and Small Business Management	S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	http://www.mced.nic.in/allproduct.aspx	MCED Product and Plan Details
2	http://niesbud.nic.in/Publication.html	The National Institute for Entrepreneurship and Small Business Development Publications
3	http://niesbud.nic.in/docs/1standardized.pdf	Courses : The National Institute for Entrepreneurship and Small Business Development
4	https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530	Government Schemes
5	https://www.nabard.org/Tenders.aspx?cid=501andid=24	NABARD - Information Centre
6	http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action	Start Up India
7	http://www.ediindia.org/institute.html	About - Entrepreneurship Development Institute of India (EDII)
8	http://www.nstedb.com/training/training.htm	NSTEDB - Training

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 21/11/2024 **Semester - 4 / 5 / 6, K Scheme**

BIOMEDICAL SIMULATION SOFTWARE	Course Code : 315005

Programme Name/s	: Medical Electronics
Programme Code	: MU
Semester	: Fifth
Course Title	: BIOMEDICAL SIMULATION SOFTWARE
Course Code	: 315005

I. RATIONALE

This course offer students a risk-free environment where students can experiment without the ethical and practical concerns associated with working on live patients. This is particularly crucial in medical electronics, where the impact of interventions needs to be thoroughly understood before application in real-world scenarios. Biomedical simulation course help to bridge biology and electronics disciplines, providing students with a comprehensive understanding of how electronic devices interact with biological systems. Students can practice procedures and understand the operational aspects of medical devices, enhancing their readiness for real-world applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/ empolyer expected outcome through various teaching learning experiences:
Use simulation tools for biomedical applications.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use available EDA software employed in the area of biomedical engineering.
- CO2 - Use software commands to simulate basic electronic circuits used in biomedical equipment.
- CO3 - Use software commands to simulate signals from heart, brain and muscles and abnormalities.
- CO4 - Use software commands to simulate pacemaker and defibrillator signals.
- CO5 - Use software commands to simulate the respiration rate and blood pressure.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315005	BIOMEDICAL SIMULATION SOFTWARE	BSO	DSC	1	-	2	1	4	2	-	-	-	-	-	25	10	25@	10	25	10	75

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

BIOMEDICAL SIMULATION SOFTWARE | **Course Code : 315005**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the need of EDA tools in simulation software. TLO 1.2 List EDA tools used in Electronics along with their major features. TLO 1.3 Describe the applications of EDA tools. TLO 1.4 Use Multisim for designing and testing Electronics circuits.	**Unit - I Overview of Electronic Design Automation (EDA)Tools** 1.1 Need of simulation software 1.2 Basics of EDA tools 1.3 Available EDA tools 1.4 Features of EDA tools: MultiSIM, MATLAB, Scilab, LAB VIEW, NI Tools, Python 1.5 Application of EDA tools in different fields 1.6 MultiSIM for Electronic Circuits Applications	Lecture using Chalk-Board Presentations Video Demonstrations Hands-on
2	TLO 2.1 Describe the applications of EDA software in Biomedical field. TLO 2.2 Explain simple data flow in LabVIEW software. TLO 2.3 Identify software commands for biomedical simulation.	**Unit - II EDA Tools for Biomedical Simulations** 2.1 Applications of EDA tools in biomedical fields (LabVIEW, VI Tools, MATLAB, Scilab) 2.2 3D SSPP, BioSPy in Python (only demonstration) 2.3 Creating a simple VI (Virtual Instrument) , front panel (controls and indicators), simple block diagram (simple data flow) 2.4 Building simple biomedical simulation - ECG, EEG, EMG, Pacemaker, Defibrillators, respiration rate and blood pressure measrement	Lecture using Chalk-Board Presentations Video Demonstrations Hands-on

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Build graphical interface to simulate half wave rectifier circuit. LLO 1.2 Test the output of half wave rectifier circuit at different points.	1	* Half wave rectifier circuit simulation using available EDA software	2	CO1
LLO 2.1 Build graphical interface to simulate full wave rectifier circuit. LLO 2.2 Test the output of full wave rectifier circuit at different points.	2	Full wave rectifier circuit simulation using EDA tools	2	CO1
LLO 3.1 Develop GUI to simulate inverting and non inverting feedback OpAmp amplifiers.	3	OpAmp based Inverting and non inverting amplifier simulation	2	CO1
LLO 4.1 Calculate the body mass index for given height and weight.	4	Body mass index calculations for user entered values of height and weight	2	CO1
LLO 5.1 Implement software simulation of different filters.	5	* Low pass and band pass filter simulation for different input frequencies and amplitudes	2	CO2
LLO 6.1 Implement software simulation of instrumentation amplifier.	6	* Instrumentation amplifier simulation for different input waves	2	CO2
LLO 7.1 Build simulation environment for ECG wave pattern. LLO 7.2 Plot ECG wave pattern using simulation software.	7	ECG wave pattern simulation for different frequency and amplitude using python (demonstration only)	2	CO3
LLO 8.1 Make connections for different lead configurations on virtual lab platform. LLO 8.2 Simulate to observe wave pattern for ECG lead configurations on virtual lab platform.	8	* ECG wave pattern simulation for different lead configurations using virtual lab platform	2	CO3
LLO 9.1 Develop simulation environment to simulate EEG signal. LLO 9.2 Plot sound sleep pattern.	9	EEG simulation to generate sound sleep pattern	2	CO3
LLO 10.1 Observe wave pattern for EEG lead configuration on virtual lab platform. LLO 10.2 Identify various abnormalities associated with EEG.	10	* EEG wave pattern verification by selecting various lead configuations in different lobes using virtual lab platform	2	CO3
LLO 11.1 Create software environment to simulate EMG signals. LLO 11.2 Observe EMG patterns for normal and stretched muscle activity.	11	EMG pattern simulation for normal and stretched muscle activities	2	CO3
LLO 12.1 Observe synchronous and asynchronous wave patterns for pacemaker using virtual lab platform.	12	* Synchronous and asynchronous pacemaker wave patterns simulation on virtual lab platform	2	CO4

BIOMEDICAL SIMULATION SOFTWARE   **Course Code : 315005**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Create GUI to simulate DC defibrillator. LLO 13.2 Observe DC Defibrillator wave pattern.	13	DC Defibrillator wave pattern simulation	2	CO4
LLO 14.1 Generate GUI environment to simulate heart arrhythmia.	14	* Heart arrhythmia simulation to identify Bradycardia or trachycardia	2	CO4
LLO 15.1 Create GUI to simulate respiration rate.	15	*Simulate GUI of respiration rate for different conditions	2	CO5
LLO 16.1 Generate GUI environment to simulate blood pressure and wave pattern monitoring. LLO 16.2 Observe wave pattern of aortic and venous blood pressure during cardiac cycle.	16	Aortic and venous blood pressure simulation during cardiac cycle	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Develop graphical environment to simulate and plot different abnormalities in sleep wave patterns.
- Develop graphical environment to simulate and plot different abnormalities in ECG wave patterns.
- Develop graphical environment to simulate and test action and resting potentials.

Assignment

- Explain utilization of biomedical simulation software in medical image processing.
- Describe how software simulation can help in diagnosis and treatment of different diseases.
- Perform internet survey of different hardware simulators available for bio-signal analysis and explain their features.
- Explain different software tools used to simulate bio-signals.
- Explain different software commands/tools to create graphical user interface for simulation of different signals /wave patterns.
- Explain advantages of biomedical signal hardware and software simulators.
- Illustrate how biomedical simulation software can overcome artifacts in biomedical signal processing.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Software with required simulation framework like labVIEW, Matlab, Scilab, Python-BioSPPy, Python-Neurokit2, etc.	All
2	Virtual Platform	All
3	Computer System with all necessary Peripherals and Internet connectivity	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

BIOMEDICAL SIMULATION SOFTWARE									**Course Code : 315005**

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of Electronic Design Automation (EDA)Tools	CO1,CO2	7	0	0	0	0
2	II	EDA Tools for Biomedical Simulations	CO3,CO4,CO5	8	0	0	0	0
		Grand Total		**15**	**0**	**0**	**0**	**0**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- For summative assessment of laboratory learning 25 marks

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	1	2	-	-	2			
CO2	3	2	1	2	-	1	2			
CO3	3	2	1	2	1	1	2			
CO4	3	2	1	2	1	1	2			
CO5	3	2	1	2	1	1	2			
Legends :- High:03, Medium:02,Low:01, No Mapping: - *PSOs are to be formulated at institute level										

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Das,Vinu V.	Programming in Scilab 4.1	New Age Publication, New Delhi, 2014, ISBN:978-8122424713
2	Gupta, Sanjay, John, Joseph	Virtual Instrumentation Lab View	Mc Graw Hill Education, New Delhi, 2014, ISBN:978-0070700284
3	Jerome, Jovitha	Virtual Instrumentation	PHI Learning, New Delhi, 2014, ISBN 978-8120340305
4	Jain, Shailendra	Modeling and Simulation using MATLAB	Wiley, 2015, ISBN:978-8126551972
5	Chapman, Stephen J.	MATLAB Programming for Engineers	Cengage, Fourth Edition, 2020, ISBN: 978-9353502874

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://bmi-iitr.vlabs.ac.in/List%20of%20experiments.html	Bio-Medical Instrumentation Lab
2	https://bmsp-coep.vlabs.ac.in/List%20of%20experiments.html	Biomedical and Signal Processing Lab
3	https://www.mathworks.com/products/matlab-online	Matlab
4	https://scilab.in/Lab_Migration_Project	Scilab
5	https://biosppy.readthedocs.io/en/stable/	Biological Signal Processing in Python
6	https://www.tutorialspoint.com/matlab/	Matlab Tutorials
7	https://in.mathworks.com/discovery/matlab-gui.html	Matlab GUI
8	https://www.youtube.com/watch?v=j2fAWGtHvao	ECG signal Generation
9	https://www.youtube.com/watch?v=dzIKcDzaEK8	EEG Signal Generation

BIOMEDICAL SIMULATION SOFTWARE   **Course Code : 315005**

Sr.No	Link / Portal	Description
10	https://www.youtube.com/watch?v=l2rCLGsylgY	EMG Signal Processing
11	https://www.youtube.com/watch?v=tHGxV5rNoLI	EMG Signal Processing using Arduino
12	https://onlinecourses.nptel.ac.in/noc22_ge17/preview	Electrocardiogram - Interpretation and Application
13	https://pypi.org/project/neurokit2/	Python Toolbox for Neurophysiological Signal Processing

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MSBTE Approval Dt. 24/02/2025   **Semester - 5, K Scheme**

APPLICATIONS OF IoT	Course Code : 315347

Programme Name/s	: Instrumentation & Control/ Instrumentation/ Medical Electronics
Programme Code	: IC/ IS/ MU
Semester	: Fifth
Course Title	: APPLICATIONS OF IoT
Course Code	: 315347

I. RATIONALE

The Internet of Things (IoT) is a digital revolution that connects physical things, resulting in a massive network of intelligent systems. Internet of Things is revolutionizing industries and in our daily lives from smart homes to industrial automation, healthcare to agriculture. By combining IoT with cloud computing, AI, big data, and machine learning, it enables extraordinary capabilities. This course will prepare students to be acquainted with this technological transformation, with the ability to create and deploy advance smart IoT solutions.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

This course aims to attain the following industry/employer expected outcome through various teaching-learning experiences:
Implement IoT-based systems for various applications

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Describe the fundamental architecture of IoT.
- CO2 - Apply programming principles to develop basic IoT applications using the NodeMCU IoT platform.
- CO3 - Implement IoT communication for data handling.
- CO4 - Describe IoT-based application in given specific field.
- CO5 - Describe applications of the Internet of Medical Things (IoMT).

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315347	APPLICATIONS OF IoT	AOI	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

APPLICATIONS OF IoT   **Course Code : 315347**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the evolution of IoT. TLO 1.2 Describe the advantages, disadvantages and applications of IoT. TLO 1.3 Explain the architecture of IoT with a suitable diagram. TLO 1.4 Sketch a generic diagram of IoT.	**Unit - I Overview of IoT** 1.1 Definition of IoT, Evolution of IoT 1.2 Advantages, disadvantages and list the applications of IoT 1.3 Architecture of IoT with all associated components 1.4 Generic block diagram of IoT System 1.5 IoT Enabling Technologies: Big Data Analytics, Cloud computing, Wireless Sensor Networks, Embedded Systems	Video Demonstrations Lecture Using Chalk-Board Presentations Collaborative learning
2	TLO 2.1 Use of NodeMCU open-source IoT (Internet of Things) platform. TLO 2.2 Develop simple program using Arduino IDE. TLO 2.3 Describe working of IoT sources: sensors and actuators devices.	**Unit - II IoT Hardware Fundamentals with NodeMCU and Arduino IDE** 2.1 NodeMCU IoT platform: firmware, Wi-Fi, development board, NodeMCU ESP8266 development board pinout configuration, NodeMCU ESP8266 specifications and features, application of NodeMCU ESP8266 with Arduino IDE 2.2 Arduino Integrated Development Environment (IDE), Arduino IDE setup, creating, compiling and uploading programs from Arduino IDE to NodeMCU 2.3 Sensors: temperature sensor, humidity sensor, air quality sensor, light sensor, soil moisture sensor, accelerometer, gyroscopes, motion detector 2.4 Actuators: LED, relays, servo motor, DC motor	Lecture Using Chalk-Board Video Demonstrations Collaborative learning
3	TLO 3.1 Explain IoT communication protocols. TLO 3.2 Connect NodeMCU to Wi-Fi. TLO 3.3 Implement a web server using NodeMCU. TLO 3.4 Create a web page and control applications remotely. TLO 3.5 Implement data communication using MQTT. TLO 3.6 Describe basic methods of data handling in IoT. TLO 3.7 Describe in brief different IoT platforms. TLO 3.8 Explain IoT network technologies.	**Unit - III IoT Protocols and Standards** 3.1 Overview of IoT Communication Protocols: HTTP, MQTT, CoAP 3.2 Setting up Wi-Fi on NodeMCU: Wi-Fi libraries, code for connecting to Wi-Fi networks 3.3 Web server using NodeMCU 3.4 Web page on NodeMCU and control applications remotely 3.5 Data Communication using MQTT with NodeMCU: connecting to a broker, publishing and subscribing to topics 3.6 Basic data handling: collecting, sending, and receiving data using MQTT 3.7 Introduction to IoT platforms: AWS IoT, ThingSpeak, Google Cloud, Microsoft Azure IoT, Arduino cloud 3.8 Introduction to IoT network technologies: LoRa, NB-IoT	Video Demonstrations Lecture Using Chalk-Board Presentations Site/Industry Visit Collaborative learning
4	TLO 4.1 Explain the key applications of IoT in smart cities. TLO 4.2 Explain the key applications of IoT in smart Farming. TLO 4.3 Explain the key applications of IoT in Industrial automation.	**Unit - IV Applications of IoT** 4.1 Smart Cities: traffic management, smart lighting, waste management with conceptual diagram 4.2 Smart Farming: crop monitoring and irrigation systems with conceptual diagram 4.3 Industrial IoT (IIoT):predictive maintenance in manufacturing using IoT sensors to monitor equipment health and prevent failures with conceptual diagram	Video Demonstrations Lecture Using Chalk-Board Presentations Collaborative learning Site/Industry Visit

APPLICATIONS OF IoT			**Course Code : 315347**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Explain IoMT (Internet of Medical Things) key components. TLO 5.2 Describe various smart devices in IoMT. TLO 5.3 Describe the role of instrumentation in medical IoT applications. TLO 5.4 Explain the integration of IoT in medical devices. TLO 5.5 Explain autonomous IoT based medical monitoring system. TLO 5.6 Describe the impact of IoT on healthcare.	**Unit - V IoT in Medical Electronics and Instrumentation.** 5.1 Definition, Significance, working principle of IoMT with block diagram 5.2 Smart Devices in IoMT: Wearable devices(Fitness Tracker watch,ECG Monitor), Implantable devices (Cardiac-Pacemakers,Insulin Pumps,Smart Pills), Medical Imaging equipment (MRI), Smart bed and wheelchairs 5.3 Medical Instrumentation: Medical sensors (ECG sensor, Pulse Oximeter, Blood Pressure sensor, Glucometer) working principle and applications 5.4 Integrate medical sensors (ECG sensor, Pulse Oximeter, Blood Pressure sensor, Glucometer) with NodeMCU 5.5 Autonomous IoT based medical monitoring system: definition, conceptual diagram, working principle and application 5.6 Impact of IoT on Healthcare: benefits, challenges, and future trends	Video Demonstrations Lecture Using Chalk-Board Presentations Collaborative learning Site/Industry Visit

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the key components of the NodeMCU-ESP8266 development board. LLO 1.2 Establish a connection between the NodeMCU-ESP8266 and a computer using appropriate cables and drivers.	1	*NodeMCU-ESP8266 Hardware Overview and Computer Interface	2	CO1
LLO 2.1 Configure Arduino IDE for NodeMCU programming.	2	*Configuration of Arduino IDE for NodeMCU	2	CO2
LLO 3.1 Implement LED control using NodeMCU through simulation and practical application.	3	Software simulation and hardware implementation for LED control with NodeMCU	2	CO2
LLO 4.1 Control a automating electrical devices through simulation and practical application.	4	Control relay using NodeMCU and software simulation	2	CO2
LLO 5.1 Measure temperature and humidity using interface of DHT11/DHT22 sensors to NodeMCU.	5	*Interfacing DHT11/DHT22 sensors with NodeMCU for temperature monitoring	2	CO2
LLO 6.1 Monitor heart rate using a pulse sensor with NodeMCU.	6	Pulse sensor integration with NodeMCU to track heart rate	2	CO3
LLO 7.1 Display measured blood pressure using interface of BMP180 sensor with NodeMCU.	7	*Use BMP180 sensor with NodeMCU to measure blood pressure	2	CO3
LLO 8.1 Display measured oxygen saturation using MAX30100 sensor to NodeMCU.	8	Use MAX30100 Sensor with NodeMCU to measure oxygen saturation levels	2	CO3
LLO 9.1 Measure glucose level using glucometer interface with NodeMCU.	9	Gulcometer interface with NodeMCU to measure gulcose level	2	CO3
LLO 10.1 Configure NodeMCU to connect a Wi-Fi network and troubleshoot connectivity.	10	*Establishment of Wi-Fi network connectivity using NodeMCU	2	CO3
LLO 11.1 Use HTTP protocol to send sensor data from NodeMCU to a web server.	11	Web data transmission of sensor data to a web server	2	CO3
LLO 12.1 Set up MQTT communication to publish and subscribe to topics using NodeMCU.	12	Implement MQTT protocol on NodeMCU for data exchange	2	CO3
LLO 13.1 Configure ThingSpeak to log data from NodeMCU and view it online.	13	Cloud data storage and access with ThingSpeak	2	CO3
LLO 14.1 Control the intensity of an LED based on light levels detected by an LDR, with cloud integration.	14	*LED brightness control based on ambient light using LDR, NodeMCU, and cloud platform	2	CO4
LLO 15.1 Control a DC motor using NodeMCU with commands sent through a cloud platform.	15	*Cloud-controlled DC motor operation with NodeMCU	2	CO4
LLO 16.1 Design a remote patient monitoring system. LLO 16.2 Implement data acquisition and transmission for patient health parameters.	16	*Remote patient monitoring system	2	CO5

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
Note : Out of above suggestive LLOs -				

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- This list of suggestive microprojects are optional, as there is no SLA component and faculties may encourage students to perform any one of them.

1. Develop chart depicting IoT sensor used in sensors in the oil and gas industry
2. Design and develop, a smart home automation system with NodeMCU for remote device control.
3. Prepare a case study report on analyzing the implementation, benefits and challenges of IoT in smart cities with a focus on traffic management and smart lighting
4. Prepare a report on IoMT smart devices used in intelligent ICU autonomous patient monitoring (visit to nearby hospital)

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	20mm Light Dependent Resistor (LDR) sensor.	14
2	5v DC motor.	15
3	L298N dual H-bridge motor driver.	15
4	RGB LEDs.	3
5	5V, 10A 2-Channel relay interface board.	4
6	DHT11/DHT22 temperature and humidity sensor module.	5
7	Pulse sensor module.	6
8	MAX30100/MAX30102 pulse oximeter and heart rate Sensor.	6,8,9
9	BMP180 blood pressure sensor module.	7
10	NodeMCU-ESP8266 development board.	All
11	Arduino IDE software.	All
12	Jumper wire set M2M, M2F, F2F.	All
13	400 pin breadboard.	All

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Overview of IoT	CO1	10	4	4	4	12
2	II	IoT Hardware Fundamentals with NodeMCU and Arduino IDE	CO2	12	4	4	6	14
3	III	IoT Protocols and Standards	CO3	12	2	4	8	14
4	IV	Applications of IoT	CO4	12	2	4	8	14
5	V	IoT in Medical Electronics and Instrumentation.	CO5	14	2	6	8	16
		Grand Total		**60**	**14**	**22**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

• Two offline unit tests of 30 marks and average of two-unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

• End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1		2	2	3	1		1			
CO2	1	3	3	3	2	2	2			
CO3	1	3	3	3	2	2	2			
CO4	1	3	3	3	2	1	2			
CO5	1	3	3	3	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Raj Kamal	INTERNET OF THINGS Architecture and Design Principles	McGraw Hill Education (India) Private Limited ISBN-13: 978-93-5260-522-4 ISBN-10: 93-5260-522-5
2	Arshdeep Bahga, Vijay Madisetti,	Internet of Things – A hands-on approach,	VPT, 2014, ISBN 0996025510, 9780996025515
3	Sudip Misra, Anandarup Mukherjee, Arijit Roy	Introduction to IoT	Cambridge University Press, 2021,ISBN-110884295X, 9781108842952
4	Cuno Pfister	Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud 1st Edition	Make Community, LLC,ISBN-13 978-1449393571
5	B. Jayant Baliga and Rajkumar Buyya	Internet of Things (IoT): Principles and Paradigms	Elsevier ISBN: 978-0128117916
6	Khandpur R. S.	Medical Electronics and Instrumentation	McGraw-Hill Education ISBN: 978-0070587927
7	C. Raja Rao and G. K. Ananthasuresh	Principles of Medical Electronics and Bioengineering	Academic Press ISBN: 978-0123694461

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/106105166	Introduction to internet of things, IIT Kharagpur
2	https://www.linkedin.com/learning/learning-tinkercad/designing-a-circuit	Helps to create and simulate IoT circuits.
3	https://www.tutorialspoint.com/internet_of_things/index.htm	For IoT basics,hardware software,protocols,applications
4	https://www.coursera.org/specializations/internet-of-things	Offers a wide range of IoT and medical electronics courses from top universities and institutions.
5	https://infyspringboard.onwingspan.com/web/en/login	online platform for all courses

Note :

• Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

MECHATRONICS	Course Code : 315348

Programme Name/s	: Instrumentation & Control/ Instrumentation/ Medical Electronics
Programme Code	: IC/ IS/ MU
Semester	: Fifth
Course Title	: MECHATRONICS
Course Code	: 315348

I. RATIONALE

Mechatronics engineering is an interdisciplinary field of engineering involving mechanical, electronics, electrical, control and computer engineering to develop products, processes and systems with greater flexibility. This course aims to empower the diploma students for handling modern challenges in developing cognitive, psychomotor and affective domain skill sets for ensuring precise control, accuracy and reliability in the manufacturing process and other areas using mechatronics systems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:

"Maintain Mechatronics systems used in medical and industrial applications."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select sensors for real time applications of mechatronics system.
- CO2 - Interpret different mechatronics system.
- CO3 - Apply principle of pneumatic system for given application.
- CO4 - Apply principle of hydraulic system for given application.
- CO5 - Use mechatronics systems for industrial applications and medical applications.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme										Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory				Based on LL & TL				Based on SL		
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
315348	MECHATRONICS	MEC	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

MECHATRONICS   **Course Code : 315348**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe Mechatronics system architecture. TLO 1.2 Explain function of given type of sensors. TLO 1.3 Suggest suitable sensor for given application. TLO 1.4 Describe need for the signal conditioning circuits used in mechatronics system.	**Unit - I Introduction to Mechatronics System** 1.1 Mechatronics system - architecture, block diagram, function of each block, applications and introduction to Flexible Manufacturing System (FMS), Computer Integrated Machines (CIM) 1.2 Construction, operational principle and applications of proximity sensor - eddy current proximity sensors, photo electric sensors, optical encoders 1.3 Construction, operational principle and applications of velocity and motion sensors - pyro electric sensors, D.C tacho generator, incremental encoder sensor, acceleration sensors - capacitive MEMS, piezoresistive, piezoelectric, LVDT accelerometer 1.4 Construction, operational principle and applications of pressure sensors - strain gauge, manometers, torque sensors - rotary torque sensors, speed sensors - magnetoresistive, inductive 1.5 Signal conditioners - need of filters, isolators, amplifiers - fluid and optical, data converters	Presentations Video Demonstrations Hands-on
2	TLO 2.1 Draw block diagram and explain function of each block of mechatronics system. TLO 2.2 Describe working of electro - mechanical systems. TLO 2.3 Develop simple CNC programs for given problem. TLO 2.4 Troubleshoot given mechatronics system.	**Unit - II Basics of Mechatronics System** 2.1 Block diagram, applications of basic mechatronics system, analogy between mechanical system and electrical system - translational and rotational types 2.2 Electromechanical system components, function, working principle and applications 2.3 General configuration of Computer Numerical Control (CNC) system, advantages of CNC, part programming of CNC machines, G codes and M codes, simple CNC application programs, CNC drilling machine 2.4 Troubleshooting methods of mechatronics system - Sequential Function chart (SFC), Displacement step diagram (DSD)	Presentations Hands-on Site/Industry Visit
3	TLO 3.1 Describe working principle of given type of pneumatic system components. TLO 3.2 Describe working principle of pneumatic actuators. TLO 3.3 Explain working of given valve used in pneumatic system.	**Unit - III Pneumatic System and Actuators** 3.1 Basic pneumatic system components and circuits - air compressors, filters and regulators, air treatment, valves 3.2 Pneumatic actuators - working principle of linear actuators - single acting cylinder, double acting cylinder, rotary actuators - rotating vane, gear type and direction control valves -poppet valve, spool valve 3.3 Working principle of directional control valves and check valve, D.C valves - 2/2,3/2,4/2,4/3,5/2,5/3 used in pneumatics 3.4 Construction, working principle and symbol of shuttle valve, flow control valve, quick exhaust valve, A.C and D.C solenoid valve, Read switch 3.5 Features - advantages, limitations and applications of pneumatic system	Presentations Model Demonstration Video Demonstrations
4	TLO 4.1 Explain the working of given type of hydraulic system components. TLO 4.2 Explain the working principle of given type of hydraulic actuator. TLO 4.3 Describe working principle of given valve used in hydraulic system. TLO 4.4 Describe working principle of mechanical motion elements.	**Unit - IV Hydraulic System and Actuators** 4.1 Working of basic hydraulic systems components - Reservoir, hydraulic pumps, hydraulic motor, filters and pressure regulation 4.2 Principle of operation of linear actuators - single acting cylinder, double acting cylinder, rotary actuators - rotating vane, rack and pinion type 4.3 Principle of operation and application of mechanical motion elements - cams, gear, belt, rack and pinion and bearings 4.4 Working principle, construction and symbol of directional control valves - 3/2, 4/3 D.C valves used in hydraulic system 4.5 Working principle, construction and symbol of check valve, flow control and non return valve 4.6 Applications, advantages and limitation of hydraulic system	Video Demonstrations Presentations Model Demonstration

MECHATRONICS   **Course Code : 315348**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Describe with sketches the functions of the given element of the robotic systems. TLO 5.2 Explain with sketches the given degree of freedom for a robot. TLO 5.3 Explain with sketches the working of the antilock brake system. TLO 5.4 Describe the procedure to maintain mechatronics system for the specified application.	**Unit - V Mechatronics System Applications** 5.1 Block diagram and function of each component of Robotics system - sensors, drive system, control system, end effectors 5.2 Construction and degrees of freedom of cylindrical, spherical and cartesian robots and applications 5.3 Block diagram and working of Microcontroller based antilock brake system (ABS) 5.4 Basic concept, block diagram and significance of mechatronics in bio-medical field - Electrocardiogram (ECG), Electromyography system (EMG), Prosthetic Arm design 5.5 Basic concept, block diagram and significance of mechatronics in AGV (Automated Guided Vehicle)	Video Demonstrations Hands-on Presentations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different sensors used in robotic systems.	1	*Identification of various sensors used in robotic systems (Proximity, IR, PIR Sensor)	2	CO1
LLO 2.1 Use stroboscope sensor to measure speed of Motor.	2	Speed measurment of D.C servo motor using stroboscope sensor	2	CO1
LLO 3.1 Determine speed-torque characteristic of DC servomotor.	3	Determination of speed-torque characterstic of DC servo motor	2	CO1
LLO 4.1 Identify the different electronic components used in CNC machines.	4	Identification of electronic components used in machining centers (CNC, VMC, HMC)	2	CO2
LLO 5.1 Prepare manual part program of linear and circular interpolation function for the given turning job and simulate it by using simulation software.	5	*Manual part program of linear and circular interpolation function on CNC lathe	2	CO2
LLO 6.1 Perform loading and unloading of the given job on CNC lathe. LLO 6.2 Set the work zero co-ordinates for the given job. LLO 6.3 Measure the finished job using suitable measuring instrument.	6	Performance of linear and circular interpolation function on CNC lathe using G-codes	2	CO2
LLO 7.1 Perform loading and unloading of the given job on CNC lathe. LLO 7.2 Set the work zero co-ordinates for the given job. LLO 7.3 Measure the finished job using suitable measuring instrument.	7	Performance of linear and circular interpolation function on CNC lathe using M-codes	2	CO2
LLO 8.1 Prepare manual part program of linear and circular interpolation function for the given milling job and simulate it by using simulation software. LLO 8.2 Test the outcome of linear and circular interpolation function.	8	Manual part program of linear and circular interpolation function on CNC milling or VMC	2	CO2
LLO 9.1 Identify different servo components used in CNC lathe and CNC milling machines. LLO 9.2 Verify the applications of different servo components used in CNC machines.	9	*Demonstration of different servo components used in CNC machines	2	CO2
LLO 10.1 Use open source software to simulate the operation of pneumatic actuator.	10	*Sequence control of pneumatic actuators using fluidsim software.	2	CO3
LLO 11.1 Use electro-pneumatic trainer kit to operate double acting cylinder using solenoid valve.	11	Demonstration of double acting cylinder using trainer kit	2	CO3
LLO 12.1 Troubleshooting of mechatronics system using Sequential Function Chart.	12	*Troubleshoot given mechatronics system using SFC method.	2	CO3
LLO 13.1 Use open source software to simulate the operation of hydraulic actuator.	13	*Simulation of hydraulic actuator using any open source software	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 14.1 Use open source resources to familiarize the students with application of robot.	14	*Demonstration and visualization of cylindrical, spherical and cartesian robots	2	CO5
LLO 15.1 Use open source resources to familiarize the students with application of robot.	15	Demonstration of pick and place robot arm	2	CO5
LLO 16.1 Use open source resources to compare different types of links and joints used in robots. LLO 16.2 Identify different types of joints used in robots.	16	*Demonstration and visualization of different types of links and joints used in robots	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Design a microcontroller based robot arm to pick and place ferrous material from one place to another place (zero to 180 degree).

- Design a microcontroller based AVCS for speed control and mirror adjustment for car. (Use relevant speed measurement sensor for speed control and small D.C motor for mirror adjustment).

- Design a simple prototype model for Hydraulic system.

- Design a simple prototype model for Pneumatic system.

- Prepare a working model of Hydraulic crane using waste injections used by doctors.

- Prepare prototype working model of hydraulically operated hospital bed.

- Prepare visit report on Automobile vehicle cleaning service station to observe the hydraulic actuators and system used.

- Prepare a report on use of Pneumatic system used by dentist.

- Prepare a report of agricultural equipment working on Hydraulics and Pneumatics.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Models and charts of various sensors and actuators	1
2	Fluidsim Software	10
3	Pneumatic trainer with actual working components with air compressor, air filter and regulator	11
4	Stroboscope	2
5	DC servo motor demonstration setup	3
6	CNC Turning 250 with standard accessories and multi controller changing facility with simulated control panel and related software. Training or Productive type minimum diameter 25 mm, Length 120 mm with ATC along with essential accessories.	4,8

MECHATRONICS   **Course Code : 315348**

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
7	CNC Simulation software and control pads (CAMLAB CNC Software, MasterCAM/NXCAM/, DONC CNC machine simulator, PRO, SWANSOFT, CAPSMILL and CAPSTURN IN cam software, DONCMILL AND DONCTURNsoftware), CutViewer Turn& Mill, Sinewave Turn& Mill or equivalent simulationsoftware.	5,6,8,9,7
8	CNC Milling 250 with standard accessories and multi controller changing facility with simulated control panel and related software. Training or Productive type-X axis travel- 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, with ATC along withessential accessories	8
9	Windows 10 Home Intel Core i5 HDD Capacity 500 GB RAM 8 GB DDR3 18.5 inch Display, Dedicated Graphic Memory 512 MB, USB 1x3.0 Front 6 Back.	8,10,12,13,14,15,16

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Introduction to Mechatronics System	CO1	14	4	6	6	16
2	II	Basics of Mechatronics System	CO2	10	2	4	6	12
3	III	Pneumatic System and Actuators	CO3	14	2	6	6	14
4	IV	Hydraulic System and Actuators	CO4	12	4	6	4	14
5	V	Mechatronics System Applications	CO5	10	2	4	8	14
		Grand Total		**60**	**14**	**26**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

• Two offline unit tests of 30 marks and average of two-unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks. Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

• End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	1	-	1	-	2			
CO2	3	1	1	2	2	1	2			
CO3	3	2	2	1	2	1	2			
CO4	3	2	2	1	2	1	2			
CO5	3	2	2	1	2	1	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	M.D.Singh, J.G.Joshi	Mechatronics	Prentice Hall India Learning Private Limited, ISBN : 978-8120329867
2	William Bolton	Mechatronics	Pearson education, ISBN: 978-8131732533
3	Godfrey Onwubolu	Mechatronics: Principles and Applications	Elsevier Butterworth-Heinemann, ISBN: 978-0750663793

MECHATRONICS | **Course Code : 315348**

Sr.No	Author	Title	Publisher with ISBN Number
4	K.P. Ramachandran, G.K. Vijayaraghavan	Mechatronics: Integrated Mechanical Electronic Systems	Wiley India Pvt. Ltd, ISBN: 978-8126553143
5	Patranabis D.	Sensors and Transducers	PHI Learning Private Limited, ISBN: 978-8120321984

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/108108147	Sensors and actuators overview
2	https://instrumentationtools.com/pneumatic-training-course	Pneumatic System Components
3	https://archive.nptel.ac.in/courses/112/103/112103249/	Principle of Hydraulic machines and system
4	https://archive.nptel.ac.in/courses/112/105/112105211/	Computer numerical control of machine tools and processes
5	https://archive.nptel.ac.in/courses/112/101/112101304/	Design of Mechatronic system
6	https://pc-coep.vlabs.ac.in/exp/direct-single-acting-cylinder/procedure.html	Pneumatic System Components

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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Semester - 5, K Scheme

REHABILITATION ENGINEERING

Course Code : 315349

Programme Name/s	: Medical Electronics
Programme Code	: MU
Semester	: Fifth
Course Title	: REHABILITATION ENGINEERING
Course Code	: 315349

I. RATIONALE

Rehabilitation engineering deals with devices and systems that can assist individuals needs related with mobility, communication, hearing, vision, and cognition. These rehabilitation devices empower people in restoring physical and cognitive functions and assist them in carrying out day-to-day activities. This course will enable students to develop skills related to rehabilitation techniques, which is vital and an emerging field in biomedical engineering.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to attend following industry/employer excepted outcome through various teaching learning experiences:
"Apply rehabilitation engineering techniques for various disabilities."

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Select the appropriate rehabilitation for various disabilities.
- CO2 - Identify required orthosis as per the gait pattern.
- CO3 - Test the working of given type of prosthesis.
- CO4 - Test the performance and functionality of mobility aids.
- CO5 - Analyze posture and load for given situation.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Paper Duration	Assessment Scheme												Total Marks
				Actual Contact Hrs./Week			SLH	NLH			Theory				Based on LL & TL				Based on SL			
																Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
315349	REHABILITATION ENGINEERING	REN	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH- Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.

REHABILITATION ENGINEERING   **Course Code : 315349**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the concept of rehabilitation. TLO 1.2 Describe functions of rehabilitation team members. TLO 1.3 Explain the different approaches for rehabilitation care. TLO 1.4 Explain the concept of different types of rehabilitation- sensory rehabilitation, motor rehabilitation, cardiac rehabilitation, pulmonary rehabilitation, cerebral palsy rehabilitation.	**Unit - I Fundamental of Rehabilitation** 1.1 Introduction, concept and goals of rehabilitation, types of disability as per WHO 1.2 Rehabilitation team and functions 1.3 Different approaches for rehabilitation care: characteristics, advantages and disadvantages 1.4 Rehabilitation types- sensory rehabilitation, motor rehabilitation, cardiac, pulmonary and cerebral palsy rehabilitation	Lecture Using Chalk-Board Video Demonstrations
2	TLO 2.1 Interpret the given gait cycle. TLO 2.2 Classify orthosis on the basis of given aspects. TLO 2.3 Describe the principle of orthosis. TLO 2.4 List contraindications of orthosis. TLO 2.5 Specify the material and characteristics features of given orthosis. TLO 2.6 Explain the silent features of given spinal orthosis. TLO 2.7 Explain the silent features of given splint.	**Unit - II Orthotics** 2.1 Gait cycle, anatomical lever system, goniometer, foot switches, gyroscope 2.2 Definition, orthosis classification on the basis of function and anatomical area , principle of orthosis 2.3 Contraindications of orthosis 2.4 Lower limb orthosis- material and types of lower limb orthosis: foot orthosis, ankle foot orthosis, knee ankle foot orthosis, hip-knee ankle foot orthosis 2.5 Spinal orthosis- types: cervical, thoraco lumber sacral 2.6 Upper limb orthosis/splint - Static and dynamic types	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
3	TLO 3.1 Classify the prosthesis. TLO 3.2 Describe the role of given components of prosthesis. TLO 3.3 Describe the myoelectric prosthesis. TLO 3.4 Explain the silent features of given lower prosthesis. TLO 3.5 Describe the specified advanced prosthesis.	**Unit - III Prosthetics** 3.1 Concept of prosthesis, classification of prosthesis 3.2 Basic components of prosthesis and its role 3.3 Upper prosthesis - myoelectric prosthesis 3.4 Lower prosthesis - knee joint, jaipur foot 3.5 Advanced prosthesis- an intelligent prosthetic knee, hierarchically controlled prosthetic hand	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit
4	TLO 4.1 Explain the concept, function and criteria for selection of mobility aid. TLO 4.2 Describe with sketches the function of given mobility aid along with sketch. TLO 4.3 Describe with sketches the function of given part of wheelchair. TLO 4.4 Explain functional electrical stimulation. TLO 4.5 Explain motion analysis using selspot with neat sketch.	**Unit - IV Mobility Aids and Instruments** 4.1 Mobility aids – Concept, functions, criteria of selection 4.2 Walking frames, parallel bars, crutches, walking stick, tripods and quadripods 4.3 Wheel chair's parts and their functioning, powered wheel chair 4.4 Concept of functional electrical stimulation 4.5 Motion analysis- selspot	Lecture Using Chalk-Board Video Demonstrations Model Demonstration Site/Industry Visit
5	TLO 5.1 Describe rehabilitation robotics. TLO 5.2 Describe therapeutic robots. TLO 5.3 Describe the concept of upper limb rehabilitation exoskeleton robots. TLO 5.4 Describe the concept of lower limb rehabilitation exoskeleton robots. TLO 5.5 Explain concept of tele-rehabilitation. TLO 5.6 Explain ergonomics rehabilitation.	**Unit - V Advanced Rehabilitation Systems** 5.1 Rehabilitation robotics- assistive robotics, therapeutic applications 5.2 Upper limb rehabilitation exoskeleton robots (ULRERs), lower limb rehabilitation exoskeleton robots (LLRERs) 5.3 Concept of tele-rehabilitation 5.4 Ergonomics rehabilitation- Introduction to ergonomics, domains of ergonomics, principles of ergonomics	Lecture Using Chalk-Board Video Demonstrations Site/Industry Visit Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the different components of laser cane. LLO 1.2 Test the performance of laser cane.	1	*Performance of laser cane	2	CO1
LLO 2.1 Identify the different components of ultrasonic spectacles. LLO 2.2 Test the performance of ultrasonic spectacles.	2	Performance of ultrasonic spectacles/ glass	2	CO1

REHABILITATION ENGINEERING   Course Code : 315349

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Identify the different components of goniometer. LLO 3.2 Measure knee joint angle of an object by using goniometer. LLO 3.3 Measure elbow joint angle of an object by using goniometer.	3	*Measurement of joint angle using goniometer	2	CO2
LLO 4.1 Measure parameters related with motion of an object.	4	Motion by using a gyroscope	2	CO2
LLO 5.1 Measure gait step length, stride length, degree of toe out. LLO 5.2 Compare gait patterns with relevant standard.	5	*Determination of gait pattern	2	CO2
LLO 6.1 Identify the given types of orthosis. LLO 6.2 Identify different components of orthosis.	6	*Orthosis identification	2	CO2
LLO 7.1 Test the working of myoelectric prosthesis.	7	Performance of myoelectric prosthesis	2	CO3
LLO 8.1 Test the working of Intelligent prosthetic knee.	8	Performance intelligent prosthetic knee	2	CO3
LLO 9.1 Identify the different parts of jaipur foot. LLO 9.2 Make a model and design of jaipur foot.	9	*Critical observation of jaipur foot	2	CO3
LLO 10.1 Identify different parts of walking aid. LLO 10.2 Identify the various manufacturers of walking aids. LLO 10.3 Prepare specifications of mobility aid.	10	*Identification of walking aids	2	CO4
LLO 11.1 Identify different parts of manual wheel chair. LLO 11.2 Test the performance of manual wheel chair.	11	*Performance of manual wheelchair	2	CO4
LLO 12.1 Identify different parts of powered wheel chair. LLO 12.2 Test the performance of powered wheel chair.	12	Performance of powered wheel chair	2	CO4
LLO 13.1 Test the performance of selspot. LLO 13.2 Detect the movement by using selspot.	13	Performance of selspot	2	CO4
LLO 14.1 Identify the components of functional electrical stimulator. LLO 14.2 Test the functionality of electrical stimulator.	14	Functionality of electrical stimulator	2	CO4
LLO 15.1 Use relevant software to observe sitting and standing postures of body segments.	15	*Sitting and standing postures of body segments using software	2	CO5
LLO 16.1 Use relevant software to observe load analysis for the patient: a) when one hand to lean on a stick, b) when two hands to lean on a stick. LLO 16.2 Use relevant software to observe load analysis for the patient: a) when patient fully standing and using the stick, b) when patient fully standing and using the arm support walker.	16	Load analysis for the patient using software	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Do internet survey on suppliers of reputed manufacturers of rehabilitation aids to collect specifications and details of their products and prepare a comparative report.
- Visit rehabilitation centre. Prepare a report.
- Prepare a chart on gait cycle.
- Do internet survey on latest rehabilitation robot. Prepare a report.

Micro project

- Observe effect of toilet and shower chairs to reduce the stresses applied on body segments.
- Find moment analysis for patient seating on the manual wheelchair using relevant software.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII.   LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Laser cane: Laser light, ergonomic handle, adjustable length: can be adjusted from 31" – 40" using the push button for users from 5' – 6'1" tall, lightweight and stable, powered by AA batteries	1
2	Walking aids: Parallel bar- 6ft mirror, parallel bars 8*3*4, with gait matQuadripod :- four feet with extra-grip rubber ferrules for more stability, height adjustable, swan shaped, curved neck, max. capacity: 19.6st / 125kg, 2 base sizes Walking frame:- height: 528mm, length: 874mm,width: 596mm, product weight: 2025g, maximum user weight: 160kg (25st), height: 790 - 850mm (31 - 33½'),width: 570mm (22½'), depth: 540mm (21¼'), size: mediumTripod:-1 handle, with 1 shaft, 3 tips, and 3 ferrules, handle: should be covered with a durable material (e.g. nylon 6/6) which has good abrasion and hydrocarbon resistance. Double adjustment underarm crutch: - pair light aluminium alloy, center handgrip and washable cover 120-142 cm,weight 1 kg. max load 100 kg	10
3	Manual wheelchair: 3 or 4 wheels, folding/rigid frame, push handles, armrest, lightweight frame maximum product weight 16 kg complete - includes frame, wheels, castors, upholstery, wheel lock and footrests	11
4	Powered wheel chair: Driving range- 10-12 km (depends on speed, road condition and loading weight), maximum speed: 6 km/h, joystick: intelligent joystick, height between seat and ground: 48 cm, battery: 12 AH, overall size: 114x64x93.5 cm, seat width: (L) 45 x (W) 43 cm	12
5	Selspot: 16 cameras and 120 LEDs, multi lab is a high-level programming language that performs all of the calculations for angles, velocities, acceleration, moments, etc., and provides customized reports containing all of the information necessary for sophisticated motion analysis	13
6	Electrical stimulator: Output- asymmetrical or symmetrical biphasic voltage driven waveform, output amplitude- 10 to 100 ma, frequency- 20 - 60 hz in 5 hz steps, pulse width- 0 to 365 s, output time- 0.3 to 6 s, extension time: 0 to 2 s rising edge ramp time- 0 to 2 s, falling edge ramp time: 0 to 2 s. delay- 0 to 2 s, flexible triggering- heel rise or heel strike (foot switch on contralateral side) adaptive, fixed or no time out timing intelligent footswitch- the sensitivity adapts to the weight of the user, controls: easy to use amplitude control, test and pause switches low battery indication, exercise mode - on time: 1 to 20 s off time: 0 to 20 s ramp time- 0 to 6 s battery- pp3, standard 9v alkaline or rechargeable battery, weight (with battery): 112gm dimensions- 72 x 62 x 26 mm (excluding controls and belt clip)	14
7	Sitting and standing postures of body and load analysis software: 3DSSPP or any relevant software	15,16
8	Ultrasonic glasses for the blind - ultrasonic sensor, arduino UNO, buzzer, LED, battery	2
9	Goniometer: Inclinometer 360 degree, linear scale 30cm	3
10	Gait pattern measurement setup: Tape: 20 m and 30 m, scale: upto 30cm, goniometer- inclinometer 360 degree, linear scale 30cm	5
11	Orthosis : Cervical- soft collars- flexion / extension limited by 8-26%, lateral bending is limited by 8%, rotation is limited by 10-17%, Thoraco lumber sacral- fabric body belt and an aluminium back plate	6
12	Myoelectric prosthesis: Size : 7.25inch-8.25inch, wrist sizes: 45mm-54mm, maximum speed:220mm/s, grip strength:c.90N, maximum opening width:100mm, length: maximum upto 175mm, operating voltage: 7.2V DC	7
13	Prosthetic knee: Multi-speed ambulation, higher impact levels and heavier loads, geometric locking system, 30mm (13/16)	8
14	Jaipur foot: Micro-cellular rubber, cosmetic rubber compound, nylon cord rubber, trade rubber compound, cushion rubber compound, wooden keel with a connection bolt (foot); H.D.P.E. pipe, H.D.P.E. sheet, Jaipur foot, padeline sheet, leather straps (below-knee) Dimensions: 9.5-inch (foot), 9-inch (instep), 9-inch (ball girth), 21-inch (below-knee), 19.5-inch (maximum diameter)	9

IX.   SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamental of Rehabilitation	CO1	12	4	4	4	12
2	II	Orthotics	CO2	12	2	4	8	14

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Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	Prosthetics	CO3	12	4	4	6	14
4	IV	Mobility Aids and Instruments	CO4	16	4	8	8	20
5	V	Advanced Rehabilitation Systems	CO5	8	2	4	4	10
		Grand Total		**60**	**16**	**24**	**30**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two-unit test marks will be consider for out of 30 marks.
- For formative assessmant of laboratory learning 25 marks.
- Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks.
- End semester summative assessment is of 25 marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	1	2	-	2			
CO2	3	2	1	2	2	-	2			
CO3	3	2	1	2	2	-	2			
CO4	3	2	1	1	2	-	2			
CO5	3	1	-	2	3	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	S. Sundar	Textbook of Rehabilitation	Jaypee Brothers Medical Publishers, Fourth Edition, ISBN 978-8184487114
2	A. K. Agrawal	Essentials of Prosthetics and Orthotics	Jaypee Brothers Medical Publishers, (P) Ltd, First Edition, ISBN: 978-9350904374
3	Sashi S. Kommu (Ed.)	Rehabilitation Robotics	I-Tech Education and Publishing, ISBN: 978-3902613042
4	John Ebnezar	Essentials of Rehabilitation for Orthopedic Surgon	Jaypee Brothers Medical Publishers, First Edition, ISBN: 978-8180612718
5	Susan J. Hall	Basic Biomechanics	McGraw-Hill Education, Sixth Edition, ISBN: 978-0073376448
6	Clifford, Morgan; Richard, King; Weisz, John; Schopler, John	Introduction to Psychology	McGraw Hill Education, Seventh Edition ISBN: 978-0071347099
7	Peterson, Donald R.; Bronzino, Joseph D.	The Biomedical Engineering Handbook	CRC Press Inc Fourth Edition, ISBN: 978-1439825334

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description

REHABILITATION ENGINEERING | **Course Code : 315349**

Sr.No	Link / Portal	Description
1	https://www.nsec.ac.in/images/bme_Rehabilitation%20Engineering.pdf	Sensory and Motor Rehabilitation
2	https://www.ncbi.nlm.nih.gov/books/NBK558985/#:~:text=A%20goniometer%20is%20a%20device,joint%20plane%20are%20called%20goniometry	Goniometry
3	https://www.orthobullets.com/foot-and-ankle/12278/orthotics	Lower Limb Orthosis
4	https://www.physio-pedia.com/Introduction_to_Spinal_Orthotics	Spinal Orthosis
5	https://my.clevelandclinic.org/health/treatments/25252-splint	Splint
6	https://www.jaipurfoot.org/	Jaipur foot
7	https://www.physio-pedia.com/Prosthetic_Knees	Prosthetic Knees
8	https://www.armdynamics.com/research-and-technology/prosthetic-technology	Advanced Prosthesis
9	https://www.verywellhealth.com/parallel-bars-in-physical-therapy-5075725	Parallel-bars
10	https://www.medicalnewstoday.com/articles/318463#Types-of-mobility-aids	Mobility Aids
11	https://3dsspp.software.informer.com/download/	3DSSPP Software
12	https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBMA5301.pdf	Ergonomics & Rehabilitation
13	https://downloadmedicalbooks.wordpress.com/wp-content/uploads/2011/08/rehabilitation-robotics.pdf	Rehabilitation Robotics- Assistive Robotics, Therapeutic applications
14	https://www.researchgate.net/publication/365945127_Rehabilitation_Robotics_History_Applications_and_Recent_Advances	Rehabilitation Robotics: History, Applications, and Recent Advances

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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Semester - 5, K Scheme