Programme Name/s : Mechatronics

Programme Code : MK

Semester : Sixth

Course Title : MECHATRONICS IN HEALTH SERVICES

Course Code :

I. RATIONALE

Today the healthcare industry increasingly relies on sophisticated mechatronic systems for diagnosis, treatment, monitoring, and rehabilitation. This course is designed equip diploma students in mechatronics with specialized knowledge and skills to work with medical equipment and devices that incorporate mechatronic principles. T increasing adoption of automation, robotics, and smart systems in healthcare has created a demand for technicians who understand both the technical aspects of mechatro systems and the specific requirements of the healthcare environment, including safety standards, sterilization protocols and patient considerations.

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: Carry out repair and maintenance of medical equipment.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Use concept of AI, ML and IoT in health care service equipment and devices.
- CO2 - Rectify the faults in given primary health care device/s using troubleshooting chart.
- CO3 - Troubleshoot the given medical imaging machine.
- CO4 - Check the performance of infusion pump and MEMS drug delivery system.
- CO5 - Prepare a plan for use of robot/s in given medical situation.

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		To Ma
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
	MECHATRONICS IN HEALTH SERVICES	MHS	DSE	4	-	2	2	8	4	3	30	70	100	40	25	10	25#	10	25	10	17

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 Learnin Pedagogies.
1	TLO 1.1 Explain the various healthcare systems with its core functions, advantages and disadvantages. TLO 1.2 Interpret various healthcare facilities available in India: its funding, administration and delivery. TLO 1.3 Analyze given case on use of AI and ML in health services. TLO 1.4 Design a simple IoT application for a selected health service.	**Unit - I Introduction to health services** 1.1 Need of health services, Types of healthcare systems: primary, secondary, tertiary and quaternary. 1.2 Categories of healthcare facilities available in India: public and private sectors. 1.3 Role of technology in health services: Artificial Intelligence (AI), Machine Learning (ML) and Internet of Things (IoT).	Lecture Using Chalk Board Presentations Video Demonstratio
2	TLO 2.1 Illustrate Primary healthcare equipment. TLO 2.2 Explain Heart rate monitoring system. TLO 2.3 Calculate Body mass index. TLO 2.4 Explain functions of pulse oximeter and glucometer. TLO 2.5 Describe function of Blood pressure monitoring system and digital thermometer. TLO 2.6 Interpret troubleshooting chart for identification of fault in give equipment/device.	**Unit - II Primary healthcare equipment** 2.1 Primary healthcare equipment, Heart rate monitoring system: functional block diagram, working principle, advantages and applications. 2.2 Body mass index (BMI) measurement system and pulse oximeter: functional block diagram, working principle, advantages and applications. 2.3 Blood pressure monitoring system, glucometer and digital thermometer: functional block diagram, working principle, advantages and applications.	Lecture Using Chalk Board Presentations Video Demonstratio

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learnin Pedagogies.
3	TLO 3.1 Describe the physical properties of X-rays. TLO 3.2 Identify and describe the components of the given medical imaging machine (X-ray, CT scan and MRI machines). TLO 3.3 Explain the working principle of medical imaging machine (X-ray, CT scan and MRI machines). TLO 3.4 Describe the steps of installation of X-ray, CT scan and MRI machines. TLO 3.5 Describe with sketches the function of CT scan and MRI machine. TLO 3.6 Interpret troubleshooting chart for identification of fault in give medical imaging machine (X-ray, CT scan and MRI machines).	**Unit - III Medical Imaging Machines** 3.1 Block diagram of X-ray machine, control circuit for high voltage (KV), current (mA), exposure timer circuit. 3.2 Concept of mobile X-ray technology and dental X-ray machine, risk involved in X-ray machine 3.3 Basic principle of CT scan, block diagram of CT scan machine, parts of CT scan machine, clinical application 3.4 Magnetic resonance imaging(MRI): Principle, block diagram, types of magnets, biological effects of MRI imaging, function and applications of MRI system 3.5 Installation, maintenance and troubleshooting of X-ray machine, CT scan machine and MRI machine	Lecture Using Chalk Board Presentations Model Demonstratio Video Demonstratio Flipped Classroom Site/Industry Visit
4	TLO 4.1 Identify the components of the Drug delivery systems. TLO 4.2 Explain the function of infusion pump. TLO 4.3 Describe with sketches the function of Closed-Loop Control in Infusion System. TLO 4.4 Describe the function of given MEMS Drug delivery device. TLO 4.5 Examine the MEMS device for any visible defect, cracks, consistency and repeatability of actuator motion, and packaging.	**Unit - IV Automated drug delivery systems** 4.1 Major components: Transducers, logic unit and activating mechanisms. 4.2 Syringe pump: Working principle, function, applications. 4.3 Infusion pump: Implantable infusion system, closed-loop control in infusion systems. 4.4 Insulin pumps: Working principle, function, applications. 4.5 MEMS Drug delivery devices: A Miniaturized Wireless Micropump Enabled by Confined Acoustic Streaming	Lecture Using Chalk Board Presentations Video Demonstratio Site/Industry Visit
5	TLO 5.1 Describe role of robotics in health science TLO 5.2 Identify Rehabilitation robotics. TLO 5.3 Describe the working of robots used in hospital automation TLO 5.4 Explain concept of AI and robotics in diagnostic	**Unit - V Robotic in health science** 5.1 Role of robotics in health science: Advancements, applications, and future directions 5.2 Rehabilitation robotics- assistive robotics, therapeutic applications 5.3 Hospital automation: Disinfection robot (UV light robot), Pharmacy robot (Automate medication dispensing), Logistic robot (Transport supplies, lab samples). 5.4 AI and robotics in diagnostic: Robot-Assisted imaging Lab automation	Lecture Using Chalk Board Presentations Video Demonstratio 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.	Relevan COs
LLO 1.1 Enlist health care equipment. LLO 1.2 Give applications of observed health care equipment.	1	* Identification of various Health care equipment available in laboratory	2	CO1
LLO 2.1 Prepare the report on use of AI, ML in health services	2	AI and ML in health service	2	CO1
LLO 3.1 Develop a simple IoT/IoMT application for use in health services	3	*Internet of Things in health services	2	CO1
LLO 4.1 Identify the components of pulse oximeter. LLO 4.2 Compare the result obtained from two different pulse oximeter	4	* Performance of pulse oximeter	2	CO2
LLO 5.1 Identify the components of stadiometer LLO 5.2 Check the performance of stadiometer by taking measurement of weight and height LLO 5.3 Suggest measures for accurate performance	5	Performance of stadiometer	2	CO2
LLO 6.1 Identify the components of sphygmomanometer LLO 6.2 Check the performance of sphygmomanometer by taking measurement of blood pressure. LLO 6.3 Suggest measures for accurate performance	6	Performance of sphygmomanometer	2	CO2
LLO 7.1 Identify the components of glucometer LLO 7.2 Check the performance of glucometer by taking measurement of sugar level in blood. LLO 7.3 Suggest measures for accurate performance	7	* Performance of glucometer	2	CO2
LLO 8.1 Identify the components of digital thermometer LLO 8.2 Check the performance of digital thermometer by taking temperature reading. LLO 8.3 Suggest measures for accurate performance	8	Performance of digital thermometer	2	CO2
LLO 9.1 Identify the X-ray machine components. LLO 9.2 Carryout routine maintenance as per the operational manual.	9	*Routine maintenance of X-ray machine	2	CO3
LLO 10.1 Identify the faults using troubleshooting chart. LLO 10.2 Suggest measures to rectify the faults	10	X-ray machine - Fault finding and remedial measures	2	CO3
LLO 11.1 Identify the components of CT Scanner machine. LLO 11.2 Carryout routine maintenance as per the operational manual.	11	Routine maintenance of CT Scanner machine	2	CO3
LLO 12.1 Identify the faults using troubleshooting chart. LLO 12.2 Suggest measures to rectify the faults	12	* CT Scanner machine - Fault finding and remedial measures	2	CO3
LLO 13.1 Identify the MRI machine components. LLO 13.2 Carryout routine maintenance as per the operational manual.	13	Routine maintenance of MRI machine	2	CO3
LLO 14.1 Identify the faults using troubleshooting chart. LLO 14.2 Suggest measures to rectify the faults	14	MRI machine - Fault finding and remedial measures	2	CO3
LLO 15.1 Identify the components of infusion pump LLO 15.2 Carryout routine maintenance as per the operational manual.	15	* Routine maintenance of infusion pump	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevan COs
LLO 16.1 Identify type of robot used in selected situation. LLO 16.2 Develop program for identified situation. LLO 16.3 Execute the program. LLO 16.4 Prepare an action plan for use of robot in selected situation.	16	*Plan for use of robot for any one of given situations 1. Hospital automation 2.Robotics in diagnostic 3. Robotics in surgery	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

- Prepare and present a seminar on importance of health service equipment.
- Prepare a report on a visit to diagnosis center on the basis specifications and type of ECG / CT / MRI machine
- Prepare charts and present a seminar on body mass index variation on four-month duration with a group of four students. (take fifteen days interval)
- Prepare a report on health service center according to national standards.
- Collect the catalogue of modern equipment used in health services
- * Prepare a report on application, integration and limitations of MEMS accelerometers in wearable drug delivery devices for motion monitoring and adaptive drug releas

(This Microproject is compulsory and students may choose any one from the above list).

Assignment

- Make power point presentation including videos on heart rate measurement
- Identify the faults in X-ray machine
- Collect information of different standards with specification related to medical imaging equipment.
- Carry out comparative study of conventional health care services and modern health care services
- Collect information of robotic in used in health science

Visit

- Arrange a visit to the general hospital either private or government
- Arrange a visit to the nearby diagnostic center.

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 f 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	CT scanner: gantry aperture size (typically 70cm or more), slice acquisition capabilities (ranging from 16 to 640 slices), X-ray tube power (70kW or more), and image processing software	11,12
2	MRI machine: magnet strength (measured in Tesla, with common strengths being 1.5T and 3T), gradient strength and slew rate, radiofrequency system capabilities, and image processing and storage capacity.	13,14
3	Infusion pump: Minimum guaranteed flow rate range of 1-1500 mL/hr in either 0.1 or 1 mL/hr increments.	15
4	Robot offline simulation software	16
5	Computer with internet connectivity: (Minimum Core i5 Processor, 8GB RAM, 500GB HDD)	2,3,16
6	Pulse oximeter: Pulse rate: Range 30-254bpm - Accuracy: ±2% at 30-254bpm	4
7	Stadiometer: 20 - 205 cm, 1 mm / 1/8 inch, 337 x 2165 x 590 mm, 13,3 x 85,2 x 23,2 inch, 2,4 kg, 5,3 lbs	5
8	Sphygmomanometer: Gauge graduated 0 - 300mmHg (min) in 2 (max) mmHg increments, with pressure release valve. Accuracy as per ISO 81060-1: +/- 3mm Hg.	6
9	Glucometer : Hand held meter with LCD display mg/dl Reported result range : 20 - 600 mg/dL	7
10	Digital thermometer: Temperature measurement range 32 – 43 °C (minimum guaranteed)	8
11	X-ray machine: a high-frequency X-ray generator, a power output of 80kW or more, an exposure range of 40-150kV, and a minimum exposure time of 1ms or less.	9,10

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 health services	CO1	10	4	4	4	12
2	II	Primary healthcare equipment	CO2	12	4	8	4	16

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
3	III	Medical Imaging Machines	CO3	16	4	6	8	18
4	IV	Automated drug delivery systems	CO4	10	2	6	4	12
5	V	Robotic in health science	CO5	12	2	6	4	12
Grand Total				**60**	**16**	**30**	**24**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two-Class Tests of 30 marks and average of Two-Class Tests out of 30.
- For laboratory learning Maximum 25 Marks and Minimum 10 Marks.
- Self-Learning (Assignment) Question and Answers in class room, Micro Project, Visit report

Summative Assessment (Assessment of Learning)

- End Semester Assessment of 70 marks for theory learning.
- End Semester External Assessment of Maximum 25 Marks and Minimum 10 Marks for laboratory learning.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specifi 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
CO1	2	1	1	2	-	2	2			
CO2	3	3	-	2	-	2	2			
CO3	2	3	-	2	-	2	2			
CO4	2	1	1	2	-	2	2			
CO5	2	2	1	2	-	2	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.	Hand book of biomedical instrumentation	McGraw Hill Education (India) Private Limited, New Delhi,2014 ISBN: 978-9339205430
2	Cromwel, Leslie; Weibell, Fred J; Pfeiffer, Erich A.	Biomedical instrumentation and measurements	Prentice Hall of India Private Limited, New Delhi, 1995, ISBN: 978-8120306530
3	Anandanatarajan, R.	Biomedical instrumentation and measurements	PHI Learning Private Limited, New Delhi, 2015, ISBN: 978-8120352155
4	Azar, Ahmad Taher	Control Systems Design of Bio-Robotics and Bio-Mechatronics with Advanced Applications	Academic Press Inc, 2019, ISBN: 978-0128174630
5	-	Medical Equipment Maintenance Manual	Ministry of Health and Family Welfare, New Delhi October 2010 (http://www.frankshospitalworkshop.com/organisation/biomed_documents/Medical%20Equipment%20Maintenance%20Manua %20Ministry%20of%20Health%20and%20Family%20Welfare,%20New%20Delhi.pdf)

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=230k3sPKYqo	Medical Equipment- Made in India | Umesh Sonar & Ravindra Mahajan Interview | Swayan Talks
2	https://learning.edx.org/course/course-v1:DelftX+SGS1x+1T202 5/home	Biomedical Equipment: Repairing and Maintaining Biomedical Devices. EDX course
3	https://youtu.be/QX7Q0a8GxaA?si=WpT8dpxwORLPIi3i	Primary health care throughout our life
4	https://youtu.be/t_eWESXTnic?si=kojUc9hTAnNShOnW	Public Health
5	https://www.foreseemed.com/artificial-intelligence-in-health care	Role of AI and ML in health service
6	https://ordr.net/article/iot-healthcare-examples	Role of IoT/IoMT in health service

Sr.No	Link / Portal	Description
7	https://www.medicalsearch.com.au/buying-guide/maintenance-and-calibration-of-ecg-machines/f/24930	ECG maintenance and calibration
8	https://www.ncbi.nlm.nih.gov/books/NBK9622/	Blood pressure measurement using sphygmomanometer
9	https://nest360.org/wp-content/uploads/2021/08/Clinical-Job-Aid-Glucometer_Xpress2.pdf	Maintenance of glucometer
10	https://www.youtube.com/watch?v=F7hdNVA2yqU	Production of X Rays animated
11	https://www.medicalsearch.com.au/buying-guide/maintenance-and-care-of-x-ray-machines/f/25057	Maintenance and Care of X-Ray Machines
12	https://info.atlantisworldwide.com/blog/top-5-ct-scanner-issues-how-to-resolve-them	CT Scanner Issues & How to Resolve Them
13	https://www.youtube.com/watch?v=wMSryzRvC8Y	Computed Tomography | CT Scanners | Biomedical Engineer
14	https://www.blockimaging.com/blog/bid/80499/top-four-mri-scanner-service-problems-and-solutions	MRI Scanner Service Problems and Solutions
15	https://www.youtube.com/watch?v=nFkBhUYynUw	How does an MRI machine work?
16	https://pmc.ncbi.nlm.nih.gov/articles/PMC10713785/	medical devices for sustained drug delivery
17	https://spj.science.org/doi/10.34133/research.0314	Miniaturized Wireless Micropump Enabled by Confined Acoustic Streaming
18	https://jai.front-sci.com/index.php/jai/article/view/1008/820	role of robotics in medical science
19	https://nhm.gov.in/New_Updates_2018/NHM_Components/Health_System_Stregthening/Comprehensive_primary_health_care/letter/BMMP_Technical%20Manual.pdf	Biomedical equipment management and maintenance program

Note :

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