DEPARTMENT OF BIOMEDICAL ENGINEERING
BOARD OF STUDIES (2021 – 2022) ODD Semester

Minutes of the Meeting

03-07-2021

1. As per discussion with the BOS members the following new professional elective courses has been introduced from Academic year 2021 - 2022 onwards Course Medical Robotics and Wearable systems for health care. The members suggested that few lecture topics can be taken by the industrial experts and they can share their industrial knowledge to student for motivating them to implement in mini project.

2. **MEDICAL ROBOTICS**
   UNIT 5
   Students will be given real time surgeries as studies with respect to journals, internet sources and assignments.

3. **WEARABLE SYSTEMS FOR HEALTH CARE**
   UNIT 4
   IOT will be incorporated along with wireless health systems.
   Unit 5
   Topics regarding to sensors should be incorporated in unit 1
   Applications to be included in unit 5

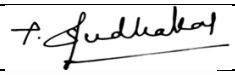
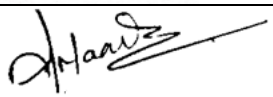
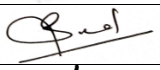
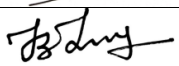
4. The above suggestions were given by the BOS members during their meeting and this come to existence from Academic year 2021 – 2022 onwards.

Members of Board of studies – Biomedical Engineering

EXTERNAL MEMBERS

1. Dr. **G. Harikrishnan**,
   Associate Professor & Research Coordinator,
   Department of Electrical & Electronics Engg.,
   Sree Vidyanikethan Engg. College, Tirupati
2. Dr. **C.M. Sujatha**,
   Associate Professor,Department of ECE, Anna University, Chennai

INTERNAL MEMBERS

S.No.	Name of the Internal Member	Signature
1	Dr. T. Sudhakar,HoD	
2	Dr. J. Premkumar	
3	Dr. Anima Nanda	
4	Dr. S. Krishnakumar	
5	Ms. Sindu Divakaran	
6	Ms. Bethanney Janney	
7	Mr. G. Umashankar	

SBMA3012	MEDICAL ROBOTICS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To expose the students to the field of medical (surgical and oncology) robotics.
- To understand the design aspects of medical robots.

UNIT 1 INTRODUCTION **9 Hrs**

Definition and origin of robotics, Different types of robotics, various generations of robots, Asimov's law's of robotics. Degrees of freedom – dynamic stabilization of robots Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics

UNIT 2 SENSORS AND TRACKING **9 Hrs**

Localization And Tracking - Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems - Hybrid systems, Basic control concepts -impedance, admittance

UNIT 3 SURGERY AND IMAGING **9 Hrs**

Minimally Invasive Surgery (MIS), Human-machine interfaces, Robot design concepts, Video images in MIS, Augmented reality Image-Guided Interventions, Robot compatibility with medical imagers(e.g., MRI, US, X-ray, CT), Image segmentation and modeling, Tracking devices, Surgical navigation, Calibration

UNIT 4 APPLICATIONS **9 Hrs**

Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery. Physically assistive robotics, Socially assistive robotics, Rehabilitation robotics

UNIT 5 CASE STUDIES **9 Hrs**

Cardiac, abdominal, and urologic procedures with tele-operated robots, Robotic catheters for heart electrophysiology, Orthopedic surgery with cooperative robots, Prostate interventions with manual "robots" Mobile robots in the body, Instrument-tissue interaction modelling

Max. 45 Hours

Course Outcomes:

At the end of the course, the student should be able to:

CO1: Describe the types of medical robots and the concepts of navigation and motion replication.
CO2: Discuss about the sensors used for localization and tracking
CO3: Summarize the applications of surgical robotics
CO4: Classify the types of assistive robots
CO5: Apply robotics to healthcare field.
CO6: Analyze the design characteristics, methodology and technological choices for medical robots.

TEXT / REFERENCE BOOKS

1 Thomas Bräunl, Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems, Third Edition, Springer-Verlag Berlin Heidelberg, 2008.
2. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2012.
3. Daniel Faust, "Medical Robots", Rosen Publishers, 2016.
4. Jocelyne Troccaz, "Medical Robotics", Wiley, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration : 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 16 marks 80 **Marks**

SBMA3013	Wearable Systems for Healthcare	L	T	P	Credits	Total Marks
		3	0	0	3	100

Course Objectives:

1. To impart the importance of smart sensors, sensor interface standards for wearable device applications
2. Identify the need for development of wearable devices and its implications on various sectors.
3. Comprehend the design and development of various wearable bioelectrode and physiological activity monitoring devices for use in healthcare applications.

Unit 1 Sensors for wearable systems

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Radiant thermal sensor, Wearable motion sensors, Wearable biochemical Sensors, Wearable gas sensors.

Unit 2 Signal Processing and Energy Harvesting

Wearability issues -physical shape and placement of sensor, technical challenges – sensor design, signal acquisition, lightweight signal processing, Rejection of irrelevant information, Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests.

Unit 3 Scope of Wearable Devices

Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Wearables: Challenges and Opportunities, Future and Research Roadmap.

Unit 4 Wireless Health Systems

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare,Technical Challenges-System security and reliability, BAN Architecture – Introduction,Wireless communication techniques.

Unit 5Wearable Devices for Healthcare

Wearable ECG devices, Wearable EEG devices, Wearable EMG devices: EMG/ SEMG Signals, EMGMeasurement – wearable surface electrodes, Smarttextile for neurological rehabilitation system (NRS), Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor, Wearable sensors for Body Temperature: Intermittent andContinuous temperature monitoring.

Course Outcomes:

1. Discuss and analyse the usage of various biochemical and gas sensors as wearable devices.
2. Identify the technical challenges for signal processing and Energy Harvesting.
3. Describe the scope of the wearable devices and its design constraints for measuring physical and biological signals.
4. Design and develop various wearable device for detection of physiological body signals, blood pressure and body temperature for use in healthcare applications.
5. Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.
6. Able to design and perform experiments on the sensors and develop the projects based on the customer needs.

References:

1. Annalisa Bonfiglio,Danilo De Rossi,"Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee,Krishna Kumar Venkatasubramanian, "Body Area Networks Safety,Security, and Sustainability," Cambridge University Press, 2013.
3. Toshiyo Tamura and Wenxi Chen, “Seamless Healthcare Monitoring”, Springer 2018
4. Edward Sazonov and Michael R. Neuman,“Wearable Sensors -Fundamentals, Implementation and Applications”, Elsevier Inc., 2014.
5. Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, “Wearable and Autonomous Biomedical Devices and Systems for Smart Environment”,Springer 2010
6. Hang,Yuan-Ting,"Wearable Medical Sensors and Systems",Springer-2013
7. Mehmet R. Yuce, Jamil Y Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012

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DEPARTMENT OF BIOMEDICAL ENGINEERING
BOARD OF STUDIES (2021 – 2022) EVEN Semester

Minutes of the Meeting

01-11-2021

1. Industry 4.0 for Bio & Chemical Engineers for UG and Industry 4.0 for Bio engineers PG introduced as PBLA course. The conduction of examination will be based 50 % theory and 50 % practical course. Internal marks will be calculated from CAE I & CAE II, TWO assignments which was conducted periodically during the course. ESE written exam will be assessed based on the case study (design, implementation, operations) and prototype model.

2. UHV course was introduced for Batch 2020 as per the AICTE guidelines, 3 credits was given according to norms of AICTE

3. The above suggestions were given by the BOS members during their meeting and this come to existence from Academic year 2021 – 2022 onwards.

Members of Board of studies – Biomedical Engineering

EXTERNAL MEMBER - Dr. **G. Harikrishnan**,
Associate Professor & Research Coordinator,
Department of Electrical & Electronics Engg.,
Sree Vidyanikethan Engg. College, Tirupati

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S.No.	Name of the Internal Member	Signature
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2	Dr. J. Premkumar	
3	Dr. Anima Nanda	
4	Dr. S. Krishnakumar	
5	Ms. Sindu Divakaran	
6	Dr. J. Bethanney Janney	

SCHA4005	INDUSTRY 4.0 FOR BIO-CHEMICAL ENGINEERS PROJECT BASED LEARNING APPROACH	L	T	P	C	Max. Marks
		1	0	2	2	100

COURSE OBJECTIVE:

- To demonstrate the achievement of efficient and economically viable production without being hazardous to human health and environment. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

UNIT 1: MODELLING AND SIMULATION **6 Hours**

Introduction to Industry 4.0 - The Various Industrial Revolutions - Modeling Principles: Introduction, definition of modeling and simulation, different types of models, application of mathematical modeling.

Simulation: Introduction, Simulation Tools, Process Simulation Software Platforms and Applications, Trends in Process Simulation Engineering

UNIT 2: SMART INDUSTRY **6 Hours**

Road to Industry 4.0 - Green manufacturing, Robotic Automation, Industrial Applications- Manufacturing, Control, Maintenance and Assembly, RFID- Type, RFID system, applications, RFID in health care, Embedded Systems - Embedded firmware, Platform software design, Wireless design, Embedded testing, modeling & amp; automation, Hardware platform design, Device Management, Monitoring – Industrial monitoring, condition monitoring, Health monitoring.

UNIT 3 BIG DATA ANALYTICS AS SERVICE PROVIDER **7 Hours**

Technologies for enabling Industry 4.0 - Role of data, information, knowledge and collaboration in future organizations. Big Data - Background - Programming- Python and R - Git - Docker - Pipelines - DNA and RNA Sequencing - Massively parallel sequencing - Applications - Next Generation Sequencing and its future and big data analytics in healthcare - Big Data Repositories - Cloud platforms and computing for automation - Embedded systems in healthcare - Digitization the future of healthcare - medical cyber physical systems - Case study - Integration of Multi-Omics Big Data in Cardiovascular Risks and Diseases.

UNIT4 PLANT/PROCESS MANAGEMENT **6 Hours**

Business issues in Industry 4.0 - Nanobiotechnology: Synthesis of different Nanostructures, Characterization of Nanostructures, Nanostructures in Diagnosis and Therapy. Tissue Engineering: Scaffolds: Natural and Artificial polymers, Scaffold fabrication, 3D Bioprinting; Bioreactors for Tissue Engineering: Effect of different Parameters, Conditions; Tissue engineering for Skin, Bone, Vasculature and Cornea; Regulatory framework in development and marketing tissue-based products.

UNIT 5 PROTOTYPING – TESTING AND COMMUNICATION **20 Hours**

Applications and Case Studies - New ideas – centered design process – functional prototype - testing methods/ideas – prototyping and test beds – proof of concept – assembly – prototyping apps – addressing the complex problems.

Max.45 Hours

COURSE OUTCOMES:

CO1. Articulate on the new age technologies in the modeling of biochemical engineering.
CO2. Integrate different emerging technologies to evolve Smart Factories
CO3. Deduce the components that lead to industrial digital revolution
CO4. Ability to assess the developments in bioengineering.
CO5. Criticize the professional and ethical issues in novel industrial technologies.
CO6. Develop a prototype/ innovative ideas in the various fields of biochemical engineering.

TEXT / REFERENCE BOOKS

1. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems, 1st Editio, CRC Press, 2020
2. Sider W.D., Seader J. D., and Lewin D.R., Product and Process Design principles, Synthesis, Analysis and Evaluation, 2nd Edition, John Wiley and Sons, 2010.
3. Thomas Varghese & K.M. Balakrishna, Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, Atlantic, 2012
4. Uthayan Elangovan, Smart Automation to Smart Manufacturing: Industrial Internet of Things, Momentum Pr, 1st Edition, 2019.

END SEMESTER EXAMINATION PATTERN

Max Marks: 100

PROJECT PRESENTATION

SCCA9504	INDUSTRY 4.0 FOR BIO ENGINEERS PROJECT BASED LEARNING APPROACH	L	T	P	C	Max. Marks
		1	0	2	2	100

COURSE OBJECTIVE:

- To demonstrate the achievement of efficient and economically viable production without being hazardous to human health and environment. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.

UNIT 1: MODELLING AND SIMULATION **6 Hours**

Introduction to Industry 4.0 - The Various Industrial Revolutions - Modeling Principles: Introduction, definition of modeling and simulation, different types of models, application of mathematical modeling.

Simulation: Introduction, Simulation Tools, Process Simulation Software Platforms and Applications, Trends in Process Simulation Engineering

UNIT 2: SMART INDUSTRY **6 Hours**

Road to Industry 4.0 - Green manufacturing, Robotic Automation, Industrial Applications- Manufacturing, Control, Maintenance and Assembly, RFID- Type, RFID system, applications, RFID in health care, Embedded Systems - Embedded firmware, Platform software design, Wireless design, Embedded testing, modeling & amp; automation, Hardware platform design, Device Management, Monitoring – Industrial monitoring, condition monitoring, Health monitoring. Sensor Technology and its applications, AI in smart manufacturing, Smart Factory logistics

UNIT 3 BIG DATA ANALYTICS AS SERVICE PROVIDER **7 Hours**

Technologies for enabling Industry 4.0 - Role of data, information, knowledge and collaboration in future organizations. Big Data - Background - Programming- Python and R - Git - Docker - Pipelines - DNA and RNA Sequencing - Massively parallel sequencing - Applications - Next Generation Sequencing and its future and big data analytics in healthcare - Big Data Repositories - Cloud platforms and computing for automation - Embedded systems in healthcare - Digitization the future of healthcare - medical cyber-physical systems - Case study - Integration of Multi-Omics Big Data in Cardiovascular Risks and Diseases.

UNIT4 TISSUE ENGINEERING **6 Hours**

Introduction, Methods, Materials, Material characterization; Scaffolds: Natural and Artificial polymers, Hydrogels, Bioceramics, Scaffold fabrication, Self-assembly, 3D Bioprinting: Introduction, Workflow, Imaging, 3D modeling, CAD-based design, Bioink, Techniques; Bioreactors for Tissue Engineering: Effect of different Parameters, Conditions; Tissue engineering for Skin, Bone, Vasculature and Cornea, Synthesis of different Nanostructures, Characterization of Nanostructures, Nanostructures in Diagnosis and Therapy, Organ printing. Scaffold techniques and the efficiency of gene-editing tools and their ability to fill the existing gaps in stem cell and regenerative therapies. Regulatory framework in development and marketing tissue-based products

UNIT 5 PROTOTYPING – TESTING AND COMMUNICATION **20 Hours**

Applications and Case Studies - New ideas – centered design process – functional prototype - testing methods/ideas – prototyping and testbeds – proof of concept – assembly – prototyping apps – addressing the complex problems.

Max.45 Hours

COURSE OUTCOMES:

CO6. Articulate on the new age technologies in the modeling of biochemical engineering.
CO7. Integrate different emerging technologies to evolve Smart Factories
CO8. Deduce the components that lead to industrial digital revolution
CO9. Ability to assess the developments in bioengineering.
CO10. Criticize the professional and ethical issues in novel industrial technologies.
CO6. Develop a prototype/ innovative ideas in the various fields of biochemical engineering.

TEXT / REFERENCE BOOKS

5. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, Handbook of Industry 4.0 and SMART Systems, 1st Editio, CRC Press, 2020
6. Sider W.D., Seader J. D., and Lewin D.R., Product and Process Design principles, Synthesis, Analysis and Evaluation, 2nd Edition, John Wiley and Sons, 2010.
7. Thomas Varghese & K.M. Balakrishna, Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, Atlantic, 2012
8. Uthayan Elangovan, Smart Automation to Smart Manufacturing: Industrial Internet of Things, Momentum Pr, 1st Edition, 2019.

END SEMESTER EXAMINATION PATTERN

Max Marks: 100

PROJECT PRESENTATION

SAIC4003	UNIVERSAL HUMAN VALUES	L	T	P	Credits	Total Marks
		2	1	0	3	100

COURSE OBJECTIVES

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence
- To strengthen self-reflection
- To develop commitment and courage to act

MODULE 1 COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

MODULE 2 UNDERSTANDING HARMONY IN THE HUMAN BEING - HARMONY IN MYSELF!

7. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
8. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
9. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
10. Understanding the characteristics and activities of 'I' and harmony in 'I'
11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
12. Programs to ensure Sanyam and Health.

Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

MODULE 3 UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY- HARMONY IN HUMAN-HUMAN RELATIONSHIP

13. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
14. Understanding the meaning of Trust; Difference between intention and competence
15. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
16. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
17. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

MODULE 4 UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS COEXISTENCE

18. Understanding the harmony in the Nature
19. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature
20. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space

21. Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

MODULE 5 IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS

22. Natural acceptance of human values
23. Definitiveness of Ethical Human Conduct
24. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
25. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
26. Case studies of typical holistic technologies, management models and production systems
27. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
28. Sum up.

Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Total: 28 Lectures And 14 Practice Sessions

COURSE OUTCOMES

On completion of the course, the student are expected

CO1: To become more aware of themselves, and their surroundings (family, society, nature)

CO2: They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind

CO3: To have better critical ability

CO4: To become sensitive to their commitment towards what they have understood (human values, human relationship and human society)

CO5: To apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

TEXT /REFERENCE BOOKS

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj – PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

ASSESSMENT:

Assessment by faculty mentor: 10 marks

Self-assessment:: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks
Semester End Examination: 50 marks