ADAMAS UNIVERSITY
KOLKATA
PURSUE EXCELLENCE

School of Science

M.Sc. (Tech)

in Medical Physics and Instrumentation

Programme

HANDBOOK

Department of

PHYSICS

School of Science

Department of Physics

M.Sc. (Tech) in

MEDICAL PHYSICS AND INSTRUMENTATION
Program Student Handbook

This handbook contains basic information and policies regarding the M.Sc. Program in the Department of Physics. More information for current graduate students in our department can be found online: http://adamasuniversity.ac.in/

The matters covered by this booklet are subject to periodical review and amendments.

Table of Contents

Message from the Dean, School of Science

I would like to welcome you in the School of Science, which has been established right at the inception of the university in 2015, in the domain of Physics, Chemistry, Mathematics, Geography, and Psychology. The school has a vision, to be recognised globally as a provider of education in Basic and Applied Sciences, fundamental and interdisciplinary research. The School has a rich heritage of qualified teaching and research works in the field of aforesaid subjects. It is currently running UG, PG as well as PhD programmes in many areas of Physics, Chemistry, Mathematical Science, Geography and Psychology. It has started some joint inter-disciplinary programmes in collaboration with other departments.

The School of Science believes that the education is not only conventional book-based classroom pedagogy. It should be outcome-based education, which ensures the professional establishment of graduates. The professional establishment is possible only when a student can acquire the skill through hands-on training and real problem-solving exercise. Building the capability of handling real problem is only possible if research based and project-based learning can be imparted. Accordingly, the academic programmes are being designed towards project and research directions. The school enriched of a pool of well knowledgeable professors, is committed to impart student centric Outcome Based Education through project and research-based pedagogy and State-of-the art laboratory facility.

Best regards

Prof. Bimal Kumar Sarkar

Message from the Head of the Department....

"What we know is a drop, what we don't know is an ocean"-

--- Isaac Newton

Welcome to the Department of Physics under School of Science, Adamas University.

As everybody says "*Physics is the Law of Nature*" and if you want to explore Nature, and learn its patterns, Physics is absolutely the right destination for you. All the under graduate and post-graduate programs are designed meticulously to make these a comprehensive study with focus on basic theoretical foundations in a rigorous way and applications in currently relevant academic and industry fields.

Physics is everywhere, from functioning of the miniaturized Nano-scale devices to the understanding of Large Astronomical object with the emerging success of Astrophysical concepts, from the application of Non-Linear Dynamics in Weather forecasting to the prediction of Economical Markets by using Novel Statistical ideas, from using Bulk materials to manipulating Molecules in new age Transport phenomena, from Conventional Electronic devices to the mind boggling success of Robotics and Artificial Intelligence. Physics lies at the heart of every breakthrough fundamental Concepts. So, work hard and prepare yourself to be a successful and bright Physicist and make your learning experience an unique one!

While we hope that you will be so involved with your studies but at the same time we want you to enjoy the outstanding scenic beauty of the campus. The University provides lots of opportunity to learn though extracurricular activities and different club activities. Try not to learn only from the classrooms or laboratories. Life never stops you from surprising, so enjoy each moment with your friends and fellow classmates also. We want you to have an experience of a life time.

Dr. Moumita Dey

Head of the Department

Department of Physics

About the Department

Vision of the Physics department is to lay the foundational stone of excellence and spur development of the University as a premier Institution in the field of Physics, by igniting and nurturing enthusiasm, interests and passion, among the students through the advanced curricula.

Located in the scenic green campus of Adamas University, Kolkata, the Department of Physics started its activity in 2015. The department is an active beehive of research being carried out in the wide variety of frontier areas as well as high quality Under-graduate, Post-graduate and Doctoral program. The research program of the department cover both pure and applied physics areas like Condensed Matter Physics, Particle Physics, Theoretical Nano-Science, Material Science, Plasma Physics and Microelectronics, Bio-Medical Instrumentation, Electronics, Applied Electronics, Thin Film, Biophysics and many more…

The department has flexibility in framing courses and conducting tests and examinations. The Department conducts programs at the Bachelor's, Master's as well as at the Doctoral Research levels. Establishment of state-of-the art experimental and computational facilities has allowed us to venture into emergent career oriented programs like Medical Physics and Instrumentation and interdisciplinary area like Nano-science and Nano-technology. With a vibrant and active Ph.D. program, in which research students are currently enrolled, Department of Physics thrives to be one of the leading research group of the world.

In addition to these programs conducted by the Department, the faculties regularly offer several core and elective physics courses to the Engineering, Science (other than Physics) and Law students of the University**.**

Mission

1. To provide quality training to the students for Physics education and equip them with skills required for higher studies in International and National institutions of great repute.

2. To motivate young minds and unravel their talents both in the fields of Theoretical and Experimental Physics, through dedication to teaching, commitment to students and innovative teaching learning methods and assessment throughout the year.

3. To provide the students state of the art knowledge through upgraded and advanced syllabus, modern laboratories and to make them competent from a global perspective.

4. To enable the students having a clear perspective of ongoing research activities in different fields of Physics by introducing several enriched courses like "Seminar on Contemporary in Physics", "Dissertation", "Projects" etc.

5. To prepare the students ready for industry oriented jobs by having hands on training through "Summer Internship" program in different reputed Companies or Research Organizations.

6. To add to the values of the University by introducing pioneering programs like M.Sc. (Tech) in Medical Physics and Instrumentation which is more job oriented program.

7. To evolve strategies in the Department for continuous Improvement in all aspects of academic and administrative issues.

PROGRAM NAME: M.Sc. (Tech) in Medical Physics and Instrumentation

- ***Introduction to the Program:***

The discipline "Medical Physics & Instrumentation" is a concoction of medical science and technology to offer humanity a better health. The M.Sc. (Tech.) in Medical Physics & Instrumentation course aims to produce postgraduates with an ability to develop medical instruments and systems used for monitoring, detecting and analyzing biomedical data. The present program will provide opportunity to develop practical skill sets. The student will also develop an in-depth understanding of the Physics and technology behind the medical devices use in health sectors eg: diagnostic devices, therapeutic devices, medical imaging equipment and medical instrumentation devices.

With increasing life expectancy, there is a constant demand and scope of improvement in the healthcare industry around the world. This course thus opens up students from any science and technology background to lucrative jobs as well as research opportunities in the healthcare sector of India and around the world. Thus a passion to serve mankind through technology is the driving force of this interdisciplinary course.

- ***Program Outcome:***

The course/syllabus includes discussion of medical equipment and its design by investigating a range of issues including user regulation, requirements, impacts of risk, legislation, radiation safety, quality insurance mechanisms, certification and ethics. Industry interaction and hands-on-training program in collaboration with Health sector/Hospitals are conducted as an integral component of course-curriculum.

A post graduate from this course will have the skills and abilities to

1. Develop an integrative understanding of the complex human body, its normal functioning and abnormalities that are addressed through biomedical devices.
2. Apply the concept of medical physics in diagnostics and therapeutics of healthcare sector.
3. Actively participate in research activities that are impactful for human health
4. Design and realize a biomedical device, component, or process to meet the rising demands of healthcare industry.
5. Investigate various problems and ways to solve which will be very beneficial to society.
6. Identify and solve problems and function on multi-disciplinary teams
7. Approaches of qualitative and quantitative data analysis and physiological data interpretation.
8. Understand professional and ethical responsibility.

Programme Eligibility:

Qualified B.Sc. in Physics/Chemistry/Mathematics/any Biological Sciences/ Electronics/ Computer Science or equivalent examination from any UGC/AICTE approved University or Universities abroad with equivalent curriculum.

Teaching - Learning Process:

While framing teaching-learning process for postgraduate physics, we follow a holistic view of learning including situational, continuous, and transformational aspects which relies on principle of 'continuity of experience' i.e. continuously transformed by the transactions that occur between the individual and his or her surroundings. This occurs when present experiences are carried forward by being connected to previous experiences in a continuous process.

The teaching-learning processes for postgraduate students doing M.Sc. Tech in Medical Physics and Instrumentation are oriented towards enabling students to understand the fundamentals and applications of physical and scientific theories of biomedical sciences while appreciating the interdisciplinary nature of the program.

The outcome based approach, particularly in the context of postgraduate level studies in Medical Physics and Instrumentation has been designed to significantly shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies.

Each course of the study lends itself to well-structured and sequenced acquisition of knowledge and skills in technical and physical sciences. An important aspect of the teaching-learning process is that the postgraduate student will achieve the practical skills in physical sciences which include an appreciation of the link between theories and experiments through hands on experiments.

Teaching methods, guided by such a framework, comprises of (i) lectures supported by group tutorial work, (ii) lab based on hands on training, (iii) the use of prescribed textbooks and e-

learning resources and other self-study materials, (iv) open-ended project work, some of which may also be team-based, (v) activities (presentations, seminar etc.) designed to promote the development of generic/transferable skills in physical and biomedical sciences.

There will be home works based on fundamental knowledge and the capability of their application (problem solving approach) that will allow students to demonstrate their knowledge on each chapter and to increase their analyzing power further. There will be regular quiz and class presentations which shall enable the students to demonstrate knowledge and enhance communication skills. Two/Three class tests will be given through the semester along with one Mid-term and one End-term examinations to have students demonstrate mastery of key concepts. Information and communication system (ICT) will be used selectively for decoding and interpreting mainly graphs and shapes as well as to process experimental measurements or to simulate interaction of sensors with physiological phenomena. Students are trained in various programs (e.g., Matlab, COMSOL, C etc.).

Attendance and Condonation:

Students must have 75% of attendance in each semester to appear for the end semester examination. Students who have attendance below 75% shall apply for condonation in the prescribed form with the prescribed fee. Students who have attendance below 75% are not eligible to appear for the examination. They shall re-do the semester(s) following approval of the competent authority.

About the Course Structure

School of Science has implemented an advanced and well developed curriculum for all postgraduate programmes run under its umbrella. The Course structure provides an opportunity for the students to choose courses from the prescribed courses comprising Foundation course, Core (Theory and lab), Advanced Electives (Theory and Lab) etc. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin

with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Elaboration of some terms in course structure:

1. **Core Course:** A course, which should compulsorily be studied by a candidate to gather the essential knowledge about the subject to make the foundation stronger i.e., a core requirement is termed as a Core course.
2. **Elective Course:** Subjects from different aspects of medical physics and instrumentation are offered as elective like Biosensors and related devices, Robotics for Biomechanics, Biomaterials and tissue culture, Bioinformatics and simulation, Brain-Computer Interfacing etc, which covers most of the specializations of biomedical sciences. A student can choose any option as per their choice or orientation and study the courses (both theory and lab) offered under this specialization.
3. **Dissertation/Project:** Dissertation is compulsory for postgraduate student during the last two semesters. This course helps the student to get introduced to the various research fields and the related works that is being going on all over the world. Through such open ended courses, students are encouraged to study beyond curriculum and express their learning and views through presentation.
4. **Internship:** Summer internship is compulsory during summer vacation in any reputed academic organization or industry. Such courses enable the students to have a hands on training directly in the fields of research or industry related jobs. This is exceptionally helpful for broadening of the exposure of students in academic and industry fields.

Meaning of Credits and Contact Hours:

Practical: 3 credit means 6 hour(s) per week for full term (15 weeks in a Semester)

Lecture: 4 credit means 4 hour(s) per week for Full Term (15 weeks in a Semester)

Tutorial: 1 credit means 1 hour(s) per week for Full Term (15 weeks in a Semester)

Course Structure

Semester I

Subject Code	Subject	L	T	P	C
SPH51111	Applied Mathematics & Statistics	4	-	-	4
SPH51113	Anatomy & Physiology	4	-	-	4
SPH51115	Advanced Electronic Circuits & Microprocessor	4	-	-	4
SPH51117	Medical Equipment Management	4	-	-	4
SPH51119	Physics for Medicine	4	-	-	4
SPH51205	Advanced Electronics Circuit Lab	-	-	4	2
SPH51207	Microprocessor Lab	-	-	4	2
	TOTAL CREDIT				**24**

Semester II

Subject Code	Subject	L	T	P	C
SPH51112	Nuclear Medicine Technology	4	-	-	4
SPH51114	Medical Equipment Calibration and Maintenance	4	-	-	4
SPH51116	Clinical Instruments & Systems	4	-	-	4
SPH51118	Medical Application of Spectroscopy and Image Processing	4	-	-	4
SPH51120	Radiation Safety Techniques	4	-	-	4
SPH51208	Sensor and Medical Instrument Lab	-	-	4	2
SPH51210	Numerical Methods and Programming Lab	-	-	4	2
	TOTAL CREDIT				**24**

Semester III

Subject Code	Subject	L	T	P	C
SPH52153	Nano-Biotechnology	4	-	-	4
SPH52155	Tissue Engineering and Artificial organ	4	-	-	4
SPH52251	Image processing lab	-	-	4	2
	Elective I	4	-	-	4
	Elective II	4	-	-	4
SPH52601	Dissertation I				6
	TOTAL CREDIT				**24**

Semester IV

Subject Code	Subject	L	T	P	C
SPH52604	Internship				8
SPH52704	Dissertation II and Grand Viva				20
	TOTAL CREDIT				**28**

Options for Elective Papers (Elective I and Elective II)

Subject Code	Subject	L	T	P	C
SPH52157	Bio-Sensors and MEMS	4	-	-	4
SPH52159	Robotics and Artificial Intelligence	4	-	-	4
SPH52161	Simulation in Biomedical Engineering	2	-	4	4
SPH52163	Bio-Informatics and Simulation of Physiological Systems	4	-	-	4
SPH52165	Advanced Bio-Materials and Prosthetics	4	-	-	4
SPH52167	Bio-Telemetry and Tele-Medicine	4	-	-	4
SPH52169	Brain-Computer Interface	2	-	4	4
SPH52171	Tissue Engineering	4	-	-	4

Total: 100 credits

Course Name: Applied Mathematics & Statistics **Course Code: SPH51111**

Course Aim: The aim of the course is to impart mathematical and statistical knowledge for developing models replicating bio-systems and data analysis.

Number of Lectures and Course Content Module wise:

Introduction **(5L)**

Introduction the scope and purpose of statistics, types of data, estimation and Measurement, errors**.** Descriptive and summary statistics, means, SD**,** SEM**,** Median**,** centiles**,** outliers**,** missing data**.** Elements of Probability**.** Measurements, Probabilities and distributions**.** Conditional probabilities**.** Bayes theorem**.** ROC curves**.** Diagnostic use of probabilities**.** Methods of uncertainty reasoning**.**

Estimation and hypothesis testing **(6L)**

Estimation, hypothesis testing: Confidence limits for means, t-distribution, chi-square distribution. Confidence limits for variances, t-tests, comparisons of variances Comparisons of several means: Analysis of Variance, A priori tests, A posteriori tests Two and three-way analysis of variance, Analysis of covariance.

Statistical Quality Control **(5L)**

Introduction, control charts of all types, ISO 9000 series & their importance, OC curves, advantages & limitations of SQL in industries.

Random Variables & theoretical distributions **(6L)**

Discrete & continuous frequency distributions, stochastic process, Markovian chain, simulation techniques.

Reliability Theory **(6L)**

Theory of reliability, maintainability, availability, failure distribution, state dependent systems, series & parallel connection, redundancy of systems.

Linear Programming Problems **(5L)**

Introduction & formations of the problems, graphical method, simplex method, duality concept in LPP & solution of the dual.

Regression and correlation **(6L)**

Simple and multiple regression, nonlinear fitting, correlation nonparametric statistics, goodness of Fit tests, resampling methods, role of Computer in solving bio-statistical problems.

Modeling of bio-systems **(6L)**

Mathematical modeling and solution of biomedical problems namely respiratory rate, blood

flow, cardiac output and impedance diffusion, ultra-filtration etc. Operational research applied to the description of physiological systems and signal processing by interfacing instrumentation. Perturbation technique in dealing with the problems of thermodynamics. Fitting a straight line.

Course Outcome

1. Students will be able to develop basic mathematical knowledge behind probability and statistics.
2. Students will be able to acquire the knowledge Estimation, hypothesis testing and analysis
3. Students will be able to comprehend Statistical Quality Control
4. Students will be able to compare discrete & continuous frequency distributions, stochastic process, Markovian chain, simulation techniques.
5. Students will be able to interpret Theory of reliability, maintainability, availability, failure distribution
6. Students will be able to solve for regressing and correlation with Linear Programming Problems
7. Students will be able to formulate models for biological systems

Teaching Methodology

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts through which several problems of biophysical phenomena can be addressed. Regular class tests are taken to nurture the ideas of the subject and related domain and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods

The evaluation process consists of the following components.

1. **Internal Assessment: 30**
2. **Attendance: 10**
3. **Mid-Term Examination: 20**
4. **End-Term Examination: 40**

*In the Internal Assessment Component Class Tests/ Presentations/ and Assignments will be there.
In case of distribution of marks of attendance, the following pattern is maintained

Attendance	Marks Obtained
95%-100%	10
90%-95%	8
85%-90%	6

80%-85%	**4**
75%-80%	**2**
< 75%	**0**

List of Books:

1. Mathematical Biology: Murray, J.D. Vol. I, II,Springer- 2007.
2. A Brief on Tensor Analysis: James Simmonds, Springer-Verlog, 2005
3. A quick introduction to tensor analysis: Ruslan Sharipov
4. Numerical methods by S. S. Sastry, (Pearson Education)
5. Statistical methods by S. P. Gupta.
6. George Dassios, Dimitrios I Fotiadis, Christos V Massalas, Kiriakie Kiriaki, Mathematical Methods in Scattering Theory and Biomedical Technology, Chapman 7 Hall/CRC; 1 edition 1998.
7. Reliability & Maintainability Engg. By Charles E. Ebeling, (Pearson Education Mc- Graw Hill).
8. Operations Research by S.D. Sharma, Kedar Nath Ram Nath Company,Meerut.

Course Name: Anatomy and Physiology **Course Code: SPH51113**

Course Aim: This course aims at recapitulation of basic structure and function of different parts of the human body and detailed study of the mechanisms behind normal functioning of individual organs.

Course Content

Organization of Human Body (4L)

Anatomical position, terminology, regions and planes. Basic anatomy and physiology of cells, Tissues (epithelial, connective, muscle, nervous, blood, glands), Permeability of cell membrane, genesis of membrane potential excitation of cell.

Skeletal System (4L)

Functions of skeletal system, Anatomy of long bone, Bone histology, Naming all bones of axial and appendicular skeleton, Formation, growth and repair, Structural and functional classification of joints, Types of movement, Calcium homeostasis.

Muscular System (4L)

Functions of muscular system, Names of all major muscles, Origin, insertion and action, Sliding Filament Model, Neuromuscular junction, Structure (gross and microscopic), Physiology of muscle contraction, Muscle metabolism (ATP), Fiber types, Exercise physiology.

Unit IV: Cardiovascular System (4L)

Functions of circulatory system, Heart structures (chambers, valves, and vessels), Circulatory routes (systemic, pulmonary, coronary and hepatic portal), Blood vessels and pressure, Blood components, function and typing, Blood clotting, Regulation and conduction (EKG). Blood-composition, blood groups, role of R.B.C and W.B.C.

Unit V: Lymphatic/Immune System (3L)

Functions of lymphatic system, Structures (vessels, nodes, cells), Lines of defense, Humoral immune response, Cell mediated immune response, Immune cell types.

Unit VI: Digestive System (3L)

Functions of digestive organs, Modes of mechanical digestion, Chemical digestion (hormones, enzymes, pH), Absorption and elimination, Name parts of GI Tract and accessory organs, Nutrition and metabolism (production of ATP).

Unit VII: Excretory System (3L)

Functions of urinary system, Kidney, ureter, bladder, urethra, Microanatomy and function of nephron, Formation of urine-steps involved.

Unit VIII: Respiratory System **(3L)**

General structure of respiratory system and functions- Lungs and Trachea, Respiratory Pathways, Functional aspects and mechanics of respiration, Mechanics and regulation of breathing, Gas exchange and gas laws, Hypoxia, effect of exercise.

Unit IX: Nervous System **(5L)**

Functions of nervous system, Nerve cell anatomy, Neural physiology (action potential, synaptic transmission, Na/K pump), Brain anatomy and hemispheres, Spinal cord anatomy, reflex arc, PNS (autonomic and somatic), Sensory motor nerve functions.

Unit X: Endocrine System **(3L)**

Functions of endocrine system, Naming organs/glands/cells and their hormones, Hormone types and target cells, Chemical messengers.

Unit XI: Reproductive System **(3L)**

Functions reproductive systems, Male and female anatomy, Menstrual cycle, Meiosis/gamete production.

Unit XII: Sensory System **(6L)**

Basic anatomy of special senses: Eye, Ear, Tongue, Nose and Skin, Properties and functions of nervous system with respect to sensory organs

Course Outcome

1. Students will be able to demonstrate the organization of human body from cell to organ and systems.
2. Students will be able to acquire the knowledge of musculo-skeletal system and its connection with nervous system.
3. Students will be able to explain circulation of blood and gases its functions in living body.
4. Students will be able to illustrate reproductive and endocrine system as a part of human body systems.
5. Students will be able to analyse the different sensory organs and their normal anatomy.

Teaching Methodology

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts of human anatomy and physiology along with ideas about diseases and dysfunction of major organs. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Charles E. Tobin, Basic Human Anatomy, Mc Graw Hill Publication.
2. J. H. Green An Introduction to Human Physiology.
3. H.B. Charles and B.N. Taylor; The Physiological Basis of Medical Practice. William and Wilkins, Baltimore, 1985.
4. C.A. Keele and Eric Neil; Samson Wright's Applied Physiology. ELBS, London, 1984.
5. S. West, E.R. Todd, W.S. Mason and H.J.T. Van Bruggen; Text Book of Biochemistry. Macmillan Co., 1976.
6. A.G. Guyton; Textbook of Medical Physiology; Saunders, Philadelphia, 1986.
7. Anatomy and Physiology in Health and Illness: Ross and Wilson (ELBS pub).
8. Human Physiology by A. Vander, J. Sherman and D. Luciano Mc Graw Hill.
9. Principles of Anatomy and Physiology: Tortora and Grabowski. (Haper Collin pub.).

Course Name: Advanced Electronic Circuits & Microprocessor **Course Code: SPH51115**

Course Aim: The aim of the course is to demonstrate semiconductor physics and its application in semiconductor devices, microprocessors and microcontrollers.

Course Content

Active Circuits (6L)

Transistor amplifiers; Basic design configuration; Class A power amplifier, Coupled Class A power amplifier, Coupled amplifier, Push-pull amplifier, Class B and Class C tuned power amplifier; High frequency effects, resonance amplifier, feedback and distortion in amplifiers.

Physical Mechanisms (6L)

Crystal structure of electronic materials (Elemental, III-IV and VI semiconductors), Energy Band consideration in solids in relation to semiconductors, Direct and Indirect bands in semiconductors, Electron/Hole concentration and Fermi energy in intrinsic/extrinsic semiconductor, continuity equation, Carrier mobility in semiconductors, Electron/Hole conductivity, Shallow impurities (Ionization energies), Deep impurity states, carrier trapping and recombination/generation in semiconductors, Shockley Read theory of recombination, switching in electronic devices.

Semiconductor Devices (6L)

Metal/Semiconductor Junction or (abrupt P-N Junction), Current-voltage characteristics, Estimation of Barrier height and carrier concentration from C-V characteristics, Surface/interface states in junction diode; Field Effect devices; C-V Characteristics of MIS diodes (Frequency dependence), Estimation of interface trapped charges by capacitance conductance method CCD, MESFET, MOSFET.

Introduction to Microprocessors (6L)

Basic instruction set and architecture of 8085 and 8086 microprocessor. Applications of 8085 and 8086 microprocessors.

Introduction to Microcontrollers (6L)

Working and Architecture of 8237 DMA controller and 8259. Basic architecture and instruction set of 8051 and AVR microcontroller with their applications.

Applications of Microprocessors & Microcontrollers in Medical Instrumentation (15L)

High speed digital design, Multi-layer PCB design, Mixed signal processing, Interfacing sensors – Blood pH, PO_2, PCO_2, Temperature, Optical, Displacement, blood flow. User interface - Message display unit, direct host control, Remote host control, LAN, GPIB interface, Interrupt handling, Analog interface, Add-on interface. Internet enabled Instruments, Portable instruments design. Typical applications: Spectrophotometer, Blood cell counter, Densitometer, aeromist.

Course Outcome

1. Students will be able to interpret the physical mechanisms behind semiconductor devices.
2. Students will be able to develop idea about active circuits.
3. Students will be able to demonstrate and categorize different types of semiconductor devices.
4. Students will be able to illustrate Microprocessors and Microcontrollers.
5. Students will be able to apply the knowledge in different medical instrumentation systems.

Teaching Methodology

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of electronic devices are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Charles E. Tobin, Basic Human Anatomy, Mc Graw Hill Publication.
2. J. H. Green An Introduction to Human Physiology.
3. H.B. Charles and B.N. Taylor; The Physiological Basis of Medical Practice. William and Wilkins, Baltimore, 1985.
4. C.A. Keele and Eric Neil; Samson Wright's Applied Physiology. ELBS, London, 1984.
5. S. West, E.R. Todd, W.S. Mason and H.J.T. Van Bruggen; Text Book of Biochemistry. Macmillan Co., 1976.
6. A.G. Guyton; Textbook of Medical Physiology; Saunders, Philadelphia, 1986.
7. Anatomy and Physiology in Health and Illness: Ross and Wilson (ELBS pub).
8. Human Physiology by A. Vander, J. Sherman and D. Luciano Mc Graw Hill.
9. Principles of Anatomy and Physiology: Tortora and Grabowski. (Haper Collin pub.).

Course Name: Medical Equipment Management **Course Code: SPH51117**

Course Aim: The course aims at building management skills required for medical equipment and patient safety management in hospitals.

Course Content

UNIT I: Introduction to management **(4L)**

Concept, process and significance of management; managerial roles; an overview of functional areas of management.

UNIT II: Planning **(4L)**

Concept, process and types; Decision making; Medical Equipment planning – understanding the need, selection and purchase.

UNIT III: Organizing **(10L)**

Concept, nature, process and significance. Authority and responsibility relationship in a hospital. Governance; Management structure; centralization and decentralization, departmentation: units of a hospital: Emergency services, Clinical laboratories, diagnostic imaging (Radiology, Nuclear Medicine, Ultrasound, MRI) Surgical Department, Physical Medicine and Rehabilitation, CATH lab, critical care unit, neonatal unit.

UNIT IV: Equipment control and asset management **(10L)**

Management and maintenance of medical equipments; consumables for medical eqipments; hospital information system for asset management; biomedical waste management.

UNIT V: Patient Safety and Risk management: **(4L)**

Hospital safety rules, Security and loss prevention, Fire safety, Bomb threat, Alarm systems, Disaster and Disaster preparedness plan, Safety codes for electrical and medical equipments, Medical standards for hospitals and equipments.

UNIT VI: Biomedical Ethics: **(2L)**

Patient autonomy, informed consent, Justice, Beneficence and Non-maleficence, patient data management, biomedical research ethics.

Course Outcome

1. The students will be able to develop the concept of management, planning and organizing
2. The students will be able to apply organizing concept in medical equipment and asset management of hospitals
3. The students will be able to explain patient safety and risk management in hospitals
4. The students will be able to asses biomedical ethics towards patient data management

5. The students will be able to adapt biomedical research ethics

Teaching Methodology

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life problems where ideas of handling and management of biomedical equipment are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. G.B. Kunder and Gopinath, "Hospital Planning, Design and Management", Tata McGraw Hill.
2. S. L. Goel and R.Kumar, "Principles of Hospital Administration and Planning", Deep and Deep Publications.
3. Tom L. Beauchamp, James F. Childress, "Principles of biomedical ethics", Oxford University Press.
4. John Webster and Albert Cook, "Clinical Engineering Principles and Practices", Prentice Hall.

Course Name: Physics for Medicine **Course Code: SPH51119**

Course Aim: This course aims at interpreting the physics behind different physical phenomena occurring within the living system and deduce the system characteristics from them.

Course Content

UNIT I: Cell and Tissue (10L)

Cell Organization Cell as the basic structural unit, Origin & organization of Prokaryotic and Eukaryotic cell, Cell size & shape, Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell), Internal architecture of cells, cell organelles, compartment & assemblies membrane system, Ribosome, Polysomes, Lysosomes & Peroxisomes, Connection between cell & its environment, Glycocalyx, Extracellular Matrix, Kinetics of cell growth, Structure and type of tissues in human body.

UNIT II: Tissue Optics (8L)

Light-matter interaction: absorption, scattering, reflection, refraction, luminescence, interference, polarization; their physical models and mechanisms. Specific features of living tissues from the point of optics. Relations of scattering and absorption in tissues -different interaction of lasers with tissues – Thickness and optical properties of appropriate skin layers - Skin pigments (melanin, bilirubin, carotene, hemoglobin) and their spectra - Composition of blood. Spectral properties of erythrocytes, thrombocytes and blood plasma - Differences between oxygenated and deoxygenated hemoglobin absorption spectra.

UNIT III: Dynamics of biomolecules (6L)

Diffusion, Laws of diffusion, Active transport, facilitated diffusion, Osmosis, Osmotic pressure, Osmoregulation, Viscosity and biological importance, Surface tension, Factors influencing surface tension, Biological importance.

UNIT IV: Thermodynamics of living systems (4L)

Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Coupled reactions.

UNIT V: Statics and kinematics of the body (6L)

Forces, moments, angular momentum, Rigid Body Mechanics, Musculoskeletal Anatomy, Basic Statics and Joint Mechanics (elbow, shoulder, spine, hip, knee, ankle), Basic Dynamics to Human Motion: Review of linear and angular kinematics; Kinetic equations of motion; Work & energy methods; Momentum methods; Examples in biomechanics; Modern kinematic measurement techniques; Applications of human motion analysis

UNIT VI: Electrical properties of excitable membranes: (6L)

Basic electricity and electric circuits; Neurons as conductors of electricity; Equivalent circuit representation; Electrical properties of excitable membranes: Membrane conductance, linear and nonlinear membrane, ionic conductance, current-voltage relations; Ion movement in excitable cells: Physical laws, Nernst-Planck Equation, active transport of ions, movement of ions across biological membranes; Membrane potential and role of sodium and potassium pumps.

Course Outcome

1. The students will be able to explain cell and tissue structure and organization
2. The students will be able to discuss the physics behind interaction of light and tissue structure
3. The students will be able to illustrate on the dynamics of biomolecules and the physical phenomena occurring within the living body
4. The students will be able to deduction the mechanics of human body movement
5. The students will be able to demonstrate the excitability of cells responsible for signal transduction within the body

Teaching Methodology

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various real life pathophysiological phenomena problems. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Herman, I.P. (2007), Physics of the Human Body, Springer. ISBN: 978-3540296034
2. Cameron, J. R., Skofronick, J. G. and Grant, R. M. (1999), Physics of the Body, Medical Physics Publishing, 2nd Ed., ISBN: 978-0944838914
3. Davidovits, P., (2008), Physics in Biology and Medicine, 3rd Edition, Elsevier/Academic Press, ISBN: 978-0123694119.

Course Name: Advanced Electronics Circuit Lab **Course Code: SPH51205**

Course Aim: This course aims at demonstrating designing of advanced analog and digital electronic circuits

Course Content

List of Experiments:

1. Study of Filters: (a) Active Filter (b) Passive Filter

2. Study of Amplitude and Frequency modulation and demodulation.

3. Studies on Characteristics of SCR (Silicon controlled Rectifier).

4. Studies on different types of characteristics of DIAC and TRIAC.

5. To design an astable/momstable multivibrator of given specifications using 555 Timer.

6. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.

7. To build JK Master-slave flip-flop using Flip-Flop ICs

8. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.

Course Outcome

1. Students will be able to develop the Concept of design and study of frequency response of Passive filters (a) High pass (b) Low pass (c) Notch filters. (d) Wide Band pass Filter.
2. Students will be able to design and study of frequency response of 1st order Active filters (use OPAMP as active element) (a) High pass (b) Low pass (c) Band pass (d) Band reject (e) Narrow band pass filters.
3. Students will be able to build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates and building of JK Master-slave flip-flop using Flip-Flop ICs
4. Students will be able to design a 4-bit Counter using D-type/JK Flip-Flop Ics, and design of a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop Ics.
5. Students will be able to build up the Concept of Study of Amplitude/Frequency modulation and demodulation.

Teaching Methodology:

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

Assessment Methods:

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

References:

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

Course Name: Microprocessor Lab **Course Code: SPH51207**

Course Aim: This course aims at utilizing microprocessor programming techniques for algebraic and logical operations on numbers.

Course Content

List of Experiments:

1. Addition of Two 16-bit data and store the result in Memory.

2. Subtraction of Two 16-bit data and store the result in Memory.

3. Multiplication of two 8 bit numbers and store the result in memory address

4. Division of two 8 bit numbers and store the result in memory address

5. Find the Largest number in given data array. Assume array size is-06

6. Find the Smallest number in given data array. Assume array size is-06

7. Perform addition and subtraction of 8 bit data using 8051 microcontroller

8. Perform 8 bit BCD addition/subtraction

9. Perform Decimal to Hexadecimal code conversion

Course Outcome

6. Students will be able to develop programming skills for storing data digitally through microprocessors.
7. Students will be able determine mathematical solutions of 8/16 bit numbers.
8. Students will be able to determine logical solutions of 8/16 bit numbers.
9. Students will be able to evaluate numbers using microcontrollers.
10. Students will be able to formulate data type conversions.

Teaching Methodology:

The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

Assessment Methods:

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

References:

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

Semester-II

Course Name: Nuclear Medicine Technology **Course Code: SPH51112**

Course Aim: This course aims at introducing the application of nuclear physics in diagnostic and therapeutic purposes.

Course Content

UNIT I: Introduction to Nuclear physics: (12L)

Elementary introduction to structure of matter- elements- compounds and mixtures molecules and atoms- Atomic & Nuclear structures- Atomic models – Periodic table- simple ideas of quantum mechanics - Mass energy equivalence – Fluorescence – Phosphorescence – luminescence - electromagnetic spectrum. Radioactivity - Discovery– Natural & Artificial Radioactivity- Isotopes and nuclides – binding forces between nuclear particles –alpha & beta particles – gamma radiation - mechanisms of radioactive decay – half life - Interaction of electrons, X-rays & ɤ-rays with matter - Radiation intensity & exposure - radiation dose - Radiation quality – law of exponential attenuation – half value layer – linear attenuation coefficient – Scattering – photoelectric effect – Compton-scattering – pair production – article interactions – total attenuation coefficient- relative clinical importance.

UNIT II: Components of nuclear medicine instrumentation (8L)

Radiation detectors, Spectrometer, Rectilinear scanner, Gamma camera, RF transmitter, principle of NMR imaging system; Nuclear spin and nuclear magnetic moment; vector description of magnetic resonance; NMR spectroscopy; basic NMR components; MRI components, spin echo technique.

UNIT III: Nuclear medicine techniques (12L)

In vitro diagnostic technique: Radio immunoassay, IRMA Immunoradiometric assay, ELISA. In vivo techniques: a) General Principles of non-imaging techniques, Tracer dose, uptake studies, compartmental analysis in radio nuclide studies, volume dilution studies. (b) General Principles of scintigraphy: Introduction, imaging modalities, documentation of images, analog/digital images, hard copy, formatter, intensity settings, image resolution and contrast, gray scale, color scale. (c) Clinical Nuclear Medicines - Diagnostic studies.

UNIT IV: Recent advances in Nuclear Medicine Techniques (10L)

Recent advances in imaging techniques & image processing including fusion techniques- image guiding for radiotherapy & stereotactic surgeries. Recent advances in equipments- SPECT, PET including hybrid systems. Recent advances in radiopharmaceuticals- FDG - Sodium fluoride for bone imaging –Neuro & cardiac radiopharmaceuticals.

Course Outcome

1. Students will be able to demonstrate nuclear physics and interaction with matter

2. Students will be able to analyze the application of nuclear physics in medical science
3. Students will be able to illustrate on the instruments related to nuclear physics required for diagnostic and therapeutic purposes
4. Students will be able to discuss on different nuclear medicine techniques used for clinical purpose
5. Students will be able to adapt the applications with undergoing research on development of the instruments

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of nuclear medicine are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Care of patient in diagnostic Radiography. Chesney & Chesney. Pub: Blackwell Scientific.
2. Krishnamurthy, Medical Radiographic Technique and Dark Room Practice
3. Rehani, Diagnostic Imaging and Quality Assurance
4. Rehani, Advance Medical Physics
5. Physics in Nuclear Medicine – Simon Cherry, James Sorenson & Michael Phelps.
6. Basic Medical Radiation physics: Stanton
7. Medical Radiation Physics – William R. Hendee.
8. Basics of Computers and Image hard copy production in Nuclear Medicine.
9. Computers in Nuclear Medicine –A practical Approach – Kai.H.Lee

Course Name: Medical Equipment Calibration and Maintenance **Course Code: SPH51114**

Course Aim: This course aims at elaborating categorically various medical instruments calibration and maintenance techniques.

Course Content

UNIT I: Fundamentals of Medical Instrumentation (12L)

Basic Sensors and Principles-including biopotential electrodes; Electronic Interfacing: including system noise figure, system bandwidth, pre-amplifiers, post amplifiers, A/D and D/A converters, aliasing, triggering and signal averaging; Computation: including data capture and signal processing; Systems: complete system response using specific examples (electromyogram, pressure sensors and blood pressure measurements, flow sensors and blood flow measurements, and chemical biosensors)

UNIT II: Operation, functional circuit details (6L)

Medical device regulation, Patient Safety, Repair, Service and Maintenance of a range of medical equipment, preventive maintenance and trouble shooting.

UNIT III: OT/Critical care Equipment & calibration (10L)

BP Apparatus, Suction Machine, Anaesthesia Machine, Short wave and Ultrasonic Diathermy, Ventilator, Humidifier, Nebulizer, Aspirator, Cardiac Defibrillator, Blood gas analyser, bed side monitor, etc.

UNIT IV: Clinical Lab Equipment & calibration (10L)

Colorimeter, Spectrophotometer, Semi-Auto Analyzer, Centrifuge and Oven, audiometer, spirometer, Imaging Systems: X-Ray and Ultrasound Machines etc.

UNIT V: Maintenance of pc based medical equipment (5L)

Introduction to - System configuration and BIOS, Indentification & Troubleshooting of PC components viz-Motherboard, HDD, FDD, CD ROM, Monitor, Printers, Modems, Ports etc. Installation and operation of - Windows Operating System, Antivirus Software, Internetworking.

Course Outcome

1. Students will be able to explain principles of biopotential acquisition, storage and analysis
2. Students will be able to discuss on preventive maintenance of medical instruments upto circuit level
3. Students will be able to calibrate medical equipment for uninterrupted functioning
4. Students will be able to evaluate conditions of critical care instruments and analytical instruments

5. Students will be able to compare PC based instruments and their difference with other instruments

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of bio-instrumentation are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Short Term Training Curriculum Handbook- Medical Equipment Technology Assistant. MEDICAL EQUIPMENT TECHNOLOGY ASSISTANT. Ministry of Health and Family Welfare 2017
2. WHO's Medical Equipment maintenance program.
3. http://apps.who.int/medicinedocs/documents/s21566en/s21566en.pdf.
4. Qualifications pack - occupational standards for allied healthcare, Medical Equipment Technology, Health sector skills council.

Course Name: Clinical Instruments & Systems **Course Code: SPH51116**

Course Aim: This course aims at demonstrating intricate details of medical instruments and clinical systems from the basics to the application level .

Course Content

Unit I: Introduction to Biomedical Instrumentation (2L)

The age of biomedical engineering, Development of biomedical instrumentation, Biometrics, Introduction to the main-instrument system, Components of the main instrument system, Physiological Systems of the body, Problems encountered in measuring a living system, Design for bio-medical problems, diagnosis of disease and therapeutic applications.

Unit II: Sources of Bioelectric potentials, Transducers and Electrodes (10L)

Resting and Action Potentials, Propagation of Action Potentials, Biochemical Transducers, the transducer and transduction principles, Active transducers, Passive transducers, Transducers for biomedical applications, The Bioelectric Potentials Electrode theory, Bio Potential Electrodes, Study of various types of electrodes used in ECG, EEG, ENG, EOG and EMG, Measurement of ECG, EEG, ENG, EOG and EMG signals along with their diagnostic applications.

Unit III: Clinical laboratory instrumentation (8L)

Emerging trends in medical diagnostics and therapy, Clinical laboratory instrumentation, Blood cell counter and associated hematology system, Endoscopic diagnosis and foreign body removal, medical image rendering, blood gas analyzers, Design of haemodialysis Machine, Design of Electro surgical Generator or Cautery.

Unit IV: Bio telemetry and Instrumentation (5L)

Introduction to biotelemetry, physiological parameters adaptable to biotelemetry, the components of biotelemetry system, implantable units, applications of telemetry in patient care.

Unit VI: X–ray and radioisotope instrumentation (10L)

Generation of Ionizing radiation, instrumentation for diagnostic X–rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy. Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention. Digital Subtraction angiography system, Instrumentation in Dental care & Hand piece control, Interfacing of brailler with PC, Design of traction machine.

Unit VI: Measurements in the Respiratory System (10L)

The physiology of the respiratory system, Tests and instrumentation for the mechanics of breathing, Gas exchange and distribution, Respiratory diagnosing equipment (Spirometer).

Course Outcome:

1. Students will be able to understand the basics of evoked potential, its application and measurement technique
2. Students will be able to demonstrate the circuit of EMG - its principle and application.
3. Students will be able to learn the basics of impedance techniques, its application and limitations
4. Students will be able to interpret the basics of bioelectric signal and electrodes, its different types, operation principle.
5. Students will be able to apply the principles of biomedical recording systems, its different types, principle of operation.
6. Students will be able to conceive the concepts of oxymeter, blood flow and cardiac output.
7. Students will be able to understand the basics of pacemaker, diagnostics systems, advanced diagnostic equipment

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of classical electrodynamics are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Khandpur R.S., Hand book of Biomedical Instrumentation, TMH, 2003.
2. Tompkins, Biomedical Digital Signal Processing.
3. Leslie Cromwell, Fred J. Weibell, Pub: Erich A. Pfeiffer. Biomedical Instrumentation and Measurements.

Course Name: Medical Application of Spectroscopy and Image Processing **Course Code: SPH51118**

Course Aim: This course aims at providing concepts of imaging techniques, medical imaging and digital image processing.

Course Content

UNIT I: Introduction (3L)

Review of atomic structure and atomic particles: electrons, protons, neutrons, positrons, neutrinos, etc.; Classification of elements as per the periodic table; Nuclear transitions and radioactive decay of nuclei; atomic energy levels; nuclear forces; nuclear energy levels; particle radiation; Electromagnetic radiation; Binding energy; General properties of alpha, beta and gamma rays.

UNIT II: Light-matter interaction (6L)

Optical spectroscopy in medicine & microscopy: Optical characteristics of biomolecules from the point of spectroscopy ; principles of UV ; Visible absorption ; IR and FTIR absorption; Raman and Fluorescence spectroscopy; phosphorescence; application with regard to characterization of biomolecules, blood oxygen, glucose measurements, monitoring drug concentration, cancer diagnosis; ESCA and Auger spectroscopy; optical, electron (TEM, SEM), Atomic force microscopy, optical profilometer and confocal laser scanning microscopy

UNIT III: X-ray matter interaction (8L)

Medical X-ray: Electron transitions and the generation of X-rays; Fine structure of X-ray; Photoelectric effect; Compton effect; Bremsstrahlung; Characteristics of x-ray beams; Interaction with matter; Attenuation and interaction of x-rays in the human body; Films and fluoroscopic screens; Generation and detection of X-rays (radiography techniques). Principle and Theory of computer tomography (CT) scanning, spiral CT scanning & radiation dose in CT scanner.

UNIT IV: Ultrasound matter interaction (5L)

Physics of ultrasound imaging; Uses in diagnosis: Wave fundamentals, generation of ultrasound, Interaction of Ultrasound with tissue; Image quality description & patient risk, Tissue harmonic imaging; biological effect of ultrasound;

UNIT V: Infra-red imaging (3L)

Thermal imaging system: physics of thermography; Infrared detectors; thermal camera-based on IR array detector;

UNIT VI: Digital Image fundamentals (5L)

Visual perception; sensing and acquisition of image; sampling and quantization; basic relationships between pixels and neighbourhood, adjacency, connectivity, distance measures.

UNIT VII: Image enhancement and filtering (6L)

Gray level transformations; histogram equalization and specifications; pixel-domain smoothing filters: linear and order-statistics; pixel-domain sharpening filters: first and second derivative; two-dimensional DFT and its inverse; frequency domain filters: low-pass and high-pass.

UNIT VIII: Image enhancement and filtering (4L)

Detection of discontinuities, edge linking and boundary detection, thresholding global and adaptive, region-based segmentation.

UNIT IX: Color Image processing (4L)

Color models: RGB, YUV, HSI; Color transformations, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation.

Course Outcome

1. Students will be able to explain light matter interaction and spectroscopy
2. Students will be able to discuss on different medical imaging techniques
3. Students will be able to illustrate digital image and its properties
4. Students will be able to improve digital image quality through processing techniques
5. Students will be able to predict clinical information through digital image processing

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of spectroscopy and image processing are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Richard P. Feynman, Robert B. Leighton, Matthew Sands: Feynman lectures on physics, Vol 2 & 3 Narosa Pub., 1986.
2. Albert Macovski: Medical imaging systems, Prentice-Hall, Englewood Cliffs, 1983.
3. W.R.Hendee&E.R. Ritenour, Medical Imaging Physics,3rdedition, Mosbey year Book,Inc.,1992.
4. R.C.Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education, 2018.
5. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 1989.

Course Name: Radiation Safety Techniques **Course Code: SPH51120**

Course Aim: This course aims at explaining the importance of safety rules for using radiation devices and demonstrating the techniques and devices used for radiation safety in diagnostic and therapeutic practices.

Course Content

UNIT I: Introduction (8L)

External radiation protection: Time, distance, shielding, external exposure personnel monitoring, posting and labelling of radioactive materials; Internal radiation protection: guidelines, limits, monitoring.

UNIT II: X-ray rooms (6L)

Design, material, protection barrier, room size, proportions of barium plaster mix.

UNIT III: Radiation protection devices (8L)

Lead rubber aprons, lead rubber gloves, thyroid shields, gonad shields; beam restriction devices for improved imaging; role of grids in scattered radiation.

UNIT IV: Radiographic technique (8L)

Patient positioning, selection of voltage and current, exposure manipulation, quality control.

UNIT V: General procedures (10L)

Approval of Staff as Radiation Personnel, Permit for Work in Radiation Laboratories, Procedures for Ordering Radioactive Materials and Radiation Emitting Devices, Using Sources of Radioactive Radiation, Radiation Safety Regulations in the Event of Mishap, Regulations for Handling and Disposal of Radioactive Waste.

Course Outcome

1. Students will be able to illustrate the guidelines of high energy radiation
2. Students will be able to design consideration of X-ray imaging rooms
3. Students will be able to asses radiation protection devices
4. Students will be able to measure radiation exposure to patient and technician
5. Students will be able to interpret rules and regulations related to radiation technique

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of radiation in medicine and it's safety measures are required. Regular class tests are taken to impart the ideas of the

subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Leonie Munro, Editor: Herald Ostensen, Gudrun Ingolfsdottir. Basics of Radiation protection for everyday use How to achieve ALARA: Working tips and Guidelines. World Health Organization. 2004
2. Krishan, Step by Step Management of Chemo and Radiotherapy
3. CEMBER, H., Introduction to Health Physics, 3rd Edition, McGraw-Hill, New York (2000).
4. INTERNATIONAL ATOMIC ENERGY AGENCY, The Safe Use of Radiation Sources, Training Course Series No. 6, IAEA, Vienna 1996

Course Name: Sensor and Medical Instrument Circuit Lab **Course Code: SPH51208**

Course Aim: This course aims at experimental verification and calibration of different types of sensors and transducers used in medical application.

Course Content

List of Experiments:

1. Calibration of ECG Unit

2. Calibration of EEG Unit

3. Calibration of Pulse Oxymeter unit

4. Calibration of Audiometer unit

5. Photosensor characterization

6. Piezoelectric sensor characterization

7. Thermal Sensor calibration

8. Radiation sensor calibration

Course Outcome

1. Students shall be able to calibrate of ECG machine.
2. Students shall be able to calibrate of EEG machine.
3. Students shall be able to experiment with Pulse-Oximeter machine and audiometer machines.
4. Students shall be able to design and study the characteristics of high-pass and low-pass filters.

Teaching Methodology:
The course will consist of practical classes of three hours duration, in which the students perform the experiments by their own hand and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

Assessment Methods:
The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

References:
The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

Course Name: Numerical Methods and Programming Lab **Course Code: SPH51210**

Course Aim: This course aims at developing programming techniques for mathematical modelling and simulation of biological systems.

Course Content

UNIT I: Numerical Analysis

Approximations and round off errors, Truncation errors and Taylor Series, Determination of roots of polynomials and transcendental equations by Newton- Raphson, Secant and Bairstow's method. Solutions of linear simultaneous linear algebraic equations by Gauss Elimination and Gauss- Siedel iteration methods. Curve fitting- linear and nonlinear regression analysis. Backward, Forward and Central difference relations and their uses in Numerical differentiation and integration, Application of different relations in the solution of partial differential equations. Numerical solution of ordinary differential equations by Euler, Modified Euler, Runge-Kutta and Predictor-Corrector method.

UNIT II: Computer Programming

Introduction to computer programming in C and C++ languages. Arithmetic expressions, Simple programs. The emphasis should be more on programming techniques rather than the language itself. The C programming language is being chosen mainly because of the availability of the compilers, books and other reference materials. Example of some simple C program. Dissection of the program line by line. Concepts of variables, program statements and function calls from the library (printf for example) C data types, int, char, float etc. C expressions, arithmetic operations, relational and logic operations. One dimensional arrays and example of iterative programs using arrays, 2-d arrays. Use in matrix computations. Concept of Sub-programming, functions. Example of functions. Argument passing mainly for the simple variables. Pointers, relationship between arrays and pointers. Argument passing using pointers. Array of pointers, Passing arrays as arguments. Strings and C string library. Structure and unions. Defining C structures, passing structures as arguments.

UNIT III: Modelling Biosystems

Fundamentals of applying mathematical modeling techniques to physiological systems in order to develop models that may be used to simulate their behaviour. Different types of models and their relation with numerical methods that may be used for their solution.

Linear and non-linear biological systems and equations responsible for building the model of such systems. Finite difference methods – ordinary and partial differential equation application in biological system modelling.

UNIT IV: Modeling tools and application

Familiarization with programming in MATLAB for building models, Labview for signal processing, and COMSOL for multiphysics coupling applications. A project on practical

applications.

Course Outcome

1. Introduction to numerical methods for solving equations
2. Fundamentals of programming language for solving equations
3. Develop mathematical models of physiological systems with numerical methods
4. Apply numerical models on biosystems
5. Familiarize with modern programming tools

Teaching Methodology:

The course will consist of practical classes of three hours duration, in which the students perform numerical solutions and simulations by their own and gain the idea of verification and accuracy of the predicted theoretical learning in their classroom lectures.

Assessment Methods:

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

References:
The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

List of Books:

1. Shastry, S.S., "Numerical Methods", Prentice Hall Inc., India, 1998.
2. Noble Ben, "Numerical Methods", New York International Publications, New York, 1964.
3. Grewal, B.S., "Numerical Methods", Khanna Pub., New Delhi, 1998.
4. Kernighan, B. W. and D .M. Ritchie, "The C Programming Language", Prentice Hall of India, 1998.
5. Yashavant P. Kanetkar. Let Us C Fifth Edition, BPB Publications
6. J.T. Ottesen, M.S. Olufsen, and J.K. Larsen. Applied Mathematical Models in Human Physiology
7. Gilat, A., MatLab: An Introduction with Applications, 5th ed, Wiley&Sons 2014.
8. Van Wijk van Brievingh, R.P., Moeller, D.P.F.: Biomedical Modeling and Simulation on a PC, New York, Springer Verlag, 1993.

Semester-III

Course Name: Nano - Biotechnology **Course Code: SPH51213**

Course Aim: This course aims at imparting knowledge about nano-science and nono-technology with their application in medical science.

Course Content

UNIT I: Introduction
(14L)

Fundamental concepts of nanoscience and nanotechnology, Size effect of Nanomaterials: Size, shape, density, melting point, wet ability and specific surface area. Diffusion properties: Diffusion laws and mechanism - Applications of diffusion. Mechanical behavior: Stress – strain behaviour, tensile strength, microhardness, wear resistance, and corrosion resistance behaviour. Thermal properties: Thermal conductivity, thermal expansion and thermal expansion coefficient. Electrical properties: Electrical conductivity, band gap tuning - band gap determination, Hall effect and its applications. Dielectric properties: Dielectric constant and its significance – Piezo electric and ferro electric materials and their behaviour and applications. Magnetic properties: Magnetic hysteresis – Superparamagnetism – Optical properties: Photoconductivity, Electroluminescence, Photoluminescence, Jablonski diagram, fluorescence and phosphorescence, Optical properties of nanostructures.

UNIT II: Synthesis of nanomaterials and device fabrication (8L)

Synthesis of nanomaterials by physical, chemical and biological methods, Characterization of nanomaterials, Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires, etc.

UNIT III: Nanobiosensors (10L)

Principles of molecular recognition of nanobiosensors, Types of nanobiosensors: potentiometric, amperometric, enantioselective, stochastic, multimode; general aspects, Mechanism of producing of the electrochemical signal for each class of nanobiosensors, Design of nanobiosensors, Response characteristics of different types of nanobiosensors, Applications of nanobiosensors, Features of nanobiosensors. Lab-on-a-chip concept.

UNIT IV: Nanotechnology application in healthcare (10L)

Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing, Nanotechnology in point-of-care diagnostics, Nanopharmacology & drug targeting.

Course Outcome

1. Students will be able to illustrate nanoscience and nanotechnology
2. Students will be able to compare physical phenomenon due to nano scaling of devices

3. Students will be able to use synthesis techniques of nano scale materials and devices
4. Students will be able to apply nano device knowledge in biosensors
5. Students will be able to utilize nano biosensors in improvement of healthcare technology

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various healthcare problems where ideas of nanotechnology are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.
4. Biosensors and Nanobiosensors: Design and Applications. Ahmed Touham

Course Name: Tissue Engineering and Artificial organ **Course Code: SPH52155**

Course Aim: This course aims at introducing biomaterials, their properties and characterization techniques for the application of cell culture, tissue engineering and organ replacement.

Course Content

UNIT I: Introduction to biomaterials and tissue engineering (2L)

Definition, evolution, synthetic and natural materials in clinical applications, strength of materials, interface of surfaces, scope and challenges of tissue engineering, biocompatibility, cell growth and differentiation, in vitro tissue control, in vivo synthesis of tissues and organs.

UNIT II: Classes of biomaterials and their properties (8L)

Metal, polymer, ceramics, hydrogels, composites, degradable and resorbable materials, nanomaterials, bulk properties, surface properties, structure property relationship of biological materials, biocompatibility.

UNIT III: Characterization of biomaterials (4L)

Mechanical properties, thermal properties, electrical, optical, X-ray absorption, acoustic, and ultrasonic characterization.

UNIT IV: Host reactions to biomaterials (2L)

Biological responses to biomaterials, inflammation, immune response, toxicity, infection, blood coagulation.

UNIT V: Cell culture and tissue engineering (8L)

Cell and tissue mechanics, cell adhesion, cell migration, Introduction to cell culture, cell line, stem cell, Culture conditions, basic equipments, contamination.

UNIT VI: Tissue engineering case studies (8L)

Tissue engineered skin, cartilage, bone, neural rehabilitation, ophthalmic application, dental application, tissue engineered artificial organ.

UNIT VIII: Organ Replacement 10L)

Organ system, eye and its replacement, Artificial Lungs, Artificial heart, Artificial blood, Artificial liver, Artificial pancreas, Artificial skin.

Course Outcome

1. Students will be able to demonstrate about biomaterials and tissue engineering
2. Students will be able to classify and characterize biomaterials

3. Students will be able to explain host reaction to artificial materials
4. Students will be able to develop approach of artificial organ through cell culture and tissue engineering
5. Students will be able to discuss on organ replacement possibilities and techniques

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of biomaterials and tissue engineering are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. S, Biomaterials Science: An Introduction to Materials in Medicine, Third Edition. Elsevier Academic Press (2013).
2. Park J.B. & Lakes R.S., Biomaterials: An Introduction, Plenum Press, New York, 1992.
3. Robert Lanza, Robert Langer, Joseph Vacanti, Principles of Tissue Engineering, Third edition. Elsevier Academic Press (2007)
4. W. Mark Saltzman. Tissue Engineering Engineering Principles for the Design of Replacement Organs and Tissues, Oxford University Press. (2004)
5. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.

Course Name: Image processing lab **Course Code: SPH52251**

Course Aim: This course aims at developing programming knowledge for different image processing techniques that are required for medical diagnostic applications.

Course Content

List of Experiments:

1. Programs for image gray-level transform.
2. Program to show histogram equalization effect for an image.
3. Programs for image filtering in spatial domain
4. Programs for image filtering in frequency domain.
5. Program for image segmentation.
6. Programs for image edge detection.
7. Program for color image segmentation.

Course Outcome

1. Students will be able to develop programs for loading, storing and basic operations on digital image
2. Students will be able to develop programs on Image filtering in spatial and frequency domain
3. Students will be able to identify specific region of an image through segmentation and edge detection
4. Students will be able to develop programs for color image handling
5. Students will be able to develop programs apply image processing techniques for medical diagnostics from images.

Teaching Methodology:

The course will consist of practical classes of three hours duration, in which the students learn to write MATLAB codes and apply them on real images for post processing and gain the idea of experimental verification and accuracy of the predicted theoretical learning in their classroom lectures.

Assessment Methods:

The evaluation process is same as already been given in the previous courses. In the Internal Assessment component marks will be given as an average of the marks obtained at the Viva Voce Examinations after completion of each experiment. In case of distribution of marks of attendance the same rule is followed as given previously.

References:

The Manuals are given in Lab per experiment. Students are also encouraged to do research from different open access materials available in internet.

Paper Type: Elective I and II

Options: Bio-Sensors and MEMS / Robotics and Artificial Intelligence / Brain-Computer Interface

Course Name: Bio-Sensors and MEMS **Course Code: SPH52157**

Course Aim: This course aims at enlightening students about different types of biosensors and their applications in healthcare.

Course Content

UNIT I: Overview of biosensors and their electrochemistry (6L)

Molecular reorganization: Enzymes, Antibodies and DNA, Modification of bio recognition molecules for Selectivity and sensitivity, Fundamentals of surfaces and interfaces.

UNIT II: Biosensor devices (12L)

Components and working principle of biosensor, Types of Biosensors – Electrochemical, amperometric, potentiometric, impedimetric, voltametric, piezoelectric, thermometric, optical, and FET based biosensors.

UNIT III: MEMS Technology (12L)

Introduction to Microelectronics and Nanotechnology, Crystal structure and properties of silicon, crystal growth and epitaxy, thermal oxidation, impurity doping, MEMS & NEMS, MEMS design, and fabrication technology – Lithography, Etching, MEMS material, Bulk micromachining, Surface micromachining, Microactuator, electrostatic actuation, Micro-fluidics.

UNIT IV: MEMS types and medical applications (10L)

Mechanical, Electromagnetic, Magnetic, and Optical MEMS. Application in Diagnostic, Surgical and drug delivery.

Course Outcome

1. Students will be able to explain interaction of biosensors and biomolecules
2. Students will be able to classify biosensor devices
3. Students will be able to describe different MEMS techniques
4. Students will be able to apply MEMS technology in biosensor fabrication
5. Students will be able to implement of biosensors for diagnostic and therapeutic purpose

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various healthcare related problems where ideas of MEMS and microsystems are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Turner, A.P.F., Karube,I., and Wilson G.S., Biosensors - Fundamentals and Applications, Oxford University Press (2008).
2. S. M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, John Wiley and Sons, (2007)
3. Gardner, J.W., Microsensors, Principles and Applications, John Wiley and Sons (1994)
4. Victor C. Yang, Biosensors and Their applications, Springer (2000)

Course Name: Robotics and Artificial Intelligence **Course Code: SPH52159**

Course Aim: This course aims at introducing robotics and artificial intelligence to the students for application towards medical diagnosis and therapy.
Course Content

UNIT I: Introduction (8L)

Brief history, types, classification and usage, Science and technology of robots, Elements of robots -- joints, links, actuators, and sensors, Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision.

UNIT II: Kinematics and dynamics (8L)

Transformation matrices and their arithmetic, link and joint description, Denavit-Hartenberg parameters, frame assignment to links, direct kinematics. Dynamics: Introduction to Dynamics, Trajectory generations, Manipulator Mechanism Design, Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer

UNIT III: Velocity and statics of robot manipulators (4L)

Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom,

UNIT IV: Motion planning and control (4L)

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators.

UNIT V: Artificial Intelligence (10L)

Logic & Theorem Proving - Review prepositional & predicate Calculus, Resolution; Production Rules - Procedural versus declarative knowledge, Forward versus backward reasoning, Matching, Control Knowledge; Statistical Reasoning - Classical logic versus nonmonotonic logic, Default logic, Circumscription, Fuzzy Logic, Typicality, Levels of confidence, Baye's Theorem, Dempster-Shafer theory of evidence.

UNIT VI: Application of robotics and AI in medical technology (6L)

Surgery, Dentistry, Rehabilitation, Prevention, Neural signal processing, virtual reality, speech recognition.

Course Outcome

1. Students will be able to illustrate the component for development of robots
2. Students will be able to describe the mechanics related to movement of robots
3. Students will be able to analyze functionalization of robot through defined control
4. Students will be able to design robots through artificial intelligence
5. Students will be able to apply artificial intelligence and robotics in medical technology

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of robotics and AI are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Ghosal,A. Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
2. Fu,K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence, McGraw - Hill, 1987.
3. Amit Konar, Artificial Intelligence and Soft Computing, CRC Press, 2000
4. Deepak Khemani.A First Course in Artificial Intelligence, McGraw Hill Education (India), 2013.
5. Patrick H. Winston, Artificial Intelligence, 3rd Edition, Pearson
6. Alessandri, Elena & Gasparetto, Alessandro & Valencia-García, Rafael & Martínez-Béjar, Rodrigo. (2005). An application of artificial intelligence to medical robotics. Journal of Intelligent and Robotic Systems. 41. 225-243. 10.1007/s10846-005-3509-x.

Course Name: Brain-Computer Interface **Course Code: SPH52169**

Course Aim: This course aims at demonstrating different signal processing techniques and types of brain computer interface used for clinical applications and research purposes.

Course Content

UNIT I: Basic Neuroscience
Structure of neurons, synapses, generation of action potential, nerve conduction, Central nervous system, peripheral nervous systems, organization of brain in controlling activities of human.

UNIT II: Recording and Stimulating the Brain
Types of electrodes for recording and stimulation, characteristic differences in recording and stimulation, types of neural stimulation, recording devices specifications.

UNIT III: Signal Processing
Feature Extraction Methods Time/Space Methods – Fourier Transform, Wavelets, AR, MA, ARMA models, Bandpass filtering, Template matching, Kalman filter, PCA, Laplacian filter – Linear and Non-Linear Features; Feature Translation Methods Linear Discriminant Analysis – Nearest neighbours, Support Vector Machines - Regression – Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks

UNIT IV: Major Types of BCIs
Invasive BCIs, Semi-Invasive BCIs, Non-Invasive BCIs, Stimulating and Bidirectional BCIs. Application in medical technology.

UNIT V: BCI Clinical Applications and Ethics
Potential BCI users: totally disabled, partially disabled, disabled with sustained neuromuscular control; ethical issues with patients for recording data, acceptance of patients for uses of BCI.

Course Outcome

1. Students will be able to illustrate basic neuroscience.
2. Students will be able to compare electrical stimulation and recordings in brain
3. Students will be able to infer neural data through signal processing
4. Students will be able to compare different types of BCI systems
5. Students will be able to perceive ethics to be followed in medical application of BCI.

Teaching Methodology:

The course will consist of lectures and tutorial classes. Special emphasis has been given on assignments. Majority of the classes will focus on the development of fundamental concepts which can be addressed further to solve various problems where ideas of neural signal processing

are required. Regular class tests are taken to impart the ideas of the subject and related domain further and special classes are conducted for student presentations and student-teacher interaction.

Assessment Methods:

The evaluation process is same as already been given in the previous course. In the Internal Assessment component Class Tests/ Presentations/ and assignments will be there. In case of distribution of marks of attendance, the same rule is followed as already given.

List of Books:

1. Jonathan Wolpaw,Elizabeth Winter Wolpaw,'Brain Computer Interfaces: Principles and practice", Edition 1, Oxford University Press, USA, January 2012
2. Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006.
3. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
4. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
5. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals" JOURNAL OF NEURAL ENGINEERING, VOL.4, 2007, PP.32-57
6. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.

Course: Dissertation I (SPH52601)

This course introduce the students towards the frontier research domains of the subject. The topic may vary from theoretical to experimental fields depending on the choice of the concerned students.

Semester-IV

Course: Internship (SPH52604)

The University will provide the opportunity to have industry exposure and BARC certified "Radiation safety" courses under different specialized hospital which can illuminate young minds towards the direct field of application and ignite their interests to explore this subject further.

- ✓ Summer Internship in reputed health sectors / Bio-Medical Industries/ Research Institutes that will give direct exposure to the healthcare industry, providing the students with technical knowledge, real life challenges and problem solving abilities, responsibility towards the society.
- ✓ Hands-on training of medical devices for the students to acquire in depth knowledge about the working of the instruments.
- ✓ Special training on "Radiation Safety" necessary for medical physicist jobs in government and private hospitals and diagnostic centres.
- ✓ Training beyond regular classroom teaching for GATE/UPSC/PSC examinations for students preparing for government jobs.
- ✓ Extensive project work and representation through dissertation and thesis writing to develop independent thinking, data analysis, drawing inferences and representation of results through paper writing.

Course: Dissertation II (SPH52704)

Successful completion of the course will provide a deeper insight about the fundamentals as well as advanced research activities around the world. Students shall learn about presentation and documentation of research data.

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